cartographic perspectives

journal of the
North American Cartographic Information Society

Number 48, Spring 2004

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in this issue

Letter from the President

A hearty welcome to yet another cool issue of *Cartographic Perspectives!* Editor Scott Freundschuh, Assistant Editor Jim Anderson and the Editorial Board have done a spectacular job in getting the journal back on schedule. The NACIS Board of Directors has asked Scott to continue to edit *CP* for the next two years: the Board, membership and I look forward to many more great issues of *Cartographic Perspectives.*

As President of NACIS my focus has been on a few key projects: the formation of subcommittees on the NACIS Board, a template for planning NACIS conferences, and enhancements to *Cartographic Perspectives*. Subcommittees are intended to focus the work of NACIS board members. We now have subcommittees devoted to promotion of NACIS, the NACIS WWW pages (which will undergo a major revision soon), Publications (primarily

(*continued on page 3*)

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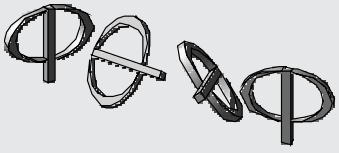
about the cover



The cover image was created by Matt Knutzen, artist, cartographer and Assistant Chief Librarian of the Map Division of the New York Public Library.

CP), Conference planning, Practical Cartography Day (part of the Annual NACIS conference), and Nominations. Please contact me if you are interested in serving on the NACIS Board, particularly if you have abilities and expertise in any of the Board Subcommittee foci.

After handling local arrangements for the NACIS meeting in Columbus and the Program for the meeting in Jacksonville I decided that NACIS needed a detailed conference-planning document. This document assists NACIS members who want to host a NACIS meeting in their city (let me know if you are interested in hosting a NACIS conference), and helps plan the conference once a location is chosen. The document also assists the NACIS Vice President in planning the Conference Program. A tremendous amount of planning and work goes into each annual NACIS conference, and make sure you congratulate Trudy Suchan (NACIS VP and Conference Program Organizer) and Mike Hermann (Local Arrangements) at the next NACIS meeting in Portland Maine.

Finally, as you delve into this issue of *Cartographic Perspectives*, keep in mind that Scott is always open to new ideas and means of including the research, products, and techniques of the diverse NACIS membership in the journal. *CP* is a reflection and representation of NACIS as an organization, and it is important that all NACIS members feel they can contribute. For example, Scott and the NACIS board are discussing the inclusion of annotated maps as well as maps from the annual Great NACIS Map-Off: watch for some of these new developments in CP49. As *Cartographic Perspectives* nears its 50th issue, it is thriving and continues to evolve and reflect the diversity of NACIS.

Have a great summer, and see you in Portland, Maine in October 2004!

JohnKrygier
President

Opinion Column

TO: Denis Wood
FROM: Tom Koch
CC: Scott Freundschuh, Editor, *Cartographic Perspectives (CP)*
RE: Your Essay "Cartography is Dead (Thank God!)" (CP45, 4-7)

Dear Denis:

I really liked your opinion piece in the recent *Cartographic Perspectives* (2003, V45). I just can't figure out why Scott would choose to run it. I mean, dude, it's going to create a passel of problems.

Shorn of its rhetoric, your argument is pretty simple, and pretty much irrefutable. Cartography has everything to say about a profession that makes maps, a discipline whose brief has been the mechanical design, crafting, and critique of this type of two-dimensional graphic argument. It says little about the maps themselves, or the content they contain, and in the age of computerized mapping, well, the discipline-as-it-was is dead.

The etiology you offer is interesting but irrelevant. It doesn't matter that the word is a nineteenth century artifact "coined" as a Portuguese neologism ("cartographia") by the Viscount de Santarem in 1839. Nobody cares that "cartography" entered the *Oxford English Dictionary* in 1859 or "cartographic" in 1863. All that is simply a rhetorical device that says the word is too new to be sacred, too Victorian for us to care about. Lots of good, useful words entered the English language in the nineteenth century, and their relative modernity is no reason to disparage their use.

Nor does it matter in itself that the cartographic product academic cartographers love to discuss in journals like *Cartographica*, say, are mostly professional artifacts done mostly by working stiffs at the direction of PhD bosses at the behest of this or that employer. That's all true, but like, so what? And I mean, Denis, you were one of those academics for more than 20 years, a fellow who made his way in journals like *Cartographica* by commenting on the atlases, maps, and cartographic arguments of others.

The real problem at hand is, if *Cartography is Dead (Thank God!)*, what do you think they should call this rag, and this society? To continue to call the journal of the North American Cartographic Information Society (a geographically limiting, clumsy name) *Cartographic Perspectives* carries a whiff of necrophilia, of holding the decomposing corpse of a dead discipline to our collective bosoms. Yuck.

To think of a new name means carefully considering what to keep of the corpus, and what can safely be buried. In its short history, cartography has been about a set of tools no longer in use, or now used so frequently and so casually they require no special home. The techniques of drafting and inking and lettering that George McCleary once tried to teach me in his Introduction to Cartography at Clark University (1971) are gone, dead, already buried. They've been replaced by the digital equivalents embedded in *PhotoShop, Corel Paint, ArcView, ArcGIS, Maptitude*, and a score of other programs.

What was once a craft has been democratized out of existence in precisely the way of other *nineteenth century* crafts like typesetting and

manual layout. The hard work of crafting projections, of figuring out the algorithms of a Thiessen Polygon as an analytic tool, of calculating a spatial mean: all are booked into the mapping programs we have available at an unreasonable but affordable price.

The old cartography is work done, not work to do. The mechanics of projections (see, Kaiser and Wood, 2001, *Seeing Through Maps*. Amherst, MA: ODT, Inc.), the basics of production and reproduction are known. The result is embedded in the electronic mapping programs available to most students. The work that remains, the work UNdone, is as much theoretical as it is computational. The real work, however (as it has always been) is what mapping is about, and how it can help in the address of specific problems.

Cartography was never about, knowing. It was about a type of presenting. It was never about the subject. It has always been, to borrow from Mark Denil's (2003) piece "Cartographic Design: Rhetoric and Persuasion" (CP45: 8-61), about the signal rather than the content a map attempted to distill. Mapmaking as a craft, a profession, and a pseudo-science has never been about mapping; a manner of thinking that is relational and ecological from the start. Cartographers and cartographic commentators have wanted us to believe otherwise. *That's* why we need to drop the word, that's where the deadwood lives.

Cartography is about Arthur Robinson's *Early History of Thematic Maps* (1972); as if all maps did not have a theme, were *not* products of authorial intent. It's the stink of scientism and the arrogant assumption that mapmakers need not know anything about the subject they are hired to map, or any map they choose to discuss. Whether it is GIS or another mode of making, there is no science inherent in mapping, whatever the Big Names would have us believe.

Denil (2003) puts it nicely: cartography and cartographers "would seem to mistake the signaling for the communicating" (p. 25). Now that's a thought. The *American Heritage Dictionary* says to communicate is "to make common," or "to make known" (from the Latin *communicâre*). It insists the focus be upon a subject to be communicated, a perspective to be announced. Cartography has typically been ignorant of the subject of the maps it presents, a "science" that pretends specific topical expertise it lacks.

The question isn't Mark Monmonier's *How to Lie with Maps* (1991), or charts, or statistics. That assumes one knows the difference between truth and lie in a subject in which one has expertise enough to judge. The question is—or should be—how to *think* with maps, and where that thinking, as opposed to any other, may lead us. This is precisely what the major cartographers have not had, real knowledge about the mapped subjects they critique. Ed Tufte (1972) knew nothing about cholera when he attempted to discuss John Snow's 1854 Broad Street Map in his seminal *Visual Elements of Design*. Neither did Monmonier (1991) when he commented on the same map in *How to Lie with Maps*, and more recently, in his 1997 *Cartographies of Danger*. As a result, they made serious errors about what Snow had to say and how he tried to say it.

Mapping thinking is not about the map, but about the way we put together the things that are important to the subject at hand. Maps are attempts to take that something and distill an argument about it onto a graphic page. The Cartographic "scientists"—the professionals—tend to drop the ball whey they apply a cartographic critique in ignorance of the subjects the maps distill. You can't communicate if you don't know what you're talking about. If GIS is a science, as Nadine Schumann would have us believe, it is a science of ignorance, a continuation of the same old

thing. This is necessarily true because GIS is just another way of mapping the relation between things, albeit one sufficiently democratic that even I, who am sight impaired, can partake.

If we go with your premise Denis, and kill the word cartography, excising it from our language, lets kill the idea that mapping is about the signal rather than the content, the data and not the information derived from its consideration. Let's do away not simply with the word, but with the false scientism that gave us first cartography-as-a-science and more recently GIS-as-a-science.

This journal, this society, therefore, needs a name change, doncha think? The magazine isn't about *Cartographic Perspectives*. It's better than that, or it can be. It's certainly not about "information", that strange distillation of specific sets of data in a manner that presents us a firm aggregation of facts in a comprehensible fashion. Information is the punch-line of the story, not the narrative of its solution. So . . . what to call this non-cartographic, non-information subject the magazine seeks to present?

I thought about *Map Thinking*, but rejected it as too static. Then I thought of *Mapped Perspectives*, journal of the *North American Mapping Society*. It's descriptive and unpretentious—both good things, I think. But the society's name is cumbersome, and the "North American" limited and imperial. Why not just call it the *Society of Maps and Mapping*, hey? After all, how maps are made is less important than the way we try to distill relations on a page. And whether we live in Saskatoon or in East Anglia shouldn't matter a wit.

Then I had a brilliancy, a mind stroke, as we say here in British Columbia. Call the society what you will, the name of the journal is clear. They should just call this rag *The Power of Maps*. I'm sure your publishers (Guilford, 1992) won't mind that.

About the Author
Tom Koch (http://kochworks.com) is the author of 13 books, many of which use maps. Tom is a geographer, gerontologist, and medical ethicist with appointments at the University of British Columbia and Simon Fraser University. His book *Cartographies of Disease and Health* is scheduled for publication by ESRI Press in 2006.

The Study of Maps Made by First Nations Peoples: Retrospect and Prospect

G. Malcolm Lewis
University of Sheffield, England

In the mid 1970s, I stumbled on the then almost forgotten fact that First Nations North Americans had long made what Euro Americans intuitively categorized as maps. Those that I was able to examine here in England fascinated me. Few others seemed to share my enthusiasm, though Herman Frills of the National Archives urged me to develop it: "Malcolm, nobody in the United States is taking serious interest in Indian maps" (ca. 1975). During the 1980s and 1990s there was to be a gradual increase in interest, mainly among a few historians of cartography with backgrounds in academic geography. Pervasive these in our writings included the ways in which First Nations' maps differed from Euro Americans', their roles in contact contexts, and their incorporation in Euro American cartography. Together, we discovered many lost or long forgotten maps though we were slow to recognize different survival states. Our collecting nets were widened by the less restrictive than hitherto definition of "map" announced by Brian Harley and David Woodward in *The History of Cartography, Vol. 1* (1987). When compared with the previous—pre World War I—cycle of interest, we certainly raised the rigor of research and presentation. We benefited from improved reprographics, as did our publications. Some of us found funds to finance work on originals.

As a group we shared a number of weaknesses. We were middle aged, white, academics, products of the post World War II years and influenced by teachers whose ideas and assumptions were formed in the 1930s. Although we did not know it, Eurocentrism permeated our thinking. We treated First Nations' maps as inferior versions of our own: usually looking for similarities and often ignoring differences. Rarely did we try to place them in the indigenous context in which they were made. Some of us assumed that the maps would eventually be placeable in a universal development sequence. Charles Darwin had influenced us more than either Karl Marx or the then new wave of French philosophers, but the word "evolution" was not, I think, used by any of us.

Perhaps because our academic roots were in disciplines not being swept by the ferment of ideas then transforming other parts of academia, our work had many shortcomings. We did not try to understand the cultural perspectives of spatial perceptions of the First Nations mapmakers. Less forgivable, we did not seek the advice of First Nations individuals who might have helped us to do so. We were slow to recognize fundamental problems that others were facing up to [e.g., Calvin Martin's (1987) The American Indian and the Problem of History]. Our understanding of cultural anthropology was limited. We had received little or no training in the close reading of texts. The only geometries we were aware of were Euclidean and Projective. That there were other, more appropriate geometries was beyond our awareness. We failed to anticipate the analytical potential of GIS. Least forgivable, we ignored the writings of a few reflective and

socially aware "insiders" that could and should have widened our horizons. I think especially of Brian Harley (particularly 1988-1992), Robert Rundstrom (1990 onwards) and Denis Wood (1992 onwards).

Notwithstanding all these shortcomings and missed opportunities, by the end of the millennium we had created a platform from which others might begin a new cycle in the study of First Nations' maps. Hopefully, the new beginning would follow in much less time than the sixty-year hiatus that had preceded our efforts. But had we done enough to stimulate a next generation? For the most part our writings had been directed at fellow historians of cartography and we seemed to have had little or no influence beyond them. There were, of course, exceptions. Because of where it was published, my first, most immature, and least considered paper is still the most frequently quoted of my contributions to the field. An embarrassment I am still learning to live with. Or should I rate it high among my successes?

There were, of course, "others" from non geography-cartography backgrounds: archeologists, cultural anthropologists, historians, lawyers, literary scholars, and etc. Mostly in the their mid careers, their contributions were, and remain, significant, but they were byproducts of dominant interests and likely to remain "one offs." Several of these were published as chapters in G. Malcolm Lewis (Ed.) (1998) *Cartographic encounters: Perspective on Native American Mapmaking and Map Use*. These, and similar contributions enriched the 1980s-1990s corpus of research but did not initiate a new cycle.

It is against this background of a possible hiatus that I welcome the research of Renee Louis, Margaret Pearce and Julie Rice-Rollins as reported in the papers published here. Though the first products of their respective research careers, together they could well mark the beginning of a new cycle. Like my generation of "insiders", their backgrounds are in academic geography and cartography. But there is much that is new and exciting. Unlike the previous cycle, there are Native inputs. All three developed their interest in the rigors of graduate school, rather than it emerging as a byproduct of earlier research. A glance at the bibliographies reveals their grasp of pertinent current ideas and issues.

Each author shows respect and understanding of the culture with whose maps she is concerned. The two studies involving living cultures derive much from direct experience. Having spent only one under-prepared day in the field with a Native North American (and benefiting enormously from the experience), I am impressed by Julie Rice-Rollins' systematic interviewing of Lakota Sioux elders. My generation was fairly adept at rediscovering long-forgotten maps in archives, libraries, and museums, but none, I think, equaled her success in becoming aware of hitherto unknown maps still in Native hands.

Margaret Pearce has opened up new archival sources. But she has done far more than that. Her recognition that some maps were primarily composed of words is important and should be further explored in a range of other contexts. She has also done something hitherto rare in the history-of-cartography field: designed her research to test conclusions (concerning encroachment techniques) arising from research by others on other kinds of maps (small-scale European printed promotional maps). This kind of testing must surely replace the one-off, freestanding investigations that have given substance, but regrettably little structure to the history-of-cartography field.

Renee Louis has expressed honestly, and perhaps for the first time in print, the inner conflicts faced by a Native cartographer in trying to come to terms with Western science and Indigenous traditions. In doing so, she

has drawn on a recent literature on Native Science, knowledge, and epistemology unknown to most cartographers. Her emphasis on the importance of toponyms, stemming from a traditional oral structuring of the world, compliments Margaret Pearce's conclusions on the primacy of words over graphics. In the substantive part of her paper she reviews the practical issues faced by three groups of Hawaiians in using mapping and GIS software in the course of funded research that seeks to preserve language, culture and the environment. Hitherto abstruse issues, often associated with the past, are becoming politically significant.

I applaud these papers, not only for their content, but also for what I hope they herald: a new cycle of research on Native North American maps and mapmaking in the present, as well as the past. I have no doubt that those involved will do better research than my generation in the cycle now ending. In addition, and even more importantly, they must succeed in a task we even failed to recognize: promote an awareness among the "non mappy" of the continent-wide existence, importance, and roles of the many kinds of Native maps. To take but on recent example, it is regrettable that in his much acclaimed and innovative history of early eastern North American presented from a Native perspective, *Facing East from Indian Country* (2001), Daniel K. Richter should apparently make no reference to them. Whether from oversight, ignorance, or failure to appreciate their significance, only he can say, but my generation must take the blame. Most of what we published was directed at an already-aware readership. Almost none of it was promotional.

I welcome this evidence of a new cycle. Like me, most of my surviving co-workers of the past quarter century are running out of energy, finding it increasingly difficult to grasp new ideas, and perhaps developing post-retirement interests. I feel sure that they will be pleased that a younger generation of researchers is now emerging, that they will join me in inviting them to take over the baton, and wish them success and satisfaction if they accept the challenge. They will not be alone. Robert Rundstrom has pointed several ways ahead, and there is an emerging interest in traditional cartography on other continents.

Indigenous Hawaiian Cartographer: In Search Of Common Ground

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Maps, and the ability to spatially organize the place we live, are basic necessities of human survival and may very well be "one of the oldest forms of human communication". Whether they are derived from scientific or mythological impetus, maps do the same thing – they tell stories of the relationships between people and their places of importance. Every map is a blending of experience, theoretical concepts, and technical craftsmanship; "constructions of reality"; representations of the environment as seen by the societies that create them. The way people experience their environment and express their relationship with it is directly linked to their epistemology, which in turn indicates how knowledge is processed and used. Indigenous and Western science share many similar characteristics, yet are distinctly different in ways that affect how geographical information is communicated. Hawaiian cartography is an "incorporating culture" that privileges processes such as *moʻolelo* (stories), *oli* (chant), *ʻōlelo noʻeau* (proverbs), *hula* (dance), *mele* (song) and *moʻo kū ʻauhau* (genealogy). This article describes and defines Hawaiian cartography, identifies the internal struggles an academic Indigenous Hawaiian cartographer shares with other Indigenous scholars attempting to negotiate different epistemologies, and presents three autoethnographic Hawaiian cartographic projects that are necessary steps in resolving the differences between Western and Indigenous epistemologies.

INTRODUCTION

> I tend to differentiate between a "Cartographer" and a "Map-maker." A Cartographer is someone who makes a map by applying cartographic, geographic, aesthetic, and graphic design principles. A Mapmaker is someone who uses the default settings in the GIS software. (Anonymous)

Demand for maps of all kinds and formats continues to increase while the turnaround time to produce these maps has decreased. Not long ago there were, and still may be some people that kept street maps in the glove compartment, mounted general reference maps on their walls, and rotated the thematic map insert from National Geographic when the new one arrived. Today, however, there are software programs that allow people to download a street map into their cell phone or Personal Digital Assistant (PDA), to create customized general reference maps of an area to be visited, or to generate thematic maps of gross sales across the country. Contemporary map-making is caught up in the whirlwind of scientific and technological development driven by a market economy. As long as it remains profitable, the market will continue to provide point-and-click mapping software for users with little or no cartographic training.

"Every map is a blending of experience, theoretical concepts, and technical craftsmanship; 'constructions of reality'; representations of the environment as seen by the societies that create them."

Not to dispute Wood's witty (dis)regard for the usefulness of the modern cartographer, (Wood and Fels, 1992:193-4), there is a concern among academic and professional cartographers that software developers are

making it too easy for lay or hack cartographers to "select an inappropriate projection or a misleading set of symbols." (Monmonier, 1996:2) Furthermore,

> …unintentional cartographic self-deception is inevitable. How many software users know that using area-shading symbols with magnitude data produces misleading maps? How many of these instant mapmakers are aware that size differences among areal units such as counties and census tracts can radically distort map comparisons? (Monmonier, 1996:139)

"Indigenous people are creating maps in their own language, maps crammed with place names that fill the blank spaces and make an area appear less desirable for development, and maps sensitive to their own cultural and spiritual traditions."

Yet, these same mapping and GIS software products provide indigenous people with the economic and technologic capabilities a sense of empowerment. Indigenous people are creating maps in their own language, maps crammed with place names that fill the blank spaces and make an area appear less desirable for development, and maps sensitive to their own cultural and spiritual traditions. When indigenous people understand those cartographic techniques used in depicting their social and cultural condition, past or present, and are enlightened to what maps are capable of and where the "power" of the map resides, they not only become cartographically empowered, they must also deal with academic marginalization. Finding a niche from which Indigenous scholars can maintain cultural essence and academic veracity becomes a constant Herculean feat.

This work describes and defines Hawaiian cartography, it identifies the internal struggles an academic Indigenous Hawaiian cartographer shares with other Indigenous scholars attempting to negotiate different epistemologies, and it presents three autoethnographic Hawaiian cartographic projects that are necessary steps in resolving the differences between Western and Indigenous epistemologies.

Cartography – Perceptions of Reality

According to Robinson and Petchenik,

> cartography is generally restricted to that portion of the [mapping] operation often termed 'creative,' that is concerned with the design of the map, 'design' being used here in a broad sense to involve all the major decision-making having to do with specification of scale, projection, symbology, typography, color, and so on. (Robinson and Petchenik, 1976:19)

". . . when dealing with a type of map that is not a material artifact, the artifact is either excluded by Western culture definitions of a map, or parallel definitions exist in both Western culture frameworks and in an indigenous framework."

The International Cartographic Association (ICA) takes a broader view of cartography as a "discipline dealing with the conception, production, dissemination and study of maps in all forms" (ICA, 1995, quote from web page). Furthermore, a map is "a symbolized image of geographical reality, representing selected features or characteristics, resulting from the creative effort of its author's execution of choices, and is designed for use when spatial relationships are of primary relevance" (ICA, 1995, quote from web page).

There are probably as many definitions of cartography as there are cartographic texts. The important distinction each of the above definition makes is specific to maps as an end product. However, when dealing with a type of map that is not a material artifact, the artifact is either excluded by Western culture definitions of a map, or parallel definitions exist in both Western culture frameworks and in an indigenous framework.

Rundstrom's (1991) "process cartography" provides an alternative to the map as end-product.

> [Process cartography] consists of two concentric ideas. It situates the map artifact within the mapmaking process, and it places the entire mapmaking process within the context of intracultural and intercultural dialogues occurring over a much longer span of time. (6)

Process cartography is the result of Rundstrom's interests in the cartographies of 'incorporating cultures' as opposed to 'inscribing cultures', terms he borrows from Paul Connerton's (1989) book, *How Societies Remember*. Rundstrom (1995) summarizes:

> Incorporating cultures traditionally emphasize oral communication and other performance-based modes (e.g., dance, painting) in transmitting all sorts of meaningful information. The actions, lasting hours or days, carry greater meaning than any object they produce. In contrast, inscribing cultures hold and fix meaningful information years after humans have stopped informing, and typically must do so by means of some object (e.g., maps, GIS). Storage is crucial, and leads to stasis and fixity. (51)

"In Hawaiian cartography place names are mnemonic symbols."

Such an incorporating culture can be found in Hawaiian cartography. Like the Maori, pre-contact Hawaiians had a clear understanding of the world they lived in and communicated their perception of the world orally (Kelly, 1999:1). Hawaiian cartographers privilege process by incorporating their understanding of their island setting into their *moʻolelo* (stories), *oli* (chant), *ʻōlelo noʻeau* (proverbs), *hula* (dance), *mele* (song) and their *moʻo kū ʻauhau* (genealogy). This is a form of cartography categorized by Woodward and Lewis (1998) as "performance or ritual cartography" and may "take the form of a nonmaterial oral, visual, or kinesthetic social act [in order] to define or explain spatial knowledge or practice." (Woodward and Lewis, 1998:4)

In Hawaiian cartography place names are mnemonic symbols. Place names performed in daily rituals are a conscious act of re-implanting genealogical connections, re-creating cultural landscapes, and re-generating cultural mores. Those performing these traditional practices deliberately incorporate familiarity, awareness, expertise, and fluency of the spatial relationships of their environments thereby communicating cartographically. Sharing the names and meanings of places is a conscious act of cultural regeneration as Hawaiians are 'people of locality' (Johnson, 2003a). They continue to write their culture on the landscape and use place names as mnemonic symbols to encode their knowledge of the environment in a cognitive cartography (Basso, 1996).

"With the introduction of the Western cartographic tradition, many Hawaiian place names became the (un)intentional victims of epistemological difference."

With the introduction of the Western cartographic tradition, many Hawaiian place names became the (un)intentional victims of epistemological difference. By adopting Western cartographic techniques and accepting them as better representations of physical reality, native Hawaiians unwittingly lost many place names of cultural significance in these alien cartographic products.

Maps "are constructions of reality, images laden with intentions and consequences that can only be studied in the societies of their time" (Andrews, 2001:36). They are representations of the environment as seen by the societies that create them. The environment is a social construction and different societies have distinct and sometimes unique ways of thinking, perceiving, and relating to it. In "some cultures, or within particular

worldviews (ways of thinking), the environment can include the dead, one's ancestors and/or other entities from the 'supernatural' realm, such as gods, goddesses, spirits, angels, ghosts, etc" (Barry, 1999, 21). This means that each culture or worldview has and uses its own "symbolized images" and "geographical reality" to represent the world as they know it using "selected features or characteristics, resulting from the creative effort of its author's execution of choices". (Recall the definition of a map earlier in this article from ICA, 1995)

". . . each culture or worldview has and uses its own 'symbolized images' and 'geographical reality' to represent the world as they know it using 'selected features or characteristics, resulting from the creative effort of its author's execution of choices'."

The Hawaiian environment includes *nā kūpuna* (elders and ancestors), *akua* (gods and goddesses), and *aumākua* (spirit guardians) as part of the framework of how Hawaiians experience their geographic reality. Hawaiian reality "challenges the assumption that we learn **only** [my emphasis] by observable sensory input and not in a more mystical phenomenological way" (Meyer, 1998a:40). Hawaiians do not separate the physical from the metaphysical. Instead, they mix observable events with supernatural phenomenon in order to explain the world they live in. Wood identifies the way Hawaiians understand the world and express themselves therein as a "polyrhetoric, which emphasizes the multiple, shifting, and context-specific meanings this discourse constructs" (Wood, 1999:129-130). It is distinctly different from the discursive strategies of positivist science as a "monorhetoric" where representations of the world are composed of a singular, linear, visible reality (Wood, 1999:129-130).

The way people experience the world and express themselves in it is tied directly to their epistemology, which in turn indicates how knowledge is processed and used in an Indigenous science (cf. Meyer, 1998b; Roberts, 1996; Smith, 1999; Waddell, 2000; Gegeo, 2001, 2002). Roberts (1996) indicates that Indigenous science in the Pacific and Western sciences are "distinct but not necessarily entirely dissimilar knowledge systems" (59). Both gain information by observation over time, make use of models or theories to predict possible outcomes to particular situations, and involve explanations of cause and effect as an important component. However, Indigenous sciences include subjective sources of information and consider qualitative information relevant to their information gathering. It also tests and explains either predicted or anomalous results in different ways. Tests "largely involve trial and error 'experiments' under natural, uncontrolled conditions" (63) and explanations frequently make use of "metaphor, personification and symbolism to embellish and sometimes encode the explanation." (Roberts, 1996, 64) Lastly, the knowledge gained by Indigenous science is not meant to be an objective representation; instead, it is a culturally and geographically rooted presentation meant to impart not only the knowledge itself but also ethics and morals. "By providing standards of conduct for each individual in that society, it helps maintain social stability, order, self and cultural identity" (65).

"Native peoples have accumulated a vast amount of knowledge about the places they have occupied for centuries and have traditionally used their landscapes in ways that guaranteed their cultural survival."

Similarly Cajete (2000) presents Native science as "the collective heritage of human experience with the natural world" (3). Its "ultimate aim is not explaining an objectified universe, but rather learning about and understanding responsibilities and relationships and celebrating those that humans establish with the world" (79). Native peoples have accumulated a vast amount of knowledge about the places they have occupied for centuries and have traditionally used their landscapes in ways that guaranteed their cultural survival. They did so by maintaining and celebrating relationships with all entities of nature, aspiring to live according to an "ideal reciprocity with the landscape guided by cultural values, ethics, and spiritual practice. Living a life of relationship through ethical participation with nature is the ideal behind the practice of Native science and its orientation to place" (183).

The basic differences between Indigenous and Western sciences are embedded in their epistemologies. While Western science has developed along the line of objective/subjective separation, Indigenous science has developed in an objective/subjective union. This has direct affect on how geographical information communicated, either by representation or presentation. Maps are representations of geographical information in a Western cartography. Poetic narration and body movement are presentations of geographical information in Indigenous Hawaiian cartography. How does the Indigenous Hawaiian cartographer, or any Indigenous researcher, find common ground from which to express or deal with the internal battle between epistemologically diverse cultures?

"The basic differences between Indigenous and Western sciences are embedded in their epistemologies."

The margin: perceptions of myself

> Cradled in one culture, sandwiched between two cultures, straddling all three cultures and their value systems, *la mestiza* undergoes a struggle of flesh, a struggle of borders, an inner war. Like all people, we perceive the version of reality that our culture communicates. Like others having or living in more than one culture, we get multiple, often opposing messages. The coming together of two self-consistent but habitually incompatible frames of reference causes *un choque*, a cultural collision. (Anzaldua, 1999:100)

I am silenced by the limitation the tools that Western cartography provide for me as an Indigenous Hawaiian cartographer, tools that have been developed to favor empirical objectivity and thereby marginalize Hawaiian cartographic expressions. Yet, as I search for a means to express myself, I find myself using the language of my colonizer to convey a perception of myself. If "language is a place of struggle" (Hooks, 1989:144), then it is a place I share with other indigenous researchers (see Anzaldâua, 1990; Cajete, 2000; Gegeo, 2002; Hauofa, 2000; Hereniko, 2000; Johnson, 2003b; Kameÿeleihiwa, 1992; Little Bear, 2000; Meyer, 1998b; Momaday, 1997; Smith, 1999; Teaiwa, 2000).

Linda Tuhiwai Smith (1999), an indigenous maori researcher, "grew up within indigenous communities where stories about research and particularly researchers (the human carriers of research) were intertwined with stories about all other forms of colonization and injustice" (3). She asserts the inner struggle of the indigenous researcher comes partly from the cynicism, distrust, and abhorrence toward Western researchers studying Indigenous people, places, and issues. Sometimes these researchers promote their findings to people in authority who turn around and introduce policies that affect their lives based on the legitimacy of this research. At other times, these researchers' main goal is to advance their career by adding another publication to their curricula vitae. They think nothing of the Indigenous values of accountability and reciprocity neither maintaining relationships with their informant(s) and/or study site(s), nor giving back anything of real value to the people and places they research.

". . . the inner struggle of the indigenous researcher comes partly from the cynicism, distrust, and abhorrence toward Western researchers studying Indigenous people, places, and issues."

It's no wonder why the Indigenous researcher is often scrutinized the most by their our own people. Regardless of their experiences within the community, regardless of their meaningful intention to do right by the community, regardless of having shared the same humility and disrespect, indigenous researchers are sometimes scorned and ridiculed by the very people they have set out to help. Although these are the very people that encourage them to learn "western" ways to help the community, once they have jumped through all the hoops, they are no longer

trust worthy or respected as a member of the community because they look, sound and smell like the colonizer. Although it is a painful position to be placed in, it is a necessary reality for all indigenous researchers to remember there is more at stake than career advancement.

Bell Hooks illustrates this point in an interview with Gloria Watkins in 1989 answering the question, "why remember the pain, that's how you began?" as follows:

> Because I am sometimes awed … when I see how many of the people who are writing about domination and oppression are distanced from the pain, the woundedness, the ugliness. That it's so much of the time just a subject – a "discourse." The person does not believe in a real way that "what I say here, this theory I come up with, may help change the pain in my life or in the lives of other people." (Hooks, 198:215)

"We are hybrids of both cultures seeking a way to heal ourselves from the deafening madness of one view attempting to dominate all other views within ourselves."

As an Indigenous researcher, I know that it is our intimacy with pain that helps to define our character, not our condition. It is proof of our ability to navigate through currents pulling us in opposite directions. It is a testament of our will, not just to survive cross-cultural concepts but also to provide the groundwork of the "new consciousness" that Anzaldua (1999) writes about, where inclusivity and mutual respect are paramount.

While the blending of two contradictory epistemologies appears impossible, it is a part of the path indigenous scholars walk, an undertaking those of us that straddle cultures and embody varying views are capable of walking. We are hybrids of both cultures seeking a way to heal ourselves from the deafening madness of one view attempting to dominate all other views within ourselves. In describing the process of balancing opposing cartographic traditions it is necessary to discuss the psyche of an Indigenous[1] Hawaiian[2] cartographer.

As an Indigenous Hawaiian cartographer, I am internally rebellious and angered by the disregard and disrespect Western science has shown toward Indigenous epistemological traditions, categorizing it as a lower form of intelligence. At the same time, I also internalize an arrogant curiosity about "the other" in myself and use Western cartographic techniques to autoethnographically re-present and communicate the various aspects of the Hawaiian cultural landscape. The Indigenous Hawaiian cartographer is someone who attempts to balance Indigenous and Western epistemologies by drawing upon a vast amount of knowledge from both cartographic traditions while accepting the rhetoric of cultural politics.

"The Indigenous Hawaiian cartographer is someone who attempts to balance Indigenous and Western epistemologies by drawing upon a vast amount of knowledge from both cartographic traditions while accepting the rhetoric of cultural politics."

The idea of "balancing opposing thoughts" is not a new concept. Postmodernists have described this scenario countless times, where research is performed by listening to all voices. According to Anzaldua (1999), incorporating all voices is natural for those that operate in a pluralistic mode where "nothing is thrust out, the good the bad and the ugly, nothing rejected, nothing abandoned" (101).

As part of the journey to find common ground from which to express varying epistemologies, I have undertaken various projects in hopes they will help me find my voice. Although they are not presentations of an Indigenous Hawaiian Cartography, they are necessary steps leading toward an authoethnographic re-presentation that can only succeed in a space of mutual respect. Each project brings together different cultural and cartographic issues resulting in a successful exchange of tradition and technology.

Working in the margin: Indigenous projects of re-presentation

> What is more important than what alternatives indigenous peoples offer the world is what alternatives indigenous people offer each other. The strategies that work for one community may well work for another. The gains made in one context may well be applied usefully in another. The sharing of resources and information may assist groups and communities to collaborate with each other and to protect each other. (Smith, 1999:105)

Indigenous people, *with the means*, have been making use of cartographic and Geographic Information Systems (GIS) software for some time now.[3] Hawaiians are no different; there are several groups currently using mapping and GIS software and working to preserve language, culture and the environment in Hawai'i. Three of these will be briefly described, including the Hale Kuamo'o, the Hawai'i Board on Geographic Names, and the Office of Hawaiian Affairs.

". . . plans were put in motion to improve the geographic component of the immersion schools by adding maps designed and printed in the Hawaiian language."

Hale Kuamo'o

The Hale Kuamo'o is the Hawaiian Language Center within Ka Haka 'Ula O Ke'elikolani Hawaiian Language College of the University of Hawai'i at Hilo. Established by the Hawai'i State Legislature in 1989, the center supports and encourages the expansion of the Hawaiian language as a medium of communication in education, business, government and other contexts of social life in the public and private sectors of Hawai'i and beyond.

In December 1997, plans were put in motion to improve the geographic component of the immersion schools by adding maps designed and printed in the Hawaiian language. A total of 15 maps have been completed and approved for use including: North America, Central America, South America, Africa, Europe, Asia, Southwest Asia, East Asia, Southeast Asia, Australia, the United States, the Pacific ocean, the world with European and Hawai'i centering, and an additional Hawai'i centered world map labeling where the immersion school students' families living in Hawai'i today originated from. Some design issues that needed careful consideration included appropriate map projections, end-use vs. reproduction costs, and font sizes.

"Some design issues that needed careful consideration included appropriate map projections, end-use vs. reproduction costs, and font sizes."

Since some of the staff were not familiar with map projections and the distortion that results from them, several common projections were compiled and printed with an accompanying description about the distortion depicted in the map. After weighing all options, they decided to use an equal-area projection for regional maps, the Robinson projection for the World maps, and an orthogonal projection for the Pacific Ocean map.

There was also a lengthy discussion about end use vs. reproductive costs. They decided to produce color and black-and-white page-size maps for teacher assignments, color page-size transparencies for teaching tools, and color wall-size maps for classroom support. Additionally, both the color and black-and-white page-size maps were printed with and without Hawaiian place names so teachers could hand them out for students to complete.

After the first draft was completed, font styles and sizes were of the utmost concern. It was just as important to use the same font size for similar levels of features, city or state names, as it was to portray areas in proper proportion to one another. This was extremely challenging for

the east coast of the U.S. map, especially since they required all leader lines to maintain a 45° angle. (See Figure 1) The least challenging task was to ensure Hawaiian orthography was maintained by using Hawaiian fonts that include the kahakō or macron (long vowel sound marker) and the ʻokina or glottal stop.

". . . the United States Geological Survey (USGS) offered to begin adding Hawaiian diacritical marks (kahakö and ʻokina) to those place names with a Hawaiian component on the 7.5-minute topographic maps . . ."

Neither the staff nor I could predict that this project would have such a long learning curve or require such a lengthy decision-making process. The final finished products included 100 copies of each map, either printed or plotted, with digital copies printed to CD for future use. Additionally, the 1,500 wall maps were spray coated with UV protection and laminated prior to being bundled with the other page size maps for dissemination at a teacher's workshops.

Hawai'i Board on Geographic Names

In April 1999, the United States Geological Survey (USGS) offered to begin adding Hawaiian diacritical marks (kahakō and ʻokina) to those place names with a Hawaiian component on the 7.5-minute topographic maps now under revision for the first time in 15 years. The Hawai'i Board on Geographic Names (HBGN) accepted the offer of adding kahakō and ʻokina as long as they were added with a very deliberate attention to accuracy. The HBGN specified that these additions must be made by consulting accepted authorities on Hawaiian place names including the Hawaiian speaking kupuna (elder generation) who might have special knowledge of specific geographic areas and the meaning of the names given to places.

"The HBGN specified that these additions must be made by consulting accepted authorities on Hawaiian place names including the Hawaiian speaking kupuna (elder generation) . . ."

The HBGN was established in 1974 by Act 50, Chapter 4E, Hawai'i Revised Statutes. Their primary function is to make official decisions on the form or spelling of controversial names, reviewing and recommending a standard form and spelling both to State agencies and to the

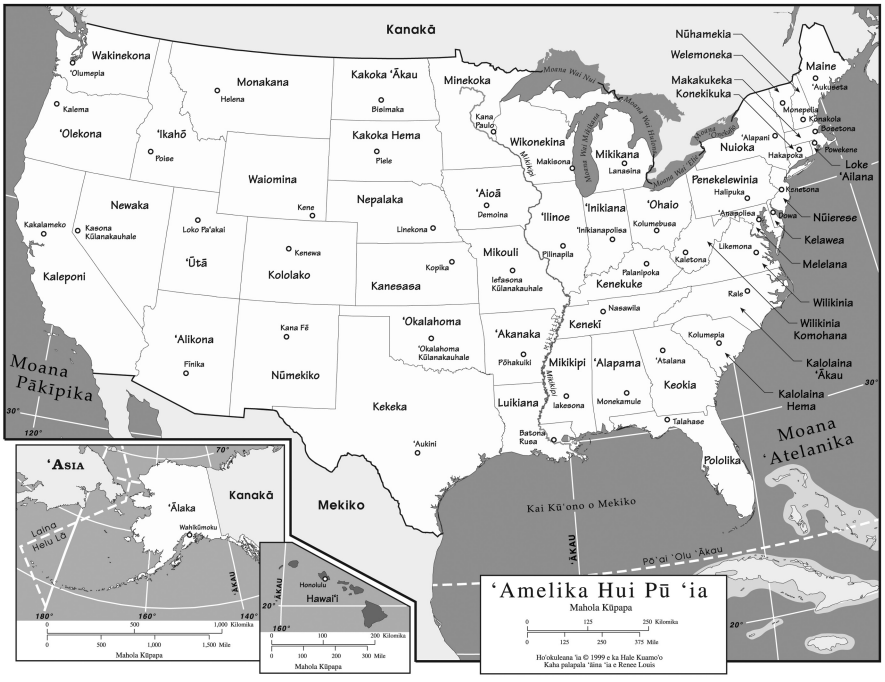

Figure 1. United States of America. Printed with permission of the Hale Kuamo'o. (See page 66 for color version)

U.S. Board on Geographic Names (USBGN) for federal approval and use on official maps and documents. The USBGN is the governing body that maintains and approves additions to the list of place names in the Geographic Names Information Systems (GNIS) database according to their place naming standards explained in their Principles, Policies and Procedures. The USBGN usually approves the recommendations from each State's Board on Geographic Names as long as it follows their naming standards.

The process to accomplish this task, agreed upon by HBGN Board members, involves recording each place name from a topographic map with a Hawaiian component into a spreadsheet. The initial attempt at correcting orthography is accomplished by using two books, *Place Names of Hawai'i* by Pukui, Elbert, and Mo'okini (1974) and the *Atlas of Hawai'i* by Juvik and Juvik (1998). Hawaiian speaking kupuna are consulted whenever possible, and generally win any place name orthography discrepancy. Any name not found in the book or known by a Hawaiian speaking kupuna is marked for further research.

"Hawaiian speaking kupuna are consulted whenever possible, and generally win any place name orthography discrepancy."

The HBGN meets to approve the names making adjustments as needed and submits their recommendations to the USGS and USBGN for inclusion on the topographic maps and the GNIS. The HBGN has also adopted some of the standards from the Hawaiian Spelling Project Report while maintaining the right to make exceptions to those standards. The report proposed "a uniform spelling system … until such time that a standardized Hawaiian orthography is established." (Ahahui 'Ōlelo Hawai'i, 1978:1)

Some of the issues the HBGN faced thus far include the treatment of place names with a geographic feature (pu'u - hill, pali - cliffs, hono/hana - bay, wai – stream, lae - point) as a component in their Hawaiian names. For example, what if there is a Hawaiian geographic component as part of the place name followed by the English geographic component (Ka Lae Point)? Shall place names with a Hawaiian geographic component be separated, compressed, or eliminated altogether? Does the meaning change when place names that are currently split like "Mauna Loa" and "Mauna Kea" are compressed into "Maunaloa" and "Maunakea"? How is it different from "Kalae" / "Ka Lae"? Why can you compress "Ko'olauloa" (Long Ko'olau) and "Ko'olaupoko" (Short Ko'olau) but separate "Kalihi Uka" (Mountain Kalihi) and "Kalihi Kai" (Ocean Kalihi)? Should you capitalize a proper name in the middle of a compressed place name like "KaluaoKamohoali'i"? What's the difference between "Haleolono" and "Hale'olono"? More importantly, what are the implications of these decisions?

"To date, the HBGN has reviewed 5,806 place names and recommended orthographic changes for 87% or 5,023 of them. The remaining 13% or 783 have been marked for further research."

One obvious implication is the economic cost of changing the current accepted spelling. If the HBGN agrees to compress Mauna Kea into Maunakea, then by law, the federal government must use the correct spelling in all correspondence and signage. But there are gray areas to this law. For example, street names found on USGS topographic maps and corrected in the GNIS may not necessarily be enforced on the City & County level.

To date, the HBGN has reviewed 5,806 place names and recommended orthographic changes for 87% or 5,023 of them. The remaining 13% or 783 have been marked for further research. Although the process is quite daunting, as nearly 93% of the names in the GNIS for Hawai'i have a Hawaiian component, it has its rewards. (See Figures 2 and 3) While the HBGN acknowledges that many Hawaiian place names do not exist on the topographic quads, additional place names will be reviewed and added in another phase of this project as it must undergo a different process.

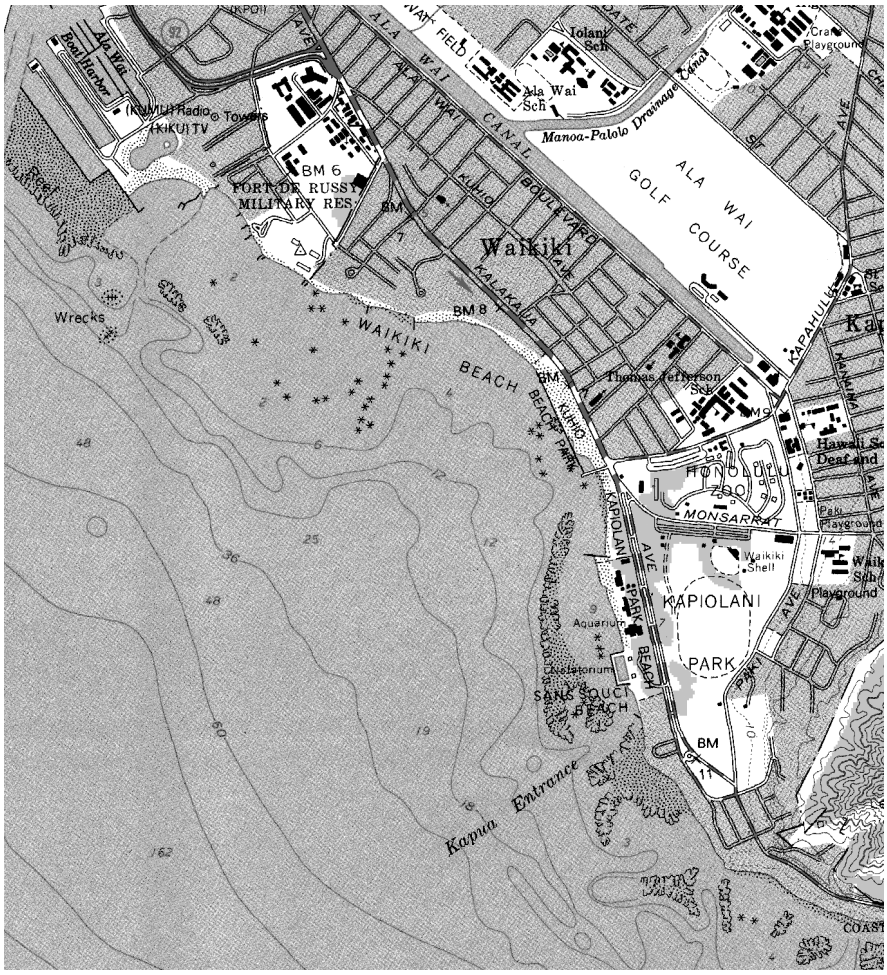

Figure 2. Section of the Honolulu 1980 Series U.S.G.S. 7.5-minute Topographic Quadrangle of Waikiki. (See page 66 for color version)

Office of Hawaiian Affairs

". . . OHA decided to implement their Geographic Information System (GIS) in a manner that would provide graphical support for their administrative decision making processes regarding the allocation of resource for their beneficiaries."

In 1978 the State of Hawai'i constitutional convention established Office of Hawaiian Affairs (OHA) as a public trust, with a mandate to better the conditions of both Native Hawaiians and the Hawaiian community in general. In June of 2000, OHA decided to implement their Geographic Information System (GIS) in a manner that would provide graphical support for their administrative decision making processes regarding the allocation of resource for their beneficiaries.

In the summer of 2000 funding for a GIS consultant was made available to assess the current GIS software, hardware and data, provide insight on the capabilities of that data, and create templates (census tracts, property boundaries, zip code areas, and moku divisions - traditional Hawaiian land divisions) for future staff use. The creation of templates lead to the most critical element of this project—educating a few staff members in various departments in the hopes they would actively use the system for their own departmental projects. Part of the funding was allocated for map compilations as visual aids on an as-needed basis. Two such projects include the use of census data to determine resource allocation, and the search for a new method of determining the location of government and crown ceded lands.

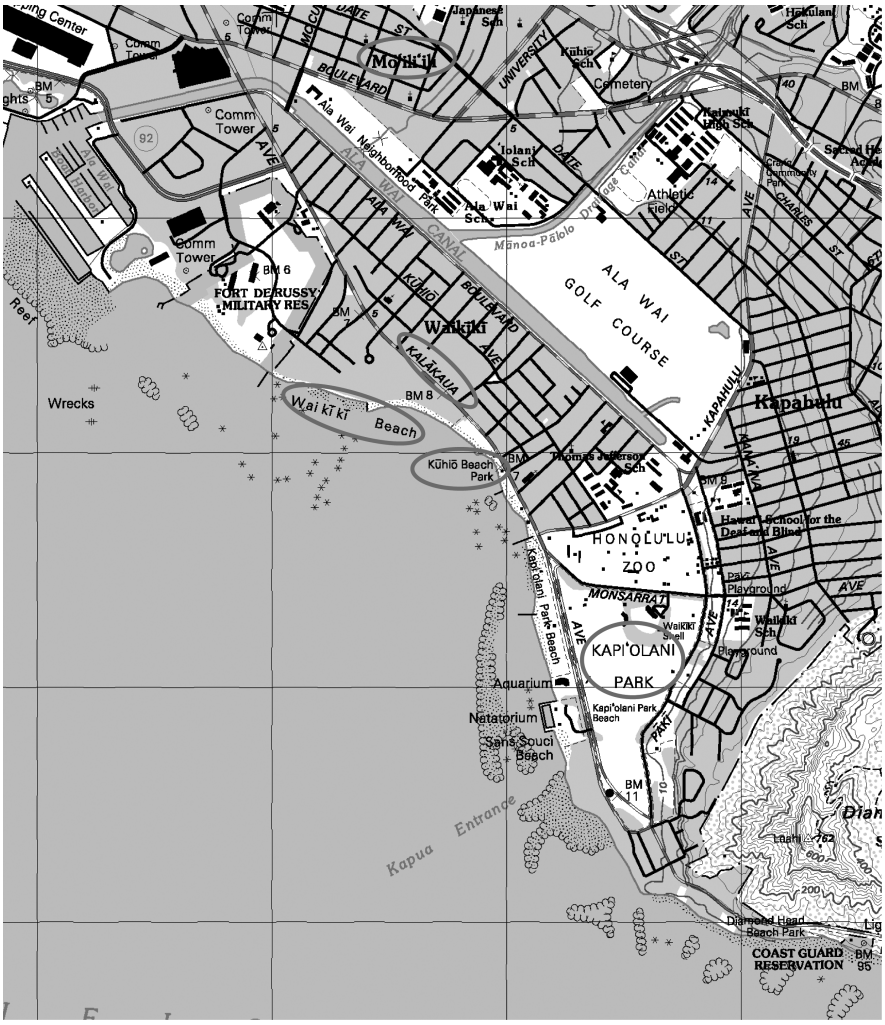

Figure 3. Section of the Honolulu 1980 Series U.S.G.S. 7.5-minute Topographic Quadrangle of Waikiki. (See page 67 for color version)

The first project involved population data from the 2000 census. OHA created four age groups that would reflect the Hawaiian perspective of demographics, specifically, keiki (child 0 – 9 years), ʻōpio (teenager 10 - 19), makua (parent 20 - 54), and kupuna (grandparent 55+). They then totaled the appropriate population statistics to determine the areas of highest Hawaiian concentration in each age group. The final products included page-size compilations for staff use and a wall-size plot for use in community meetings. (See Figure 4)

The second project is a work in progress. OHA is funded with a pro rata share of revenues from State lands designated as ceded. Ceded lands consisted of 1.8 million acres of crown lands (land belonging to the Hawaiian Monarchy) and the Kingdom of Hawaiʻi government lands that were transferred or 'ceded' to the U.S. government pursuant to the Joint Resolution of Annexation in 1898. In 1959, the U.S. government returned some of the lands to the State of Hawaiʻi and directed the State to hold the lands in trust, listing 5 purposes in section 5(f) of the admissions act.

1. Support public education
2. Better the conditions of Native Hawaiians of 50% or more blood
3. Development of farm and home ownership

"Ceded lands consisted of 1.8 million acres of crown lands (land belonging to the Hawaiian Monarchy) and the Kingdom of Hawaiʻi government lands that were transferred or 'ceded' to the U.S. government pursuant to the Joint Resolution of Annexation in 1898."

4. Public improvement
5. Public use

"Unfortunately previous attempts to accurately assess all State lands designated crown or government lands have been criticized as incomplete."

Unfortunately previous attempts to accurately assess all State lands designated crown or government lands have been criticized as incomplete. Furthermore, because the work was completed by the State Department of Land and Natural Resources (DLNR), there is a conflict of interest issue. In the summer of 2002, the State Auditor's office in conjunction with a private firm published a cost analysis of completing an accurate assessment of all ceded lands based on a small sample of parcels. Their estimated budget was nearly $10 million. OHA was expected to budget half the amount to complete the project but questioned spending such a large sum for a project they would have little to no control over. As a result of this and other issues, the project was shelved. OHA is currently seeking alternative methods to resolve this issue in-house.

Assessments and Afterthoughts

"Cartographers communicate a (re)presentation of the world, conveying perceptions of the world that can be understood by an audience that shares their same perspective."

> I did not make a conscious decision about becoming a researcher, about deciding to become actively involved in the politics of research, or in teaching of research, or in the practice of being a researcher. Research seems such a small and technical aspect of the wider politics of indigenous peoples. It is often thought of as an activity which only anthropologists do! As indigenous peoples we have our own research needs and priorities. Our questions are important. Research helps us to answer them. (Smith, 1999:199)

Cartographers communicate a (re)presentation of the world, conveying perceptions of the world that can be understood by an audience that shares their same perspective. Hawaiian cartography, like other performance cartographies, gives "preeminence to performance, privileging

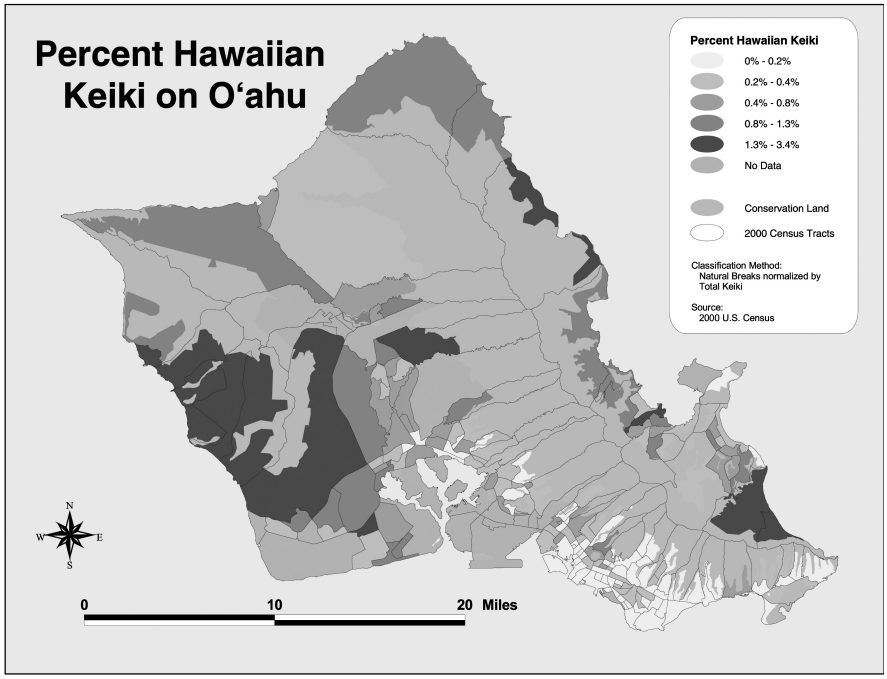

Figure 4. Percent Hawaiian children on O'ahu per 2000 census. (See page 67 for color version)

process over product, particularly where permanence of the artifact might be a disadvantage in societies where maps were designed to grasp the ever-changing rhythms of nature and territory." (Woodward and Lewis, 1998:5)

For Hawaiians, importance lies in the narration of the story, the performing of the dance, the reciting of the genealogy, the delivering of the chant, the telling of the proverb, and the singing of the song. It allows the presentation of the map to change dynamically as the performance cartographer saw fit. Hawaiians use place names as mnemonic symbols to encode their knowledge of the environment. Place names performed in daily rituals (i.e., stories, chant, song, and dance) are conscious acts of cultural regeneration.

"For Hawaiians, importance lies in the narration of the story, the performing of the dance, the reciting of the genealogy, the delivering of the chant, the telling of the proverb, and the singing of the song."

Indigenous Hawaiian cartographers are hybrid scholars sharing the same inward struggle with other indigenous researchers, working on projects that attempt to balance both Indigenous and Western cartographic traditions. Each of the projects presented here is a necessary step toward developing an Indigenous Hawaiian Cartography that thrives in a space of mutual respect.

In the first project, the staff of the Hale Kuamoʻo took the time to learn how maps distort the world and how font styles and sizes affect the way children relate to the information being represented. In this project, Western cartographic techniques, such as map projections needed to be explained so that Hawaiian language experts could appropriately incorporate non-Hawaiian concepts.

When the USGS and USBGN offered the HBGN the task of orthographically correcting all place names with a Hawaiian component, steps were taken to reverse the political and Western cartographic domination of Hawaiian place names. Although arguments could be made that it is yet another attempt for the dominant culture to appear as though it is doing a good deed…that it is 'too little, too late' to make amends for the century of cultural subjugation. All egos aside, it is a step in the right direction as the 1990's edition of 7.5-minute topographic sheets of Hawaiʻi do in fact include all approved orthographic markings, and the USGS has agreed to 'short run' many of them in an effort to give the HBGN time to resolve many of the place names requiring 'more research'. There is still much to do, but it is necessary to acknowledge a step in the right direction.

"Place names performed in daily rituals (i.e., stories, chant, song, and dance) are conscious acts of cultural regeneration."

Lastly, the OHA mission is "to mālama [protect] Hawaiʻi's people and environmental resources and OHA's assets, toward ensuring the perpetuation of the culture, the enhancement of lifestyle and the protection of entitlements of Native Hawaiians, while enabling the building of a strong and healthy Hawaiian people and nation, recognized nationally and internationally" (OHA, 2003, quote from web page). To that end, the OHA took the time to train selected staff members in GIS for the sake of their beneficiaries and their fiduciary responsibilities. Perhaps they have embraced this technology because they choose to take control of their own cartographic future in Hawaiʻi's political arena, or perhaps they just want to continue protecting the Hawaiian culture, its people, and environment. Either way, they are cautious of their use of GIS technology to better the condition of Hawaiians as they are well aware it can only represent empirical data and not present a more Hawaiian worldview.

With regard to what Indigenous Hawaiian cartography can be in this modern age, I defer to Kameʻeleihiwa, Hawaiian Historian at the Center for Hawaiian Studies. She sees it as a public domain interactive multimedia hypertext document where someone could click on a point/line/area to bring up maps, 3D terrain models, photographs, and sound

and video clips. It would also provide for other Hawaiians to contribute their own family's knowledge to dynamically enhance and enrich it for others. While I agree that this autoethnographic technique is one of many steps toward blending of Hawaiian and the Western cartographic representations, I am also reminded of Rundstrom's caution on cross-cultural representations:

"One of the most effective ways for Indigenous peoples to affectively control how they are represented cartographically is to understand how Western cartographic techniques are used . . ."

> Representations make apparent what was not apparent, and are therefore a source of knowledge. For someone steeped in the ways of the culture from which particular representations emanate, they appear transparent; the particular way in which they are thought to become a source of knowledge is deemed natural and unproblematic. In cross- cultural situations, "re-presentations" accomplished with restricted technology by an outside consultant (e.g., GIS), and then exported, can be quite dangerous for a local informant. (Rundstrom, 1995:51)

As one of a handful of Indigenous Hawaiian cartographers, my goal is to promote a cartographic literacy such that Hawaiians and other Indigenous peoples become more than just GIS users. One of the most effective ways for Indigenous peoples to affectively control how they are represented cartographically is to understand how Western cartographic techniques are used to depict the social and cultural condition, and learn where the "power" of the map really resides. Only then can Indigenous people become truly empowered cartographically, because only then can they say with certainty which parts of their world can and should be mapped and which parts cannot or should not be mapped with any tradition but their own. It is critical for Indigenous peoples to create a counter-cartographic culture informed by those that live, breathe and theorize in the "margin of radical openness" (Hooks, 1990:149). It is my belief that Indigenous peoples need to reawaken the imagery of their cultural heritage, re-create the mental maps of their ancestors by practicing our oral and performance cartographies, and, where appropriate, incorporate modern day cartographic techniques by adapting them to their cultural epistemologies.

"It is critical for Indigenous peoples to create a counter-cartographic culture informed by those that live, breathe and theorize in the 'margin of radical openness'."

NOTES

[1] The term "indigenous" is problematic as it represents yet another label popularized by post-modern, post-colonial, post-structural, post-imperial, post-…thinking Western academic researchers. Linda Tuhiwai Smith states that in "positioning [her] self as an indigenous woman [she] is claiming a genealogical, cultural and political set of experiences." (1999:12) Here, the term Indigenous does not merely mean someone native to an area; it is an accepted realization that there is a rhetoric that involves cultural politics.

[2] According to the Hawaiian Homes Commission Act, 1920, a "Native Hawaiian means any descendant of not less than one-half part of the blood of the races inhabiting the Hawaiian Islands previous to 1778."(*Hawaiian Homes Commission Act, 1920*, 1920) The Hawaiian Homes Commission Act was enacted by the U.S. Congress on July 9, 1921 and adopted in to the Hawai'i State Constitution. Only recently (2000 census) has the U.S. Census provided a category for Hawaiians and Native Hawaiians that allows for self-identification or self-perception. Nonetheless, the legal definition continues to be practiced by the Department of Hawaiian Homelands, a State agency whose current mission statement is "to manage the Hawaiian Home Lands trust effectively and to develop and deliver land to native Hawaiians." (Department of Hawaiian Homelands, 2004) For the purposes of this text, a Hawaiian is any person with Hawaiian blood and some affinity toward Hawaiian cultural practices.

[3] Some examples can be found on the Indigenous People's Specialty Group web page links to indigenous cartography (http://www.unc.edu/depts/geog/aisg/links.html).

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Encroachment by Word, Axis, and Tree: Mapping Techniques from the Colonization of New England

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It is well established that mapping has been an important tool for the colonization of North America. Techniques such as removal of toponymy, alteration of a boundary line location, and use of a map grid, were all successfully used for advancing colonial interests in the printed regional and national maps of the seventeenth and eighteenth centuries. This article compares these known techniques to those that were used in local, town level mapping in Connecticut during the same period. Whereas toponymic removal and replacement are found to remain central to cartographic encroachment at the local level, English colonists also successfully encroached on unpurchased Native lands through other uses of toponyms, as well as new devices such as the axis, tree-marking, and appropriation of Native mapping style. Native people actively contested these encroachments at the town and colony levels; these resistances successfully slowed but did not stop the mappings' effects. The final effectiveness of each encroachment technique is found to depend on its ability to maintain a vague definition of territory and boundaries within an aura of precision and legality.

INTRODUCTION

It is by now well known that the map has been a primary tool for colonizing North America. Since Brian Harley first asked us to consider the power of the map to coerce and control (Harley, 1988), the map's reputation as a mirror of nature has been supplanted by its reputation as a tool of colonizing culture. But how does one implement this colonizing effect, exactly? The power of the map may lie in the information it portrays or in the way that information is symbolized. If the power is in the symbol, which mark on the map encourages the imperial uses to which the maps are so successfully put?

For the printed promotional maps of the seventeenth and eighteenth centuries, we have some insight. Scholars have scrutinized the published cartography associated with, for example, Smith, Bellin, and Cook, for the colonial devices practiced and perfected in their printed geographies (Harley, 1988; Belyea, 1996; Spark, 1995). The body of work by Smith and the others comprised one facet of the colonial cartographic enterprise: the published, European face, designed to portray European encroachments with the authority and finality required for encouraging financial investments from map readers. Mapping, meanwhile, suffused other facets of the colonial bureaucracy. In colonial mapping at the very large scale, in the minute daily transactions and incremental encroachments between colonizer and colonized at the local level, maps were created for other purposes and other audiences. Do the maps of these other facets draw on techniques comparable to their printed, small-scale counterparts?

In this article, I address the question of encroachment techniques used by colonists in the mapping of New England town boundaries using Connecticut as an example. I will first look at what is already known about

encroachment techniques in printed maps of colonization. Next, I will turn to my findings from Connecticut land records and compare them to the known colonial techniques, outlining the ways in which they are similar as well as describing several techniques unique to local mapping. I will then bring the techniques back into context through the story of Native reaction and resistance to cartographic encroachments in one town.

This study provides a contrast to the literature of maps and colonial power. An initial exploration of Native map influence in the land records of southern New England indicated the need for a more detailed and systematic examination of the way in which Indians and colonists mapped and re-mapped colonial town boundaries over time (Pearce, 1998b). This initial exploration was expanded in an effort to take a more *processual*[1] approach, with a close reading of one body of town records over time (Pearce, 1998a), rather than focusing on unrelated documents. For this close reading, I chose the region of the second wave of English colonization in Western Connecticut, an area of ten towns settled between 1670-1719; today, this same region is divided into many smaller towns carved from the original settlements (Figure 1). By choosing this region, I was able to look at the land transaction process as it had settled into custom between Native and English people, at a time when Native people could exercise their legal rights at the town and colony levels.

Within this study area, I analyzed over 200 land records for the ways in which maps were constructed and used by Native people and English colonists during the steady marginalization of Native villages and the establishment and incorporation of colonial villages. As part of this analysis, I gave particular attention to identifying the specific mapping techniques used for encroachment. Ultimately, a cartographic encroachment must come down to a word, a line, a gesture. Where was it? Through close readings of the records, I found techniques borrowed from the printed maps, but I also found new approaches developed for local benefit.

"Ultimately, a cartographic encroachment must come down to a word, a line, a gesture. Where was it?"

Encroachment Techniques from the Printed Maps

Harley began the colonial re-reading in 1988 by pointing to two techniques used to create the "toponymic silence" of Early Modern cartography (Harley, 1988:66). One was the technique of omission, when the mapmaker simply declines to include the indigenous world and leaves instead the blank spaces of the map. In his reading of Smith's *A Map of Virginia*, Harley also pointed to the technique of toponymic replacement, the practice of removing native toponyms and replacing them with a European label. Since then, the removal and replacement of Native toponymy has been the object of several historical studies, including D'Abate's (1994) essay on naming practices in Norumbega, and Sparke's (1995) reading of Cook's *General Chart of the Island of Newfoundland*.

Belyea (1996) expanded our awareness of cartographic techniques in her reading of eighteenth century maps from the North American interior. In Belyea's analysis of Bellin's *Carte de l'Amerique septentrionale*, she called on us to rethink the function of the cartographic grid, demonstrating that apart from its projecting properties, the grid is an extremely useful device for maximizing encroachment on Native land.

Finally, in her study of colonial techniques in promotional maps of British North America, Roper also noted the removal of native toponyms, but as well discovered other colonizing techniques in use, including the alteration or movement of a boundary line to encroach on unclaimed territory, and the movement of the locations of parallels to strengthen boundary claims (Roper, 1998).

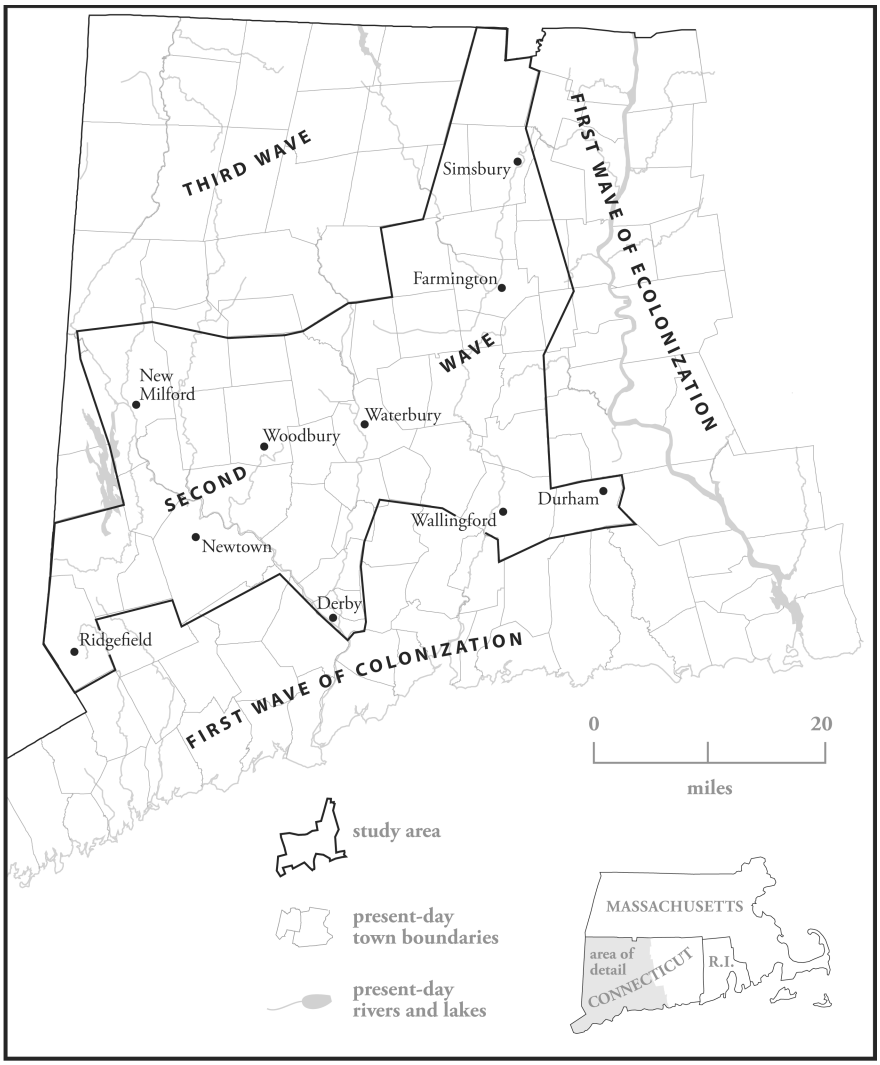


Figure 1. Context of the study area in present-day Connecticut.

"Latitude is less likely to be relevant to town mapping, where measure is scaled to smaller increments . . ."

All of the aforementioned techniques, whether from the seventeenth or eighteenth centuries, were applied in mapping projects with a specific goal: colonial expansion and promotion through the dissemination of printed maps. The techniques, therefore, reflect the apparatus and theater of the printed map industry, an industry built on compiling the sketches of fur trappers and Indian interpreters into the notations of cartographers, enhancing the line quality of engravers, and supporting the production demands of publishing houses. For example, the cartographic technique of moving a boundary line to encompass more land is only useful if boundaries are graphically symbolized as lines. By the same terms, a line of latitude conveniently relocated for encroachment is only useful in a small-scale map of a large region, where degrees of latitude are appropriate measures of location or distance.

Latitude is less likely to be relevant to town mapping, where measure is scaled to smaller increments; in the seventeenth century, these increments would have been miles or rods and chains, with locational references to rivers, stones, and trees. Further, the very measurement of latitude, as well as the construction of a cartographic grid, depends on some degree of professional training on the part of the mapmaker. Such skills

may not have been held by town proprietors founding colonial townships. In order, then, to gain a broader understanding of cartographic colonization techniques, it is necessary to include an examination of the colonizing techniques from local mapping processes, a facet of colonial mapping which operated at a different scale, with different tools and training, for a different audience.

Mapping Town Boundaries in Southern New England

There are no treaties in southern New England. The dispossession of the Native territory which would become Connecticut, Rhode Island, and Massachusetts, was achieved through the sale and purchase of Native land by groups of English town proprietors at selected sites within the colony's perimeter. It is, then, in the records of these land transactions, in particular the mapping of English town boundaries, that the taking of Native territory and re-mapping it as colonial territory initiated and evolved.

The process of mapping town boundaries in Connecticut, similar to that of other parts of southern New England, was an often lengthy process of negotiation, witnessing, and paperwork involving both Native and English people. When a new English town was to be settled, the town proprietors visited the land in question and made a verbal agreement with the Native people living at that location. Though the proprietors likely approached this agreement as the first step in land transfer, the agreement usually concerned not transfer of ownership but permission to utilize the land in a specific way, typically grazing or planting. The verbal agreement was followed by a more formalized "viewing" of the land by the proprietors, when they would make a visual survey of the land and write a report for the colony. At the same time deed negotiations began, when proprietors and Indians (with the assistance of interpreters, witnesses, and the town clerk) negotiated and recorded the terms and price of the land sale in a Native land conveyance. If the deed or conveyance was successful, a royal patent was issued for the land described in the deed. After receiving the patent, the proprietors held an official colonial declaration of the town bounds by witnessing and marking the corner trees or stones, a process in which Native people were often also involved. The final stage of mapping, formal survey of the land by a professional surveyor, often didn't occur until much later, sometimes as long as a century, following the declaration of the bounds.

". . . because the mapping process necessitated Native approval or participation at specific intervals, Native people at times had the ability to influence the mapping process."

With the exception of the final survey, the maps that resulted from this unique process were primarily composed of words, although graphic elements were incorporated in many instances. Verbal and written mapping, a combination of both Native and English mapping skills, was the prevalent mode for delineating property boundaries in southern New England up until the time of the Revolution (Pearce, 1998b).

This sequence, from verbal agreement to formal survey, describes town boundary mapping at its legal best. In practice, both the process and results varied widely from town to town, influenced by the local political and cultural conditions. When Native people were unwilling to sell, colonists adapted the sequence in a way which would best serve their needs. Patents were sometimes issued before a deed could be obtained, for instance, or proprietors negotiated with Native people having no rights to the land in question. On the other hand, because the mapping process necessitated Native approval or participation at specific intervals, Native people at times had the ability to influence the mapping process.

In sum, the localized colonial mapping process in New England differed greatly from the colonial mapping in the small-scale, printed maps. These differences were not only based on the contrast in scale, but in the motivations and training of the people (Native or non-Native) who made and used the maps, the form of the maps which resulted, and the uses to which the maps were put. Local maps were intended only for town records and required legibility and legality sufficient to obtain the royal patent; they would never be published. The mapmakers, whether Native or non-Native, were not trained as surveyors, compilers, or engravers; instead, both cultures mapped by drawing on old traditions for property mapping handed down to them by their families (Bragdon, 1996; Cronon, 1983). Each had little regard for the graphic, and focused their attentions primarily on the ability of words to convey geographical information. Boundaries were expressed in a combination of Native and English terms, and the witnessing of the symbols of the boundaries on the ground (in trees and rocks) comprised an integral part of the map. From this process emerged a different palette of cartographic techniques for encroachment.

Elements of Encroachment

Redefine the Words

The most popular and effective technique for encroaching on un-purchased land was the colonial manipulation of the Native toponyms. In each of the land purchase negotiations, English proprietors found themselves purchasing land already mapped by Native people through toponym. These toponyms referred to specific places, a meadow or a river confluence, but not to a large region of land. It was these places for which Native people were negotiating in their land sales. The proprietors, on the other hand, wanted large tracts of five and ten square miles on which to build the colony's towns. To achieve the land transaction they wanted, proprietors first had to stretch and re-define the Native place name to suit their needs. This technique of stretching the Native words from sites (places) to areas (spaces) was a highly successful means of encroaching on unpurchased lands (Figure 2).

"This technique of stretching the Native words from sites (places) to areas (spaces) was a highly successful means of encroaching on unpurchased lands."

For example, Weantinock was the place name referring to a planting ground where the later-named Great Brook flowed into the Housatonic River. To the English, this became Weantinock, "a certain tract" comprising all of the land between the town of Danbury and the town of Woodbury (Wojciechowski, 1992:237). In this way, Weantinock became a word with two meanings, one in the Native world (the Weantinock that was a planting ground), and one in the non-Native world (the Weantinock that comprised a larger tract, within which was a planting ground).

This process not only changed the meaning and definition of Native place names, it also effectively erased entire Native toponymic landscapes by collapsing them into a single word, a word which had once referred to a single place within a web of places. The 1684 Native deed for Mattatuck, for example, described the land in negotiation as a region of twenty parcels, lying on both banks of the Naugatuck River (Figure 3) (Wojciechowski, 1992:131). The parcels were identified using 24 Paugussett toponyms. All but one of these toponyms, Mattatuck, were erased by the patent of 1686, and the word "Mattatuck" redefined in English terms to signify the entire space.

The other 23 toponyms, along with Mattatuck's original Native meaning, were removed from the land transaction but not forgotten. As became

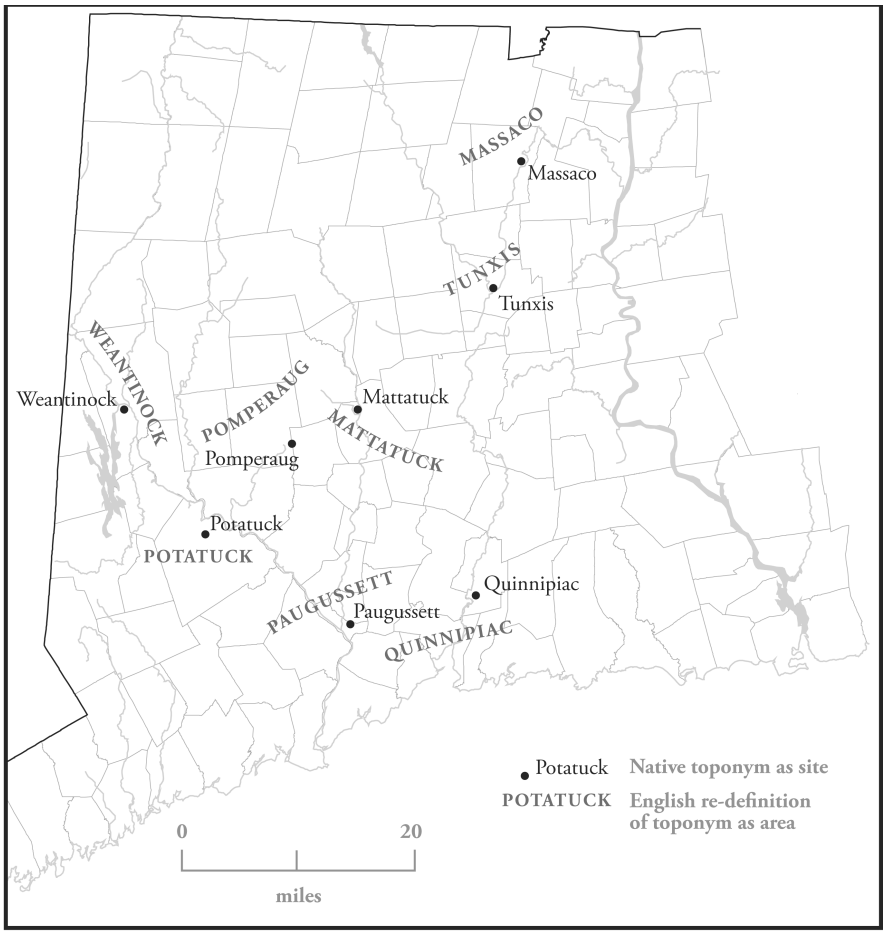


Figure 2. Sites become areas when Native toponymy is re-defined by English.

the norm throughout New England (indeed, throughout North America), the Native toponyms worked their way back into the landscape as colonial reinventions, redefined to stand for geographical features having clear boundaries. In Figure 3, for example, "Toantic Pond" lies in a place that in the Native world was mapped as Toantic. A similar toponymic reinvention brought Quassapaug Pond and the Naugatuck River onto the colonial map.

Once the Native place name was redefined and remapped in English terms, it could then be efficiently replaced with an English toponym, the colonizing technique commonly used in the colonial printed, regional maps. The royal patent which granted permission for proprietors to plant on their newly purchased lands bestowed authority by removing the English "Native" name and substituting an English name commemorative of the English landscape. So it was that Tunxis became Farmington, Massaco became Simsbury, Mattatuck became Waterbury, Paugussett became Derby, Pomperaug became Woodbury, Weantinock became New Milford, Coginchaug became Durham, and Quanneapague became Newtown. By the time that the territory was given its new English name, however, the original Native meaning and mapping, that which had been negotiated for sale, had long been erased by the proprietors.

"Once the Native place name was redefined and remapped in English terms, it could then be efficiently replaced with an English toponym . . ."

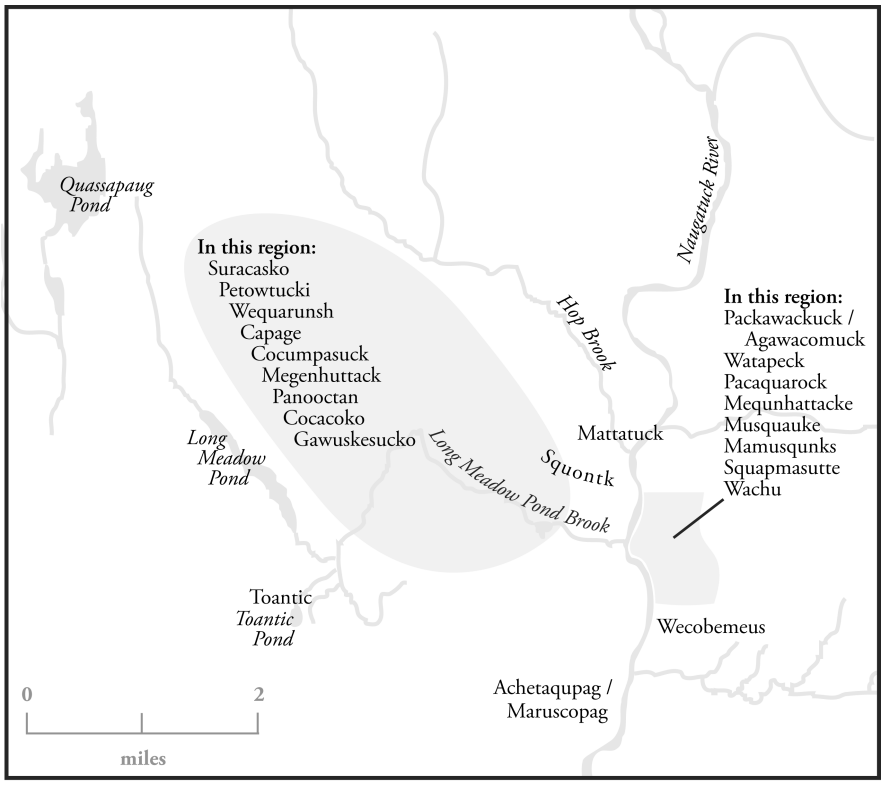


Figure 3. Native toponymy in 1684 before being re-mapped as "Mattatuck." Present-day toponymy appears in italics.

Use an Axis

"The corners remained undefined and unbounded by a box, with infinite potential for stretching into additional regions of Native territory."

While re-defining the Native place name from site to tract, in order to claim additional land, proprietors simultaneously defined the spaces of the tracts themselves in such a way as to maximize the size of their land purchases. The technique was to replace either the Native toponym or other description in the Native land transaction with an axis: two perpendicular lines of uncertain position and limitation on the landscape. This re-definition by axis was often used in the patent but sometimes it appeared in the Native land conveyance itself, in a separate section from the Native description of the territory. Unlike the grid's defined perimeters, a claim based on an axis had only the linear dimension of its axial lines. In the colonial land records, the axis typically intersected at the center of the town to be settled. The town proprietors, untrained in the surveying profession then on the rise back in England, had limited ability to measure and describe these lines as they moved away from the central point, thus ensuring the linear elasticity of the axial distances. The corners remained undefined and unbounded by a box, with infinite potential for stretching into additional regions of Native territory.

For example, the 1671 Native deed for territory which would become New Milford, defined a tract of land seven miles by six miles (Figure 4) (Wojciechowski, 1992:232). Simsbury was defined as ten miles north of the Farmington boundary and ten miles west of the Windsor boundary, although neither of these latter town boundaries had been run at that time (PRCC 2:127). In both New Milford and Simsbury, the vaguely defined corners of the axis, though useful mechanisms for encroaching on unpurchased lands, resulted in future Native land disputes in those corner spaces.

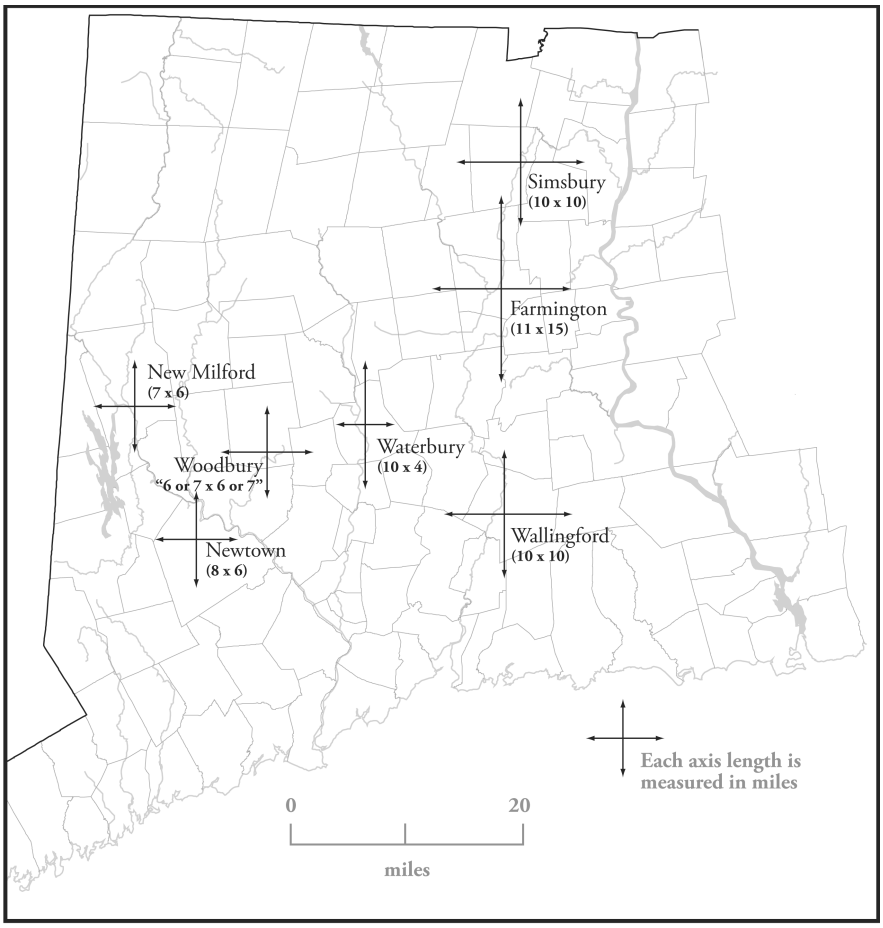


Figure 4. An axis gathers up land while leaving the perimeter undefined.

In the 1673 land sale at Woodbury, there was some initial attempt by the Potatucks to keep the axis distances under control. In the Potatuck conveyance, the territory was defined as an axis four miles by two miles, but with a defined perimeter of meadows, rivers, and existing home lots, as well as details about interior places included in the transaction (WTR, v. 2: 137). By the time of the 1683 patent, however, this specific axis with edges and details was redefined as an open-ended axis: seven miles by eight miles (Conn. Arch. TL, 1st Series, VIII:152). The axial expansion of the patent beyond that of the Native deed resulted in disputes and retroactive purchases with the Potatucks until 1759 (WTR, v. 12:119).

"Encroachment was achieved by marking trees outside the perimeter of the negotiated parcel."

Mark Trees

A third encroachment technique was to witness the corners by tree marking. Firm lines defining the edges of town boundaries were rarely a part of town boundary mapping in Western Connecticut until the final survey. Instead, edges were delineated by two or three marked trees or stones as the official "corners," the marking of which was an important part of the mapping process. Encroachment was achieved by marking trees outside the perimeter of the negotiated parcel.

For example, this technique was used by Wallingford colonists in New Haven Colony in 1660 to encroach on land held by the competing Connecticut Colony. Wallingford proprietors extended their boundaries further to the north onto territory claimed by Connecticut Colony by

marking and witnessing of trees in that region. They further authenticated this encroachment by recording that the tree-marking was performed by Mantowese, a Quinnipiac person with whom the original Wallingford town boundaries had been negotiated (Conn. Arch. TL, 1st Series, IV:66).

This technique is similar in spirit to that described by Roper of moving a boundary line on a map in order to take in more land (Roper, 1998). If a perimeter must actually be marked (whether on land or paper), one can still find opportunity for encroachment by placing the mark in a more expansive way. In the case of Wallingford, however, the strength of the encroachment hinged on Native involvement. Witnessing the corner was as much a Native mapping technique as it was English. Had the tree marking been performed by colonist alone, the claim would have been significantly weakened.

Affect a Native Style

"If a perimeter must actually be marked (whether on land or paper), one can still find opportunity for encroachment by placing the mark in a more expansive way."

In one case in the study area, proprietors used Native mapping style, or the appearance of such, as a device for authenticating a fraudulent claim to unpurchased lands. In a document filed in Woodbury in 1673, colonists drew a graphic map in a Native mapping style in order to give the appearance of having legitimately negotiated a land sale with the Indians for the site known as Pomperaug (Figure 5) (WTR v. 2:136).

This forged document was filed in the same year as Woodbury's controversial axial deed mentioned previously, a deed in which the Potatucks conveyed a tract of land disappointingly small to the proprietors. Frustrated by the unwillingness of the Potatuck people to relinquish Pomperaug to the Woodbury proprietors, an anonymous author fabricated a deed from words and pictures which recounted the sale of Pomperaug by Kenonge, Aromockomye, and Wecuppemee. To lend credibility to the forged document, the unknown mapmaker drew all line features as undifferentiated, solid, single lines, and all point features as undifferentiated, abstract, open circles, as was then typical of Native graphic style (Lewis, 1986). In Figure 5, the village of Potatuck on the Housatonic River, and the island on the Shepaug River, are depicted in the open-circle style; the Housatonic, Shepaug, and Pomperaug Rivers, and Eight Mile Brook, are depicted in the straight, geometric framework style. The success of this encroachment was temporary; a reading of the town records indicates that Potatuck people disputed the authenticity of this transaction at least by 1682 (PRCC v. 3:102; Wojciechowski 1992:207)

Native Re-Mapping and Resistance at Tunxis

Throughout the study area, the town proprietors' strategy of encroachment through various mapping techniques did not go unnoticed by Native people. Potatuck, Paugussett, Weantinock, Massaco, Mattatuck, and Tunxis people all actively disputed the encroachments at the town and colony levels, particularly in the late seventeenth century, using oral, written, and graphic mapping testimony to clarify the territorial descriptions in agreements and conveyances. Nowhere was this more powerfully illustrated than at Tunxis, the place that was eventually colonized as Farmington.

Tunxis Sepus, later abbreviated to Tunxis, was the site of a Native village and planting ground on what is today the Farmington River. In 1645, the colonial court granted permission to a group of proprietors to settle this place as Farmington. The town bounds were hazily described as a tract five miles by ten miles, with permission to "improve" an additional

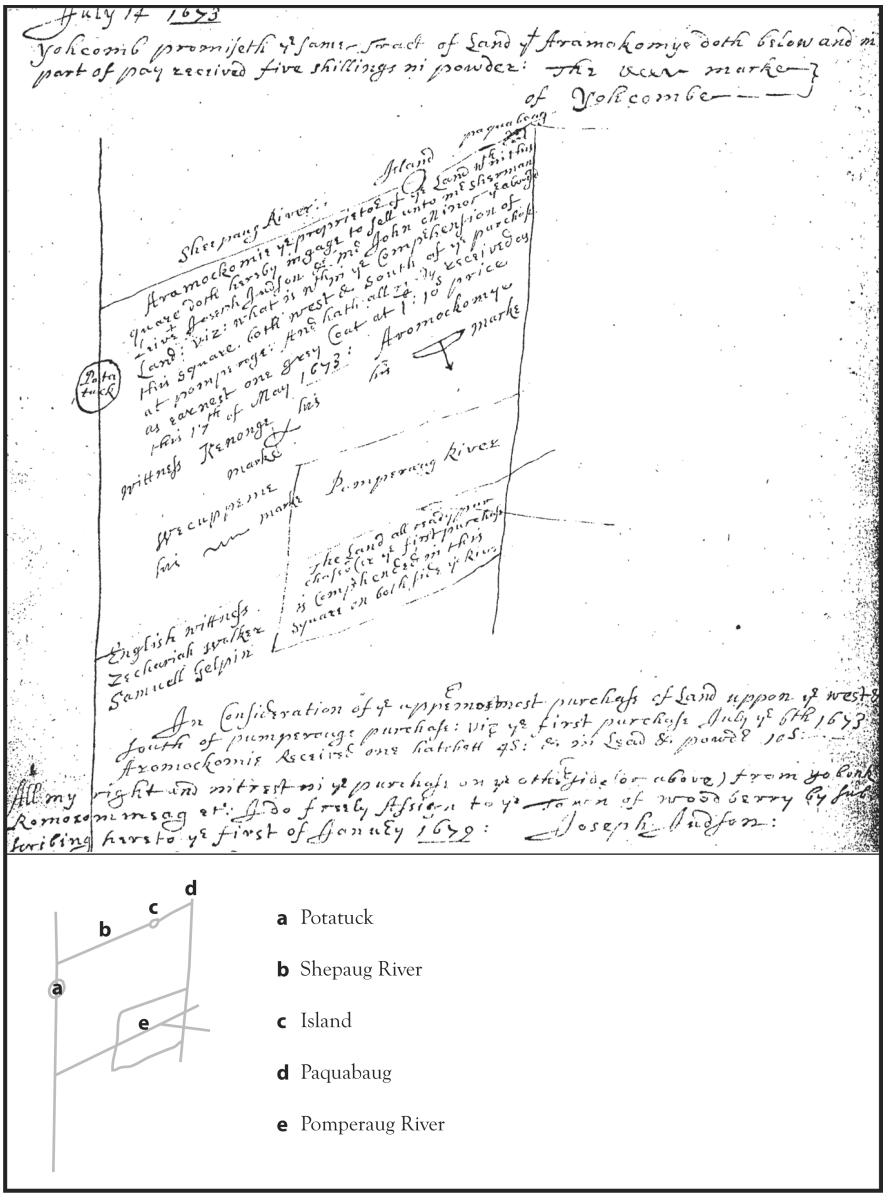


Figure 5. A fraudulent deed in Native style.

ten miles beyond the five (PRCC v. 1:133-34). The legal basis for this colonial settlement was a 1636 verbal purchase from an individual, the details of which were never recorded. From these dubious beginnings, colonists steadily began moving to Farmington from the Connecticut River Valley to compete for land with the Tunxis people.

By 1650, disputes between Tunxis and English land rights culminated in a deed to define which lands were reserved solely for Tunxis people. These territories were mapped as

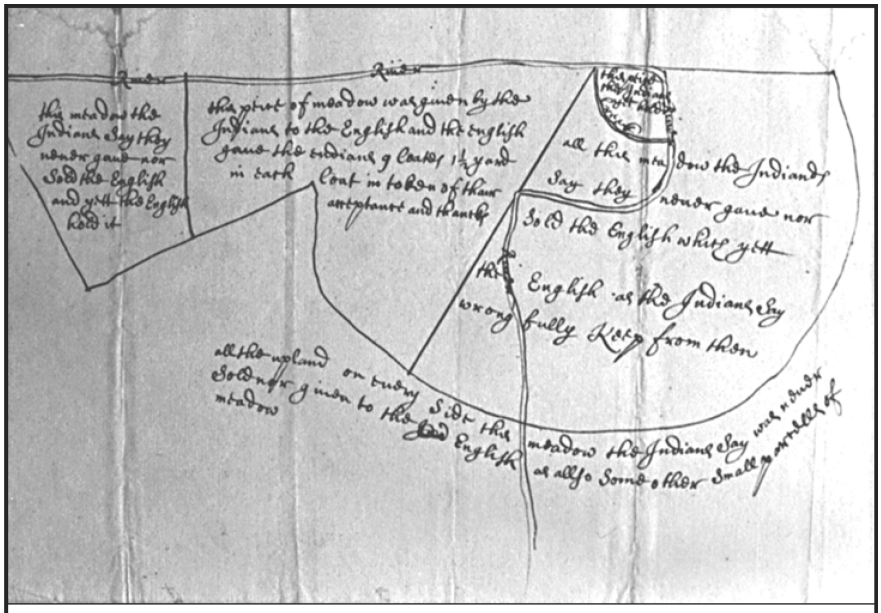
> *Reserve ground in place together compassed about with a creke & trees, and now also too bee staked out…. allso one Little slipe which Is allso to be staked out to prevent Contention* (FLR, v. 1:2)

Despite the recording and staking of this Tunxis reserve, the bounds were not respected by colonists. On May 13, 1672, the Tunxis petitioned

the General Court for return of their rightful territory, explaining that "*wee shall have ground to believe that there is yett Justice to bee had from the english which is all wee desire*" (CHS ms., 1672). In the petition was a graphic map, annotated by the court's clerk, explaining the delineation of territory in specific terms (Figure 6). As can be seen in the Figure, the Tunxis specifically bounded and described each parcel of land in its legal and political context.

A grievance committee was formed to resolve the Tunxis' claim, and the town records show the outcome of this committee in the form of a deed. Not to be out-mapped by the Tunxis, the English deed recorded three verbal mappings of the territory as well as a graphic map (Figure 7) (FLR, v. 1:43).

The difference in mapping between the initial petition in Figure 6, and the subsequent deed in Figure 7, is striking. In the deed, the town is once again mapped in terms of its theoretical axis, now extended to a full eleven by fifteen mile tract. A perimeter box is carefully included, but the



a this meadow the Indians say they never gave nor sold the English and yett the English hold it

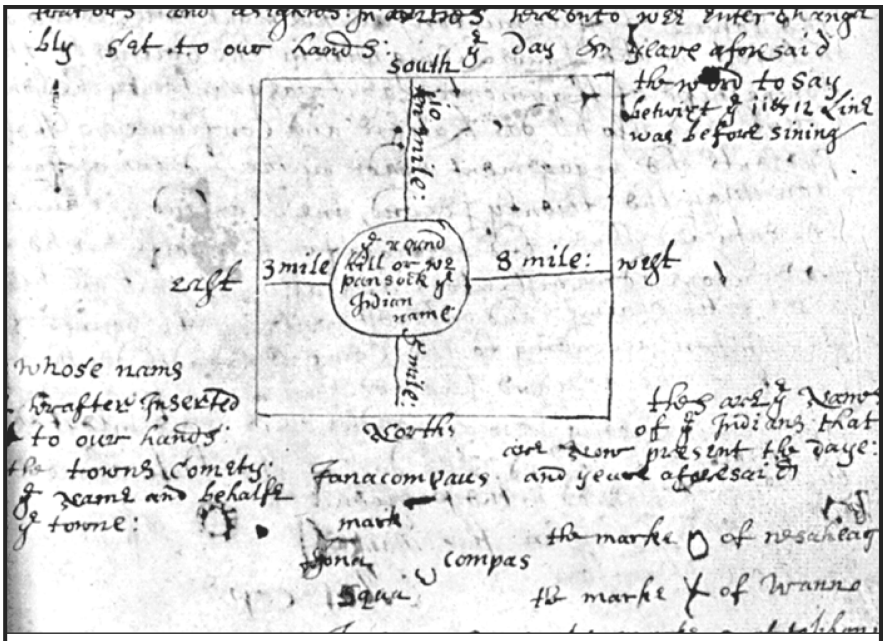
b this piece of meadow was given by the Indians to the English and the English gave the endians 9 Coates 1 1/2 yard in cloth Cloat in token of thair acceptance and thanks

c this piece the Indians yett hold

d all this meadow the Indians say they never sold the English which yett the English as the Indians say wrongfully keep from them

e all the upland on every side this meadow the Indians say was never sold nor given to the English as allso some other small parcells of meadow

Figure 6. The Tunxis petition to the General Court.



south

east b a d west

c

e

north

a ye round Hill or wepansock ye Indian name

b 3 mile

c 10 ten mile:

d 8 mile:

e 5 mile:

Figure 7. The deed in settlement of the Tunxis petition.

corners of the box are not described, and so remain efficiently disconnected from and undefined by the landscape. As was the convention, the axis is centered on a Native place, but the significance of this place to the Tunxis complaint is over-stated, if not fiction. Labeled "*Ye round hill or wepansock ye Indian name,*" there was indeed a hill north of the river and near to the land parcels in dispute. But the hill was relevant to the English axis, not the Tunxis claim; the hill is neither described nor portrayed in the Tunxis petition, nor does the name "wepansock" appear in any other Farmington document, Native or non-Native.

In the deed's narrative, the committee acknowledges that the Tunxis retained rights to "*two hundred acres of upland within ye Lands of their plantation…forthwith to be measured out to them*." In a postscript, there is also mention of Tunxis rights to land at Indian Neck. But there is no description of the location of Indian Neck, nor of the previous two hundred acres. Where the Tunxis petition is precise regarding relative locations of parcels and their ownership histories, the colonial deed is vague or

silent. And yet, the deed map appears to carry all information necessary for a legal land transaction, including a Native toponym, a graphic map in visual response to the Tunxis graphic, and verbal reference to Tunxis parcels.

The Tunxis claim to Indian Neck, the center of their territory and the coveted planting ground so desired by Farmington colonists, was repeatedly mapped in the town records with precision by Tunxis, and with ambiguity by English, in an ongoing struggle which continued for the next 100 years. In 1674, the Farmington proprietors voted to record Tunxis claims to the land at Indian Neck in the town records, but this record never transpired (FTMR v. 1: 273). In 1738, Tunxis men Jonathan Nopash and John Tanon appealed to the General Assembly to protect their rightful claim to Indian Neck, requesting that it not "*be sacrificed to satisfy the avaricious humour of designing Englishmen*" (Conn. Arch., IS I, 1:171). In 1767, the General Assembly heard another appeal for protection against encroachments at Indian Neck. In his testimony, James Wowowas summed up the settlement pressure at Indian Neck,

> "*which piece of ground the English people, Inhabitants of said town, have from time to time by little and little entered and encroached upon until they have gotten almost the whole thing*" (Conn. Arch., IS I, 2:172).

"The encroachments of the maps had effectively supported the encroachments on the ground, but because of Tunxis resistance and precise re-mapping, the process had taken a century."

By 1774, Tunxis people had lost the political power to remain on their land. The planting ground at Indian Neck was subdivided and sold as three lot sections, and the money funded the Tunxis removal to Oneida, New York (Conn. Arch. IS I, 2:193-94; CHS Ms 75832, Indian deeds 1774-1806; Bickford 1982:159-60). The encroachments of the maps had effectively supported the encroachments on the ground, but because of Tunxis resistance and precise re-mapping, the process had taken a century. On the eve of the Revolution, the Farmington colonists had finally, in Wowowas' words, "*gotten…the whole thing*."

The Importance of Being Precisely Vague

In summary, throughout the colonial period, English proprietors in western Connecticut utilized many mapping techniques in order to achieve their goal of obtaining as much unpurchased Native lands as possible. The most prevalent of these techniques, the removal and replacement of Native toponymy with English, was borrowed from the devices of colonial, printed cartography. But English colonists also developed other mapping strategies, twisting the meaning of the Native toponyms themselves, as well as making use of the axis, tree-marking, and even Native mapping style to claim lands not legally purchased.

In part, these differences from the techniques of the printed map industry were the direct result of scale. There was no use, for example, of lines of latitude in the town boundary descriptions, nor were there any instances of the use of the grid as a device for claiming control over adjacent areas. The differences may also have been the result of training because town proprietors possessed little if any formal training in land survey. Finally, the colonial techniques were developed to accommodate and manipulate the activities of Native people, with whom each land parcel was mapped and negotiated, and who retained a legal right to contest encroachments in the colonial courts until the eighteenth century.

Although the cartographic techniques ranged from written to graphic to marks on the landscape, they shared a common quality of stretching to include as much territory as possible while simultaneously remain-

ing vague as to the limits of that territory, all within an aura of precision. Faced with Native peoples who were exacting both in their bounding of territory and in their protocol concerning rights to that territory, Connecticut colonists focused on techniques that would blur those precise bounds and avoid the certainty of the borders between land purchased and land reserved. The cumulative effect of the resulting locational ambiguities were so effective that, a century later when the towns were carved, felled, and grazed, and Native people pushed into poverty at the colonial margins, frustrated surveyors labored hopelessly to find exactly the boundary where one town ended and the next town began.

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IS Indian Series
TL Towns & Lands

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[1]The necessity of taking a processual approach to the interpretation of Native maps is described by Robert Rundstrom, in Rundstrom 1991. In this approach, maps cannot be studied as separate *objects*, isolated from the mapping *processes* which produced them. Rundstrom noted that this is especially true for indigenous cartography because it comes from incorporative, rather than inscriptive, cultural practices, and so cannot be disengaged from process.

The Cartographic Heritage of the Lakota Sioux

This article serves as an introduction to traditional cartographic tools and techniques of the Lakota Sioux people of the northern Great Plains. The study reveals that the Lakota created maps and utilized other cartographic tools that, while not following a western system of coordinates, grids, and scales, were nonetheless accurate instruments for navigation to important routes, landmarks, hunting grounds, and sacred sites. The tools and techniques utilized included oral transmission of cartographic data, stories and songs in the oral tradition, stellar cartography, hide maps, petroglyphs, earth scratchings, and various other physical and spiritual markers.

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INTRODUCTION

> It is safe to say we know very little about maps and mapping in indigenous cultures.....there is the persistent European and Euro-North American problem in overcoming the Cartesian dualism of mind and world.....
>
> Robert Rundstrom (1991:2)

For over two centuries, the American Indian has been the subject of continuous study, empathetic interest, cultural curiosity, and romantic idealism. Cartographers, like anthropologists, linguists, and historians, have focused their attention on the American Indian. The greatest share of this cartographic focus, however, has analyzed maps that Indians verbalized or sketched at the request of soldiers, fur traders, mercantilists, and interested others. Lacking in historical American Indian mapping studies are works that focus on maps made by indigenous peoples specifically and solely for use by those indigenous peoples. As noted by Woodward and Lewis (1998), the reasons for this particular oversight in indigenous cartographic scholarship are many: the lack of cartographic artifacts with which to study and analyze, and the confines of western thinking as to what—physical artifact, song, poem, dance—makes a "map", to name a few.

From the author's experience, the primary reason for neglect of the subject lies in pre-conceived EuroAmerican notions of what constitutes "authentic" or "reliable" information. With few exceptions, American Indian peoples held records of their experiences, histories, and beliefs in a highly organized oral tradition, told and retold with remarkable accuracy to countless generations through time. Language was not simply a means of gathering or passing on information, but a vibrant, changing, creative force (White Hat, 1999b; Foley, 1998). The word was vital, a dynamic vehicle used to relate tribal customs, record histories, narrate creation stories, instruct the young, invoke spirits for assistance, entertain the people, and pray. In some American Indian cultures, words were also viewed as "animate, generative beings", carrying great power (Lincoln, 1983). In the past, however, it has been all too common for researchers to

dismiss these oral histories and traditions as "pre-literate", and therefore consider them less accurate and less authentic than those stories, songs, and poems written down and committed to paper. Somehow, as mankind became more literate, distinction and value became attached to those literate members of society, while those who were not lettered found their oral traditions discredited and suspect, often labeled as "primitive" and worse, unreliable (Lord, 1991). It has been documented, however, how long stories and songs passed in the oral tradition may be kept without being written down, whereas many literary persons cannot remember their grocery lists without scribbling them on the back of an old envelope. As noted by Dunbar Ortiz (1977), "For the European or the American, the oral tradition is weak. They do not pass on information very accurately, so they believe this is true of everyone." (100)

Thankfully, modern scholars of oral tradition warn strongly against this old misconception of the written word being more trustworthy—more authentic, more reliable—than the oral tradition. Because of this renewed appreciation for the oral tradition, the oral cartographic heritage of American Indian peoples has also begun to enjoy a renewed sense of validity.

When one considers both the oral tradition and nomadic nature of Plains Indian societies, and imagines their need for varied cartographic tools and techniques, the need for more scholarship on this aspect of Indian mapping becomes readily apparent. This paper seeks to bring together disparate fragments of cartographic and geographic data imbedded in larger works on Lakota culture, oral traditions, and American Indian cartography, combining those fragments with other analyses to begin work on the cartographic heritage of the Lakota Sioux.

"For the European or the American, the oral tradition is weak. They do not pass on information very accurately, so they believe this is true of everyone."

THE LAKOTA

The American Indians that this study concerns itself with call themselves the *Lakota*, as distinguished from their relatives the *Dakota* and the *Nakota*. Lakota, Dakota and Nakota are all dialects of the same Siouan language, each name meaning "allies" in their respective dialects (Hassrick, 1964). Though the dialect spoken by the Lakota varied slightly from that of the Dakota and Nakota in sentence structure, use of vocabulary, and pronunciation, the differences were not significant enough to impede communication. Four separate tribes—the Mdewakatnun, Wahpeto ŋwaŋ, Wahpekute, and Sisitun—spoke the Dakota dialect, while another two tribes—the Iha ŋktu ŋwan ŋ and Iha ŋktu ŋwa ŋi—spoke Nakota (White Hat, 1999b). Together with the Tito ŋwa ŋ, the only tribe that spoke the Lakota dialect, the seven tribes formed a loose confederation called the *Oceti Sakowi ŋ*, or the "Seven Council Fires." This was the proper name for the collective peoples. The name "Sioux," as they were commonly referred to, was a misnomer and a distorted abbreviation of an Anishinaabe (Ojibwe) word meaning "snakes" (Buechel, 1939). Given this fact, it is perhaps not surprising that the Lakota, Dakota, and Nakota people of today generally prefer not to be called "Sioux." It is because the people are typically known by this name, however, and have been written in the history books as such that I include the name in my title.

Jesuit reports from *circa* 1640 place the Oceti Sakowi ŋ people in the Upper Mississippi River Valley, living in present-day Wisconsin, Iowa, Illinois, and Minnesota (Swanton, 1952; Terrell, 1971). They were Woodlands peoples, subsisting in the forested environs by hunting, fishing, and gathering such foodstuffs as roots, berries, and wild rice. The western migration of Europeans from coastal Canada and colonial America in the

early 18th century, however, upset the balance of power among the various tribes of the larger Great Lakes area. The colonial powers coaxed and coerced tribes for furs and cooperation by providing them with trade goods, including guns and ammunition. Alliances between the Europeans and tribes such as the Huron and Iroquois led to numerous battles and skirmishes for control of lands and resources, and effectively displaced many tribal peoples who were not able to protect and defend themselves against this new firepower. The Oceti Sakowiŋ people were forced out of their eastern homelands and into the Upper Missouri River Valley when the French armed the Anishinaabe against them (Schell, 1968; Buechel, 1939).

Though the exact years of their further westward migrations are not known with certainty, it is known that the Lakota and their relatives transformed themselves from a Woodlands culture into a Plains culture with amazing speed and stunning, unparalleled success (Terrell, 1971). Royal Hassrick, a noted Sioux historian, suggests that the Oceti Sakowiŋ tribes accomplished this remarkable transition in less than fifty years (1964). It is certain that the astonishing rapidity and success of this shift would not have been possible, however, without the arrival of the horse on the Upper Great Plains, *circa* 1740; the importance of this animal to the Lakota people, especially, can hardly be understated (Hassrick, 1964).

The Lakota were the most numerous and far-ranging of the Oceti Sakowiŋ tribes, traversing and occupying the land east from the Big Horn Mountains to the Missouri River, and north from the North Platte River to the lower Canadian prairie (Figure 1). As one of the most powerful and mobile tribes on the northern plains, however, the Lakota influenced a much larger territory, their presence being felt as far as the Rocky Mountains, the plains of central Kansas, and the Great Lakes. Indeed, given the strength, success, and reputation of the Lakota Nation at its height (*circa* 1830s-1860s), their influence was felt as far as the halls of Congress in Washington, D.C.; of all the Plains tribes, the Lakota were the most resolute in resisting EuroAmerican incursions upon their land (Hassrick, 1964; Terrell, 1971; Sioux Nation Black Hills Act, 1986).

This resolution to maintain their traditional way of life lead the Lakota into conflict with both soldier and settler on many occasions and on many fronts during the first half of the 19th century. Despite a successful end to hostilities and peace negotiation with the U.S. Government in 1868 at the Second Treaty of Fort Laramie, the discovery of gold in the Black Hills in the mid-1870s led to a tremendous influx of white miners and settlers onto the Lakota lands ceded to them by the treaty. The Lakota and their Plains allies fought back, but despite victories like the Battle of the Little Bighorn in 1876, the Lakota were subdued and forced onto reservation lands. A last, desperate effort to rid the land of the white man resulted in the massacre of hundreds of Lakota men, women, and children at Wounded Knee Creek in December of 1890, effectively marking the end of armed Lakota resistance to the U.S. Government (Hassrick, 1964; Dunbar Ortiz, 1977).

Like other nomadic tribes of that expansive and topographically diverse area, the Lakota required specific, accurate, and timely information regarding the spatial constructs of their world: locations of food sources, spiritual sites, seasonal camps, friends, and enemies. Their world was structured upon their knowledge and use of spatial information, and the ability to communicate and understand it ensured nothing less than their survival as a people.

Not unlike virtually every other North American Indian tribe, the Lakota had no written language, and therefore maintained a highly efficient,

Figure 1. Traditional Lakota Sioux range and sphere of influence at the height of their power, circa 1830-1860. Source: American Indian Almanac.

highly organized oral tradition (Lincoln, 1983; Warhus, 1997; White Hat, 1999b). In other words, the primary transmission of the tribe's cultural traditions, social values, and legends was spoken or sung, and passed down through the generations in such a manner. It was the Lakota's conviction that their oral traditions had their basis in fact. That these facts were relevant to the present generation permitted and assured transmission of those traditions.

Structuring Their World

STELLAR CARTOGRAPHY

The Lakota had a well-developed and distinctive cosmology, adapted to their needs for ritual and sustenance (Miller, 1997). The stars were *wakaŋ*, a term that involved power or contact with the spiritual world and something mysterious, holy, and incomprehensible. They were the "holy breath" of *Wakaŋ Taŋka* ("Creator," "Great Spirit," "Great Mystery"), and represented sacred speech that was explained through myth and ritual (Siŋte Gleska College, 1990). The stars played multiple roles in the Lakota cosmology. They were at once supernatural people of the sky, portals and paths to the afterlife, calendars, and written "scriptures" of sacred stories (Hassrick 1964; Siŋte Gleska College 1990). They were also cartographic guides, representations of the physical landscape mirrored in the heavens and essentially the Lakota's greatest, most accessible and, in their perception, most accurate map. The Lakota closely watched the ordered movements of the constellations, the planets, and the sun, which allowed them to construct the accurate celestial calendars needed to conduct their vital and necessary religious rites (Dugan, 1985; Williamson and Farrer, 1992). It was at those times when the solar and celestial bodies came together that

specific ceremonies were performed in specific places. As the sun moved clockwise through the constellations, the Lakota people moved clockwise through the sacred Black Hills. Their annual pilgrimage mimicked the sun's path on earth (Siŋte Gleska College, 1990; Sioux Nation Black Hills Act, 1986). During the three months between the vernal equinox and the summer solstice, the sun moved through four Lakota constellations that corresponded to four places in the Black Hills. The four ceremonies performed—the Pipe Ceremony, Welcoming Back the Thunders, Welcoming Back All Life, and the Sun Dance—were life-renewing rites, and therefore the most important of the calendar. It was important that the tribe, or representatives of the tribe, be at the proper Black Hills location when the sun entered the corresponding constellation because the Lakota believed that the ceremonies were performed simultaneously in the heavens by the *Maghpia Oyate*, or Cloud People, (Hassrick, 1964; Jumping Bull, 1999; LaPointe, 1976). The concept of "mirroring"—what is below is like what is above—was symbolized by the inverted triangle characters that appeared in Lakota pictographs. Though the triangle symbols used in the picture writings were flat, it was more accurate to perceive them as three-dimensional cones, as in the glyph illustrating Figure 2. The earth "cone" (bottom figure) and the star "cone" (top figure) combined to represent the mirroring belief (Siŋte Gleska College, 1990).

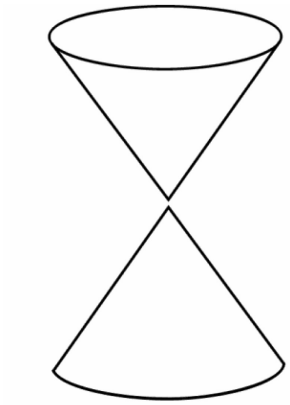

Figure 1. Symbol used to explain "mirroring" of heaven and earth0

Figure 2. Symbol representing the concept of "mirroring". Reproduced by permission from Siŋte Gleska University.

Use of the triangle symbol to represent stars or earth landforms was not uncommon in Lakota picture writing, and understanding this particular glyph is key to interpreting Lakota perceptions of space and navigation through that space. The symbol itself was used to reflect several different Lakota constructs. For instance, it described the correlation between the earth and the sky features and also the relationship between the sun and the dancers participating in the life-renewing Sun Dance.

The triangle ideogram also reflected the sacred construction of the Lakota's primary lodging structure, the *tipi*, or more correctly, the *tipestola* (Siŋte Gleska College, 1990; White Hat, 1999b). The Lakota believed that the construction of a tipi was more than the building of a shelter, something to keep out the wind and the cold; it was a map of their world, a microcosmic representation of the universe. Construction began with three poles, set in the ground and against each other to create a cone or a "vortex," mimicking the star "vortex" of the mirroring idea. This reinforced and affirmed the connection between the Lakota, as earth people, with the sky as well as the Cloud People. Seven more poles were added, symbolizing the seven directions. These directions were sacred, each endowed with powers, colors, personalities, and spirits: they lent stability and order to an otherwise chaotic world (Irwin, 1994; McGaa, 1990). Two more poles were added, enabling the tipi to both vent and take in air, thus symbolizing the give-and-take relationship between humans and the spirit world. Finally, the tipi frame was covered in buffalo robes. The buffalo was seen as an animal of the sun, life-giving and life-preserving. So in living inside the tipi, the people perceived themselves as living within the sun, within a star (Irwin, 1994; Siŋte Gleska College, 1990).

The Lakota calendar was constructed by extensive, experienced, long-term naked eye observations and interpretations. Because following the movements of the celestial bodies was so important to the people for navigational and spiritual purposes, there were within each tribal community special men designated as the *Wica'hpi yuha ma'ni*, or "The People Who Walk With the Stars" (Young Man Afraid of His Horse, 2000). It was they who noted and recorded such phenomena as meteor showers, comets, and lunar and solar eclipses (Figure 3), as well as regular celestial patterns like the movements of the planets, moon, and sun. These

Figure 3. A meteor shower as recorded in The Flame's (Lakota) winter count—"U" shaped figure represents the Moon. Source: Mallery's Picture-Writing of the American Indians.

events and celestial appearances provided sacred order and consistency to the people's yearly living. The *Wica'hpi yuha ma'ni* tracked the sun's position among the stars by watching both the set of a constellation to the east of the sun and the rise of the adjacent constellation to the west of it the next morning (Siŋte Gleska College, 1990; Williamson and Farrer, 1992). Careful observation of the constellations and mental notation of their heliacal movements allowed the Lakota to accurately predict the equinoxes and solstices, and thereby be in place for their spiritual rites and festivals.

CARTOGRAPHIC USES OF LANGUAGE

In order to successfully obtain, analyze, retain, and pass on cartographic information, it was essential for nomadic American Indian peoples to have two things in particular. The nomadic lifestyle was one of nearly constant movement—as such, a descriptive language capable of transmitting details crucial to the success of that mobility (landscape description, resource location, movement itself) was absolutely essential, for it assured their continued existence as a people. Indispensable, as well, was the powerful memory and observational training necessary to perceive and accurately commit spatial phenomena to memory. The Lakota had both of these. As observed by Powers (1986), "The creation of language, both sacred and secular, was an ongoing process with the Lakota; they loved their language and loved to analyze it, play games with it, remember it, and create it." (6) For the Lakota, language was not simply a means of gathering or passing on information, but a vibrant, changing, creative force (Foley, 1998; Lincoln, 1983; White Hat, 1999b). The word was both a critical instrument and a skill, something learned, practiced, and involving consequences and punishments for improper use. The ability to understand was just as important as the ability to describe; in other words, the job of listening was thought to be just as demanding as the act of narrating (Foley, 1985). Certain mnemonic devices were useful, but the primary transmission of an oral spatial description still depended upon the skill of both the listener and the conveyor.

"The creation of language, both sacred and secular, was an ongoing process with the Lakota; they loved their language and loved to analyze it, play games with it, remember it, and create it."

When teaching a young Lakota navigational tools and methods, he or she was strongly implored in all ways to understand fully the earth upon which he or she lived, knowledge that would only come through close observation. Children were asked to go out and look around, visualizing in their mind both what was, and what would be; where they were, and where they would be (Jumping Bull, 1999). This type of activity was an important element in developing a sense of place and placement. Rundstrom (1990) suggests that Indians were not naturally or instinctively better mappers than the rest of the world's peoples; it was in the "specific actions" taken during travel and how their mental organization, memorization, and recall was facilitated that was important to the Lakota's development of a sense of place. The importance of observation of the natural world was stressed to Lone Man as a young adolescent, as evidenced by the conversation he related to Frances Densmore *circa* 1915 (Jahner, 1987):

> "When I was a young man I went to a medicine-man for advice concerning my future. The medicine-man said: 'I have not much to tell you except to help you understand this earth on which you live. If a man is to succeed on the hunt or the warpath, he must not be governed by his inclination but by an understanding of the ways of animals and of his natural surroundings, gained through close observation.' The

> medicine-man told me to observe my natural surroundings, and after my talk with him I observed them closely. I watched the changes of the weather, the habits of animals, and all the things by which I might be guided in the future, and I stored this knowledge in my mind." (55)

Storytelling and song were vital components of the Lakota's oral tradition, ancestral voices remembered and reinvigorated by new voices. It was in the repetition of stories and songs that traditions and recollections of past events and places became part of the band's collective memory (Dunbar Ortiz, 1977; Vansina, 1985). The Lakota had scores of stories and songs in their tribal repertoire, a testament to the incredible memory skills of the storytellers and singers. Not surprisingly, Lakota stories and songs reflected the spiritual and nomadic nature of the tribe, often containing many references to the directions, journeys across the prairie, animals, the winds, hunting, and conflicts (Densmore, 1918). The Lakota embraced their nomadic way of life, and particular campsites held nostalgic memories for them just as certain places hold strong or pleasant recollections for people today.

The Lakota language was rich with words used to describe the landscape. As such, it provided very accurate and precise words and definitions that could be used for navigational purposes. The Lakota also gave names to the physical features of their landscape; these names, however, sometimes differed depending upon the time of year or season. A single place might have up to four different names, tied to either the physical appearance or social and spiritual usage of the place (Table 1). Use of a particular name was predicated upon the context in which it was spoken. Take, for example, the Black Hills in what is now western South Dakota. In most private or social settings the name *Re Sapa* ("Black Ridges"), or, more commonly, *Paha Sapa* ("Black Hills"), could be used

	Common	**Proper**	**Formal**	**Sacred**
Black Hills	*Re Sapa* (Black Ridges)	*O Onakinzin* (Sheltering Place)	*Wamaka Og'naka I'Caŋte* (The Heart of Everything That Is)	*Hocoka yapi* (The Center)
Harney Peak	*Paha Pestola* (The Peak)	*Ox'kate Paha* (Mountain of the Playful Thunder Beings)	*Hiŋhaŋ Kaga* (Owl-Maker Butte)	*Opahata I* (Mountain At the Center Where He Comes)
Devil's Tower		*Mato Tipi/Tila* (The Bear Lodge)	*Hu Nump Otiwita* (The Home Sanctuary of Wisdom)	*Mato Tipi Ta* (Bear Lodge's Sacred Pipe Mountain)

Table 1. An example of common, proper, formal, and sacred place names assigned to Black Hills formations by the Lakota. Source: Sioux Nation Black Hills Act.

to identify the place. If a more proper term of special respect were called for, the hills would be referred to as *O Onakinzin* ("Sheltering Place"), perhaps in reference to the protection the forested areas provided Lakota winter camps. *Wamaka Og'naka I'Ca ŋte* ("The Heart of Everything That Is") was a very formal name, denoting great spirituality. Finally, *Hocoka yapi* ("The Center") was the ultimate sacred name, reflecting the Lakota belief that the Black Hills was the center of the universe. This term was only used in the deepest of spiritual settings, and perhaps only within the Hills themselves (Sioux Nation Black Hills Act, 1986). It was essential that a Lakota be familiar with these ways of naming places; proper navigation of his physical landscape depended on it. Certainly, strict Lakota etiquette required proper usage of names: for the Lakota, one of the most humiliating situations was to be found speaking improperly or incorrectly (Black Elk, 2000; Hassrick, 1964).

The Lakota language also adopted and incorporated many terms for cartographic objects and concepts not traditionally found in the Lakota world, many times at the persistent request of outside persons who attempted to put down the language in written form. Few cultures actually developed writing from within their own society. Those cultures that did often found that written phonetic and grammatical restrictions crippled or lessened their culture's diverse oral discourse (Lord, 1991). According to Lewis (1998), "Word lists and dictionaries of Indian languages compiled after contact tended, at least until recently, to be unrepresentative of complete vocabularies, omitting many words that were not important in the contexts of Indian-European discourse. Conversely, Indian languages developed new words for embracing European categories." (63) This observation holds true for the Lakota dialect. For example, *A Dictionary of the Teton Dakota Sioux Language* (originally published in 1939) lists *mako owapi* as "map," made up of the root words mako ("earth") and owapi ("figured, written"). The lexicon also lists *mako gmigma* as "globe," combining *mako* with *gmigma,* meaning "to go round like a wheel" (Buechel, 1939; White Hat, 1999b). These words were not part of the traditional Lakota vocabulary, but rather were created by the Lakota to accommodate EuroAmerican objects and concepts. It is, however, an example of how Lakota people continued to be consulted and asked to bestow names on newly introduced technologies. It hints at the language's flexibility (Powers, 1986; White Hat, 2000).

SPATIAL PERCEPTIONS AND MENTAL MAPPING

The Lakota's perception of space was notably different from that of EuroAmericans (Irwin, 1994). Their world was perceived and experienced through a complex interaction of personal history, tribal traditions, and relationships between other tribespeople and the animal and natural resources they depended upon (McGaa, 1990; Warhus, 1997).

A fundamental organizing principle of Lakota visionary topography was direction. Direction was not a principle derived from coordinates of latitude and longitude, but a spiritual, dynamic form of cosmological orientation. The directions included not only the literal direction, but also realms of significance that were structured through visionary experience, ritual movement, object use, and oral narratives (Irwin, 1994; Siŋte Gleska College, 1990). The Lakota recognized seven directions: north, south, east, west, up, down, and center. Each direction included a fluid complex of qualities and powers emphasizing colors, particular beings, physical spaces, and stories that are ingrained in Lakota dogma and oral tradition (Hassrick, 1964).

The primary direction of the Lakota worldview was the center, which could be and was at once anywhere and everywhere (Sundstrom and Fredlund, 1996). The importance of the center—the center-place as a sacred pivot, a physical landmark, or structuring of the world with one's own group at the center—was a common belief in many American Indian cultures, and not simply unique to the Lakota (Nabokov, 1998). A spiritual center could be created by praying with a sacred pipe to the seven directions; any place where a visionary experience occurred or was invoked became a center and a place of power. The sacred pipe, which was itself a center and at the center, facilitated these visionary experiences (Irwin, 1994).

An individual's perception of the earth allowed him to create his own mental map, detailing his perceptions of and experiences within his known world. Some places were known from first-hand experience, acquired through personal travel and reconnaissance across the plains; considering the Lakota's large range of terrain, this personal mapping in itself would be impressive. The Lakota also knew detailed information and descriptions of places unseen and far away, as complex mental images of new places were formed with the information obtained from speaking with both members of other tribes and Oceti Sakowiŋ people. Places that otherwise might have remained little more than names were fleshed out, described vividly and in deep detail. These "verbal reconnaissances" enabled the people to identify phenomena outside their considerable traditional range, including the location of food, material resources, various tribes, and the furthest incursions and settlements of the ever-encroaching American nation.

"An individual's perception of the earth allowed him to create his own mental map, detailing his perceptions of and experiences within his known world."

An individual's own mental map detailed his perceptions and experiences within his known world, but his maps could also be informed, enhanced, and altered by the spiritual experience. In the Lakota world, the spiritual took precedence over the physical. An example of this can be found in a map constructed by Amos Bad Heart Bull sometime between 1890 and 1913 (Blish, 1967; Sundstrom, 1997; Lewis, 1998; Siŋte Gleska College, 1990). The Bad Heart Bull map depicts the sacred Black Hills by using pictographic representations—ideograms—to denote eight sacred physical features, all within the confines of a red clay valley that encircles the Black Hills. This valley is known to the Lakota as *Ki Iŋyaŋka Ocaŋku*, or "The Racetrack," as it was here that the two-legged beings defeated the "four-leggeds" for control of the world. One feature included by Bad Heart Bull within the Racetrack, however, is in actuality not physically within the red clay valley. *Mato Tipila*, better known to EuroAmericans as "Devil's Tower", is a prominent landmark that is outside of the Racetrack by nearly sixty miles.

What was important about this fact was the clue that it gave concerning Lakota perceptions of spaces. By including Devil's Tower within the confines of the valley on his map, Bad Heart Bull was reflecting the Lakota belief that everything that is on the earth is "mirrored" in the sky, and vice versa; each Lakota constellation had a corresponding landmark on the earth, so in turn each landmark had a corresponding star or constellation in the heavens (Siŋte Gleska College, 1990; Young Man Afraid of His Horse, 2000; Jumping Bull 1999). The Lakota constellation that corresponded with Devil's Tower was *within* the celestial equivalent of the earthly Racetrack, the *Caŋ Gleska Wakaŋ*, "Sacred Hoop." Therefore, in placing *Mato Tipila* within the earthly Racetrack on his map, Bad Heart Bull was acknowledging the supremacy of the spiritual world over the physical landscape (Woodward and Lewis, 1998).

Though the Lakota people were far-ranging at the height of their dominance, increased constriction and inhibition of movement before their final relegation to the reservations played havoc upon their spatial perceptions. As the people were forced to become more and more sedentary, they were further separated from their traditional nomadic routes in space and time. Speaking Lakota and practicing traditional cultural ways was forbidden, and the number of elders who had personally traversed the routes decreased, many dying without passing on the information to the next generation. Over a relatively short period of time, these factors combined to ensure the number of places accurately remembered grew fewer and fewer. For example, the Dakota were relegated to eastern reservations on the northern plains; because of this, their perceptions of the west grew blurred. Eventually they perceived the Black Hills to be huge mountains, more like the Rockies than the forested, moderately-sloping granite hills they are. Conversely, the Lakota, who were placed on the dry western reservations, remembered eastern rivers and lakes as being much larger, transfiguring the glacial lakes and rivers of northeastern South Dakota and Minnesota into bodies the size of Lake Michigan and the Mississippi (Black Elk, 2000). The isolation and restriction of the reservation system interrupted the traditional Lakota way of obtaining and transmitting spatial information, thereby corrupting the Lakota's sense and perception of space.

Physical Cartographic Tools and Techniques

PICTURE WRITING

"Visual imagery is perhaps the most powerful and widespread factor in mnemonic systems."

As observed by Rubin (1995), "Visual imagery is perhaps the most powerful and widespread factor in mnemonic systems." (62) Though the Lakota had no written language, they did utilize pictographs, petroglyphs, characters, symbols, and stylized figures to convey information, and so developed a recognized "cultural system of symbolism" (Corum, 1975; Mallery, 1893). These designs could be found on animal hides, cliff faces, rocks, bone markers, or scratched into the earth, and were used to identify particular bands, record sacred visions or stories, indicate sacred spaces, denote tribal or individual events, and transmit cartographic data. Employed in lieu of a written language, the figures presented were generally synopses of a much greater event or idea that could not be successfully or completely portrayed by solitary figures. In these cases, the figures served as mnemonic devices for prompting the oral narrative that was meant to accompany the symbol. The most common example of this practice was the Lakota *winter count*, a pictorial record of important yearly events kept on a tanned hide by the tribal historian. Repetitive use of certain figures led to their abstraction, as with this example of figures (Figure 4) use to denote the Lakota as the *Pte Oyate* or "Buffalo People" (Mallery, 1893; Sioux Nation Black Hills Act, 1986). Use of these stylized images accurately communicated information, and at the same time prevented the loss of power or integrity that was taken away from a thing when it was depicted too realistically (Douville, 1999).

Tanned animal hides were used for many different types of recordings (Hassrick, 1964; Lewis, 1998). Perhaps because of their size and curing qualities, buffalo or deer hides were most often selected to construct winter counts, tipi covers, clothing, and other items of day-to-day life. Natural earth colors of green, black, yellow, and red were mixed with animal fat to make paints, and applied with a small bone, rock, or willow branch to create the desired image or pattern (Corum, 1975).

Figure 4. Abstract and realistic "signature" mark indicating the Lakota as the Pte Oyate*, the "Buffalo People". Source:* Sioux Nation Black Hills Act.

HIDE MAPS

The Lakota also cured hides to create maps (Black Elk, 1999; Siŋte Gleska College, 1990; White Hat, 1999a). This traditional cartographic practice had been all but forgotten until the revelation of a map in the mid-1980s, and discovery of it startled even Lakota researchers and scholars (Lewis, 1998; Siŋte Gleska College, 1990). Since then, the existence of at least two and perhaps three other maps has been revealed; unfortunately, these maps are not available for examination, so no in depth description or analysis of them is possible at this time. The maps were traditionally entrusted to medicine men, and seem to have served mostly as mnemonic prompts for personal recollections and educational tools for instructing the young (White Hat, 1999a). In the aftermath of reservation relocation, people were fearful of keeping things belonging to the old ways. In many instances, the maps were buried with their keepers when they died (Douville, 1999; White Hat, 1999a). With the maps disused and removed from public view, knowledge of them disappeared amongst most of the people. These days, existing maps are kept secret. They are rarely shown to others and never outside of the Lakota community; those Lakota to whom they are entrusted have been specially tutored to interpret them. This is important, since without proper instruction the hides may not even be recognized as maps, especially to western eyes used to identifying a map by its various western elements (Black Elk, 1999; Siŋte Gleska College, 1990; Sioux Nation Black Hills Act, 1986; Young Man Afraid of His Horse, 2000). Thus it is possible that other hide maps exist, perhaps in museum archives or private collections, and that these maps have not yet been recognized for what they are. That possibility raises some concern about the condition of these hides; even the best-tanned and well-protected skins may only last a decade or so before they begin to deteriorate. At some point, such maps need to be re-copied onto newer skins if their information is to survive (Douville, 1999; Woodward and Lewis, 1998).

"In the aftermath of reservation relocation, people were fearful of keeping things belonging to the old ways."

Persons who have glimpsed the maps describe them as either earth maps (mapping features of the physical landscape), star maps (mapping positions of celestial bodies), or a combination of the two (Black Elk, 1999; White Hat, 1999a). The best account of one of these maps was described by a Lakota who was only allowed a very brief glimpse at the hide many years ago, and who has not been invited to look at it again since that short encounter—because of the nature of this experience, the author honors the individual's request to remain anonymous. The observer describes a joint land/sky map, referred to as the *Mar´piya Makoce Xina,* or the "Robe of Heaven and Earth", painted in color on a large buffalo robe. Mapped on the robe are some of the most sacred Lakota sites in the Black Hills. A large marker of two triangles, one on top of the other to form a shape not unlike an hourglass, represents the North Star and the Black Hills. The presence

of this particular glyph indicates the "mirroring" belief, and signals that the map does not simply show earth landmarks but star configurations as well (Black Elk, 1999; Siŋte Gleska College, 1990; Sioux Nation Black Hills Act, 1986). Upon the robe are scattered red and blue symbols: red symbolizing points in a valley or junctions of rivers or streams and blue denoting mountains, hills, or other landmarks (Sioux Nation Black Hills Act, 1986). Further study and analysis of the map would undoubtedly prove very interesting and insightful; however, as stated previously, it is not readily available for scrutiny.

SPATIAL MEASUREMENTS

The Lakota, like other Plains tribes, computed distances based on a day's journey, a day being either from sunrise to sunset, or sunset to sunrise; in other words, the modern twenty-four period constituted two days from the Lakota perspective (Ewers, 1977; Sundstrom and Fredlund, 1996). The possibility exists, however, that the Lakota also had a spatial measurement system; this is not a phenomena so far encountered or documented in literature pertaining to American Indian mapping. Charlotte Black Elk is a great granddaughter of Nicholas Black Elk, whose life and experiences were chronicled by John G. Neihardt in *Black Elk Speaks* (1932). An authority on Lakota oral traditions, Ms. Black Elk maintains the Lakota measured larger distances in *taŋsuŋ*, a measurement roughly equivalent to seven miles (Black Elk, 1999; 2000; Sioux Nation Black Hills Act, 1986). Apparently, this spatial delineation was based on practicality. The nomadic Lakota bands considered it the minimum space needed to ensure that each group had sufficient access to wood, foodstuffs, water, and grazing areas without either significantly stripping or depleting these resources for the following year or infringing on another band's resources. Such spacing was, of course, dependent upon the terrain and climatic conditions of the season, but it was a good general rule of thumb. The practice also appears to have been observed in the establishment of permanent reservation settlements, as noted on the Pine Ridge Indian Reservation (Black Elk, 1999; Oglala Lakota College, 1985; White Hat, 1999a).

"The possibility exists, however, that the Lakota also had a spatial measurement system; this is not a phenomena so far encountered or documented in literature pertaining to American Indian mapping."

The larger distance measurement of seven miles, as opposed to that of one mile, was also more practical when considering the vast distances of the plains and prairies. In his mapping expedition of 1838, the French geographer Joseph Nicollet came upon some Siouan-speaking people—most likely Dakota rather than Lakota—and in the course of conversation asked where their next village site lay. He was told there was another village four *taŋsuŋ* downstream. Nicollet records that he and his company walked a distance of both four kilometers and four miles without locating the settlement. Finally, when they had gone nearly thirty miles, they came across the village the tribesmen had spoken about. Rather than ascribing a spatial association to the word, however, Nicollet concluded that the word *taŋsuŋ* was another term meaning "far" (Black Elk 2000; Bray and Bray, 1993). In doing so, Nicollet became yet another early EuroAmerican who had difficulties in translating or accepting American Indian geographical knowledge outside of the context of EuroAmerican scientific mapping.

MARKERS

The Lakota made use of other cartographic techniques and tools, some intended to be short-lived and others more durable. Locational boundaries were often identified by painted markers, such as trees or rocks. The only

designated entrance to the Pipestone quarry in what is now southwestern Minnesota, for instance, was delineated by trees painted with a red stripe. This quarry was hallowed ground for many Plains Indian peoples, as the soft red catlinite stone found there was used to carve sacred pipes, a vital component of most all religious ceremonies (Brown, 1953; Hassrick, 1964). Though the quarry was open to all, those who were not Ihaŋktuŋwanŋ Nakota (the protectors of the Pipestone) knew by the tree markings that they must wait on the periphery before being invited to enter the quarry. They were further required to participate in a cleansing ceremony, acknowledging the spirituality of the place and their respect for it; the cleansing ritual also protected the site from contamination (Oglala Lakota College, 1985).

As camps moved from place to place, it was sometimes impossible to wait for young men to return from various journeys. If routes through the area were known to be familiar to the returning parties, there was no need for any sort of indicator besides a directional one (Warhus, 1997). In this case, a signpost pointing in the direction that the camp was moving would be erected at the old village site. Because several bands may have been camped within a short distance of one another, symbols identifying the particular band that was on the move were included on the signpost in an attempt to avoid any possible confusion with other groups. Usually a pictograph representing the name of the group's headman would be used, along with additional hoof marks and travois pictographs indicating movement (Figure 5). The marker was fashioned from a buffalo shoulder bone and attached to a short stick (Hassrick, 1964).

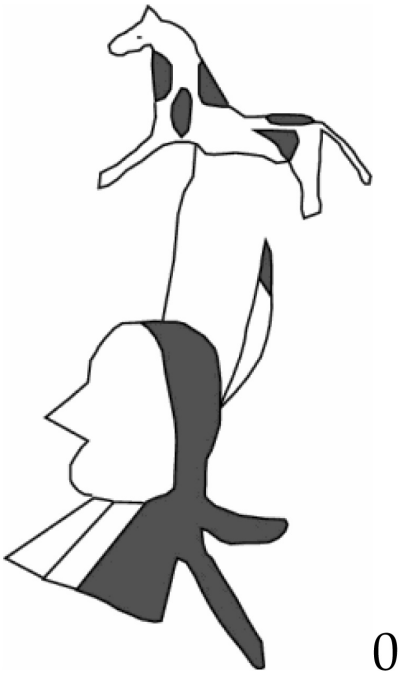

Figure 5. Pictograph representing a man named Spotted Horse. Source: Mallery's Picture-Writing of the American Indians.

Occasionally cairns (small rock piles) or large rocks would be encountered while traveling across the prairie. These stone markers served several different functions. The rocks could indicate the boundary between two territories. Often the people left them as directional markers, indicating which trail was followed. Sometimes, however, these cairns were set up as decoys to throw off an enemy pursuit, especially if a Lakota band was traveling close to unfriendly territory (Jumping Bull, 1999). In the pre-horse days, buffalo were killed when tribespeople on foot closed in and ran the animals over cliffs; an often-used cliff had specific stations designated by rock piles, indicating where the people must begin to tighten their perimeter around the herd (Hassrick, 1964). Circles of rock were constructed at vision quest sites, which those Lakota who were not seeking a vision avoided out of respect for the "sources of mysterious power" (Sundstrom, 1997). Rock piles were also built to shield warriors from the enemy's sight when they scouted their rival's position and strength. These vision quest cairns and shield piles, however, were most likely found on higher hills or bluffs, and not out on the open prairie where a moving camp was more apt to run across them.

The most ephemeral cartographic tool utilized by the Lakota was maps traced upon the earth. For quick referencing and explanation, a map could be sketched in the dirt or sand with a stick or finger (Ewers, 1977). Many times these sorts of maps were drawn by leaders when they needed to coordinate a raid but were unwilling to leave evidence of their passing behind, especially when in hostile territory (Hassrick, 1964).

PETROGLYPHIC MAPS

Pictures, symbols, or other artwork pecked, carved or scratched on natural rock surfaces are called *petroglyphs*. Many Lakota contend that several of the rock petroglyphs (*iŋyaŋ owapi,* "rock writing" or "stone inscribing") found in the southern Black Hills are hieroglyphic stone writings done by

the Lakotas themselves, and that some are maps. While it is certain that some American Indian rock art is maplike—portraying features resembling trails or landscape contours—difficulties in interpretation, dating, and authenticity leave this particular assertion open for debate. That these rock art displays are considered sacred locations today, however, is not disputed (Jumping Bull, 1999; LaPointe, 1976; Lewis, 1998; Nabokov, 1998; Sundstrom, 1997; Woodward and Lewis, 1998).

Various petroglyphs have been interpreted to represent supernatural worlds and spiritual interpretations of dream and memory; others were said to have supernatural powers attributed to them (Woodward and Lewis, 1998). Some Lakota believed that the petroglyphs were carved out by ancient peoples, or that they were predictions or warnings given to the people by spirits from the spirit world, foretelling war, spiritual encounters, the coming of animal helpers, or good hunts. It is also said that the inscriptions were done only at night by unseen carvers, to be read and interpreted in the morning light by medicine men (LaPointe, 1976). Ghost Head, a Lakota medicine man, was said to be able to predict the success of hunting and war parties by referring daily to a cliff upon which signs appeared to him, while the Lakota leader High Horse looked at petroglyphs and predicted the coming of the horse (Jumping Bull, 1999; Hassrick, 1964).

Two particular rock art sites in the Black Hills could possibly be ceremonial star charts. Each contains a cluster of small triangles, similar to the "mirroring" representations used on the hide maps to indicate astronomical and geological phenomena. Both sites also contain "mysterious" glyphs that cannot be directly "read" like other pictographic or petroglyphic art. Perhaps these sites suffer from the iconographic development described by Mallery (1893), in that the symbols were at first representations of identifiable images, but in time "became converted into ideographic, emblematic, or symbolic designs, and perhaps became so conventionalized that the images of the things designed could no longer be perceived by the imagination alone." (584) Proper interpretation of the petroglyphs, if they are earth/star maps, would probably require decipherment by a medicine man or other trained individual; an account of this deciphering, if there has been one, has not been recorded (DeMallie, 1984; Sundstrom, 1997). The lack of American Indians trained in—or perhaps it is a lack of access to American Indians trained in—the proper interpretation of petroglyphic and pictographic figures inhibits the accurate translation of many rock art sites. As noted by Sundstrom and Fredlund (1996), "If animal pictographs were used to represent places on rock art panels, researchers would likely interpret them as pictures of animals, not maps." (8) It is the old pitfall of not fully understanding the American Indian concept of map and the modes of spatial symbolism used to denote geographical detail and data. In any case, many of the rock art figures in the Black Hills undoubtedly contained an oral component that contextualized the images, and it is possible that component has long been forgotten.

CONCLUSION

This paper has focused briefly upon the cartographic heritage of the Lakota, an American Indian tribe of the northern Great Plains that historically lived a way of life contingent upon movement and navigation. Though the Lakota did not generate a written language, as such, the oral traditions passed on and cultural system of symbolism developed did serve to produce viable and accurate cartographic tools and techniques. The fluidity and descriptiveness of the language allowed cartographic and geographic information to be passed through everyday conversation, stories, place-

naming techniques, and songs. Close observation of celestial movements and topographical phenomena enabled the Lakota to create markers, and maps—both physical and mental—which allowed the people to successfully navigate both their spiritual and physical planes.

Absent from research concerning American Indian maps were analysis of those maps made by native peoples for use by themselves; this paper revealed that the Lakota created hide maps for their own use, utilized a complex symbolic system, and possibly developed a method of spatial measurement and delineation. While few studies of oral tradition have focused upon oral cartography as such, this study suggests how the precise, descriptive, and adaptable language of the Lakota was well-suited for accurate and specific descriptions of spatial phenomena. The work begins to fill in a gap in traditional Lakota cultural studies by bringing together disparate fragments of cartographic and geographic data embedded in larger works, combining these fragments with another analyses to start to understand the cartographic heritage of the Lakota Sioux.

Future research specific to Lakota cartography should include a more in-depth look at their spatial measurement system; if it can be studied and verified further, it will prove to be an exciting new chapter in American Indian cartography, as the number of indigenous scales known to EuroAmerican researchers is very few. Unfortunately, less likely is the possibility that a researcher will have the chance to study one of the hide maps known to be in private possession. An opportunity such as this could reveal new insights into traditional Lakota spatial construction, provided that cartographer had shed his or her western ways of thinking about a map and was able to approach the experience with open eyes. Though researchers continue to become more and more aware of and vigilant against the ingrained biases with which we approach native maps, we must constantly remind ourselves of that which we stand to lose should our efforts at "overcoming the Cartesian dualism of mind and world" fail—namely, the cartographic exploration of another world.

Though many facets of traditional Lakota cartography are only beginning to be examined and explained, Nabokov (1998) encourages further study of all indigenous peoples cartography, noting that the " ..cosmographies and cosmograms that Native Americans produced in order to orient themselves in worlds were just as real to them as those Rand McNally interprets for non-Indians today." (249)

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cartographic techniques

Using Valid Value Tables in Geodatabase Design to Define Feature Types

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Introduction

There are many ways to encapsulate semantic models in GIS and cartographic data. A semantic model is the set of terms used to describe features in the database or on a map. For instance, a semantic model defines whether a low-lying saturated areaperpetually on the landscape is called a swamp, marsh or bog. In order to make maps with GIS data, some part of the GIS data model must contain the data's semantic model so a mapmaker can symbolize the data for the map.

Valid Value Tables (VVTs) are a set of tables that may be used to store a semantic model in a geodatabase by defining the valid combinations of coded values that describe the kinds of features in the database. Coded values are numbers (requiring relatively small amounts of storage space in a database and low impact on digital networks) that represent larger, more descriptive, but inefficient text strings. Drawing data on maps in a GIS is faster when coded values are used to determine which symbols are used to draw features.

The **DI**gital **G**eographic Information **E**xchange **ST**andard (DIGEST) was the first semantic model that ESRI implemented using VVTs. DIGEST uses coded values to define the major kinds of geographic features, their attributes, and the values for the attributes [Digital Geographic Information Exchange Standard, 1999]. Although DIGEST does not identify features as points, lines or polygons, it does provide terms for the types of geographic features that might be included in a geographic database, as well as the types of attributes that those features might have. An example of the five-digit coded geographic DIGEST feature and its three-digit coded attribute is:

A heliport is encoded with a feature code of GB006 (Airfield) where G indicates that the feature is in the category containing Aeronautical Information and B indicates that it is some type of Aerodrome, and it is associated with the attribute APT (Airfield type) containing a coded value of 009 (Heliport).

In this example, letters are used to differentiate categories of information; however, these could be substituted with numeric values to make the database more efficient.

Coded values are also used by the U.S. Geological Survey (USGS) to define the features in Digital Line Graphic (DLG) files. In the DLG case, the coded values are stored as major and minor codes in pair combinations, and each geographic feature may have multiple major and minor "code pairs". Each major code consists of three digits indicating a major class of features, such as 050 which is hydrography. Each minor code consists of four digits identifying characteristics of a feature. The minor code may describe the basic feature type or it may indicate additional characteristics beyond the basic feature type. For example, the hydrography minor code 0412 indicates that the feature is a stream, and the minor code 0601 indicates that the feature is underground. If a feature has both of these codes it is an underground stream. The complete codes are 050.0412 and 050.0601.

Once extracted from the DLG format, the major and minor DLG codes are all displayed as numerals. For SDTS format data, entity codes, which are text strings of numerals, indicate the major code and the feature type code (e.g., 050.0412 in the example above), and the attributes are stored in fields specific to the feature type.

In both of these examples, both the major and the minor codes, or in the case of the DIGEST model, the feature and attribute codes can be considered an attribute of a geographic feature. Although the database storage of this attribute

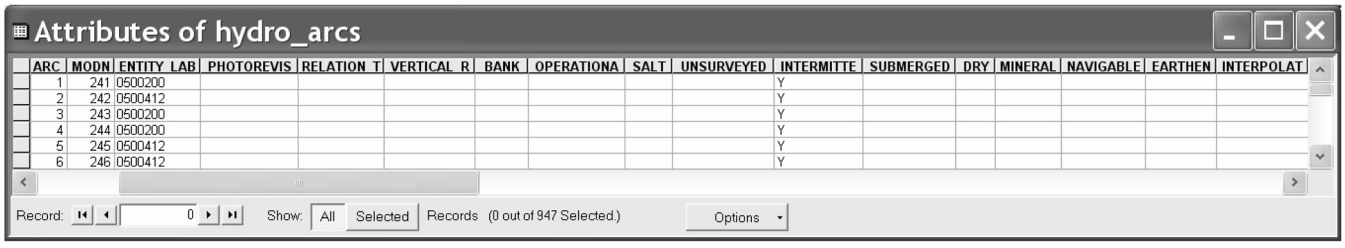
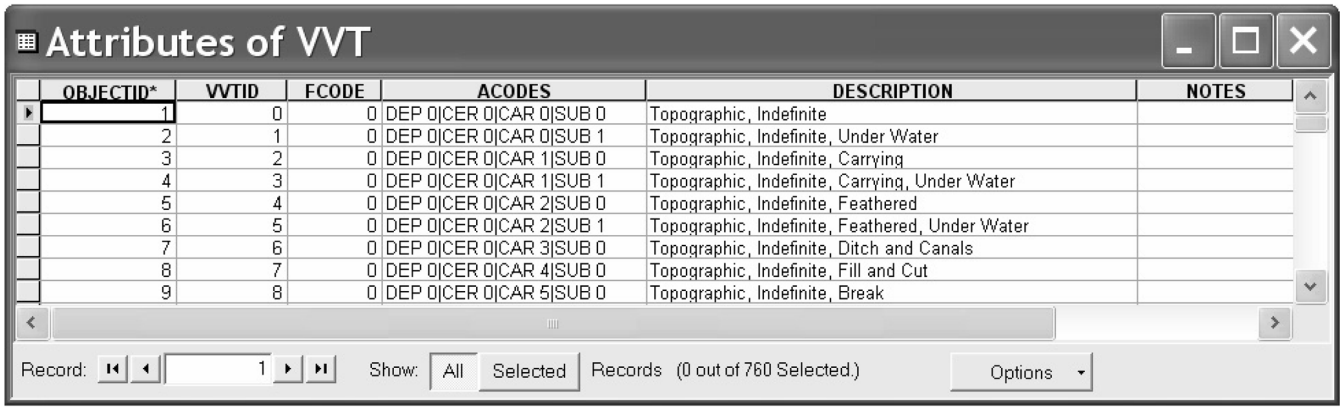


Figure 1. Portion of an attribute table for hydrographic arcs that were imported from the SDTS format. The Entity Label (entity_lab) field contains the combination major.minor code, and the remaining fields are attributes associated with DLG linear hydrographic features.



Attributes of VVT

OBJECTID*	VVTID	FCODE	ACODES	DESCRIPTION	NOTES
1	0	0	DEP 0|CER 0|CAR 0|SUB 0	Topographic, Indefinite	
2	1	0	DEP 0|CER 0|CAR 0|SUB 1	Topographic, Indefinite, Under Water	
3	2	0	DEP 0|CER 0|CAR 1|SUB 0	Topographic, Indefinite, Carrying	
4	3	0	DEP 0|CER 0|CAR 1|SUB 1	Topographic, Indefinite, Carrying, Under Water	
5	4	0	DEP 0|CER 0|CAR 2|SUB 0	Topographic, Indefinite, Feathered	
6	5	0	DEP 0|CER 0|CAR 2|SUB 1	Topographic, Indefinite, Feathered, Under Water	
7	6	0	DEP 0|CER 0|CAR 3|SUB 0	Topographic, Indefinite, Ditch and Canals	
8	7	0	DEP 0|CER 0|CAR 4|SUB 0	Topographic, Indefinite, Fill and Cut	
9	8	0	DEP 0|CER 0|CAR 5|SUB 0	Topographic, Indefinite, Break	

Record: 1 Show: All Selected Records (0 out of 760 Selected.) Options

Figure 2. A valid value table (VVT) for hydrographic lines. The VVTID is the foreign key that links to the primary key in the feature class attribute table. The ACODES are the valid descriptors and values for a given FCODE, the DESCRIPTION field carries a user-friendly statement of what the coded value combinations mean.

is complex because it consists of a major code and one or more minor codes, it still is logically a single property or descriptor of the feature.

Using the VVT approach, a VVT table contains the semantic equivalents of major and minor code combinations. There is a row in the VVT table that contains the full description for each type of feature. Each geographic feature attribute table has a VVTID attribute which links to a row in the VVT table. Entries in the VVT table include the feature types as well as any valid combinations of descriptors that apply. In this design, the codes themselves are treated like an attribute with a special kind of attribute domain.

These tables can be used as coded value domains in a geodatabase. Coded value domains can be used to specify a valid set of values for any type of attribute—text, numeric, date, etc. Coded value domains contain a simple value and a description of what that value actually means. The description makes using the coded value domain easier for the user.

VVTs can be used to extend the concept of a coded value domain because they contain a systematic structure for the valid attribute combinations. VVTs hold only those real combinations of feature codes and attributes, rather than all possible combinations. These combinations are easily exposed in common GIS activities, such as feature selection, drawing specified features using definition queries, editing and creating new features [MacDonald, 2002]. Despite these added capabilities, VVTs were mainly designed for cartography because not only the feature type often determines the symbology and labeling, but also by the characteristics of features [PLTS, 2003].

Anatomy of a VVT and Related Tables

The information in the valid value table is at the heart of this approach to modeling a semantic model. The primary contents of the VVT are the codes identifying the feature types and all their valid descriptor or attribute combinations. While other information, such as the feature class that the feature types are located within, can be also stored in the VVT, the most important information carried are the feature types and their valid attribute combinations.

In Figure 3, the main feature type is stored in an integer field called FCODE. There is also a DESCRIPTION field to help the user understand what that FCODE stands for.

The descriptors or attributes that completely describe a particular type of feature are defined by the ACODE range in the FCODE tableACODE range in the FCODE table defines the descriptors or attributes that completely describe a particular type of feature. As with the feature types, these values define discrete properties, not a numeric measurement. The ACODE, for the sake of efficiency, may be used for more than one feature class. Therefore, it is necessary to define all possible values for all the feature classes that will use a given ACODE. For example, aqueducts and pipelines can be at or near the surface, elevated, underground or unspecified; streams can be submerged, and contours can be underwater (for example, beneath the surface of a reservoir). Creating a single ACODE for all of these ensures that the semantic model is complete, and it simplifies the database design. The same ACODE can also be used for other features, such as control markers, telephone lines, and elevated railroad lines. Other examples of multiuse ACODEs that are useful for multiple feature types include positional accuracy (approximate, unknown, etc.) and operational status (under construction, aban-

Attributes of FCODE_VALUES

OBJECTID*	FCODE	ACODERANGE	DESCRIPTION	NOTES
1	0	DEP [0,1,2,3,4]|CER [0,1,2]|CAR [0,1,2,3,4,5]|	Topographic	
2	1	DEP [0,1,2,3,4]|CER [0,1,2]|CAR [0,1,2]	Bathymetric	
3	2	DEP [0,1,2,3,4]|CER [0]|CAR [0,1,2]	Glacial or Ice Surface	
4	3	CWC [0]|RTS [0,1]	Spot Elevation	
5	4	CWC [0,1]|PRM [0,1]	Horizontal Control	
6	5	TAB [0,1]	Vertical Control	
7	6	CWC [0,1]	Benchmark	
8	7	TAB [0,1]	Boundary Monument	
9	8	CWC [0]	Reference Monument	
10	9	CWC [0]	River Mileage Marker	

Record: 1 Show: All Selected Records (0 out of 193 Selected.) Options

Figure 3. The values for geographic feature types are stored in the FCODE table, which includes an FCODE field as well as a user-friendly description of the feature codes. Also included in this table are the ranges of ACODEs that are valid values for those feature types.

doned, etc.) A single ACODE that contains all possible attribute values that can be used for multiple features reduces replication and helps to simplify and clarify the semantic model as well as the physical data model.

In Figure 4, the three-letter attribute type or category is stored in a field called ACODE. The attribute types are listed, each with a unique ACODE value (VALUE). This table provides a unique list of coded attribute values for the entire database. As with the FCODE table, a user-friendly description is included. Notes are also included to indicate any special considerations relating to a particular attribute value.

The VVT is constructed using the information in the ACODE and FCODE tables. The VVT contains the valid attribute combinations, as well as a unique description that makes the VVT more user-friendly (Figure 2). In most cases, it logically easier to first create a VVT such that contains all possible combinations of FCODEs and the ACODEs that can apply to the features. Then it is necessary to delete the coded value combinations that are not sensible. Because each record of a VVT represents a unique combination of attributes, the description must also be unique.

The tables containing the FCODES, ACODES, ACODE descriptions and valid values can be created using any software that allows you to set up tables with rows and columns. Once the VVT is created, the Table to Domain tool in ArcGIS 9.0 can be used to create a geodatabase domain. When the VVT is used to produce domains, quality in the database is enhanced and enforced because only valid feature-attribute combinations are allowed.

To migrate GIS data into a database designed using the VVT approach, it is necessary to create a crosswalk table to link the original feature and attribute codes to the corresponding FCODE-ACODE combinations in the VVT. For example, if one is using DLG data imported from SDTS format, then the entity label and the various attributes are used to determine

Attributes of ACODE_VALUES

OBJECTID*	ACODE	VALUE	DESCRIPTION	NOTES
1	DEP	0		Rise
2	DEP	1	Depression	
3	CAR	0		Not Carrying
4	CAR	1	Carrying	
5	CER	0	Indefinite	Up to 100K
6	CER	1	Unspecified	
7	CER	2		Definite
8	DEP	2	Adjacent Depression 1	Up to 250K
9	DEP	3	Adjacent Depression 2	Up to 100K
10	DEP	4	Adjacent Depression 3	Up to 100K

Record: 1 Show: All Selected Records (0 out of 421 Selected.) Options

Figure 4. The ACODE table contains all the coded value attributes that could be associated with geographic features.

which VVTID a particular feature relates to. Alternatively, the FCODEs and ACODEs can be defined in the native data format and the resulting VVTID can reflect at least part of the native major-minor code description, if they were originally in numeric format. However, if multiple attributes are assigned to a feature, then unique VVTIDs must be assigned to each feature-attribute code combination.

The VVT can be created for the entire geodatabase, or separate VVTs can be created for each feature class. If a single VVT is used, then queries and such can be applied across the entire domain once the VVT is converted to a domain for the geodatabase. If multiple VVT tables are used, it might be useful to include a look up table to define which feature classes use which VVT tables. Each VVT will then relate to the combination of one particular type of geographic data and its geometric representation (point, line, polygon). Using a single VVT for the entire database allows feature representation to vary, for example, between scales. As a general guideline, it might be useful to consider using one VVT if features will change geometry between scales. If working at only one scale, then multiple VVTs, one for each feature class, could be used.

Implications of a VVT Approach

A VVT approach helps to ensure semantic integrity in geodatabase design, and it offers additional advantages for database use and for multi-scale and multi-purpose database specifications. There are a number of feature coding standards in the GIS industry that describe features and their characteristics. Any of these feature-coding standards can be stored in VVTs, making it easier and more efficient for users to work with the data. Many of the current database implementations for these systems are inefficient and difficult to learn, and they do not inherently contain easy to understand descriptions.

The VVT approach starts first with identification of the themes to be included in the database (e.g., hydrography, hypsography, cultural features, etc.) Then the feature classes are roughly identified and become further refined as all possible feature types are determined. Finally the attributes of the features are defined and the invalid combinations of features and attributes are eliminated. In the process of first organizing major kinds of features into feature classes, then determining which FCODEs apply to each feature class, and then which ACODEs apply to each FCODE, some basic rules of thumb can be applied to ensure the integrity of the valid values.

1. The number of possible combinations of valid values should not be excessively large; when it is, it is usually a sign that there are not enough FCODEs. Meaning that one of the ACODEs is really more than just an attribute. Occasionally, one FCODE may need to become its own feature class.
2. In many cases ACODEs have default or implied values, rather than explicit values. Because the descriptions from the ACODE values are appended to the FCODE descriptions to form the VVTID descriptions, it is often logical and sensible to leave the implied value blank.
3. The sequence of ACODEs and ACODE values listed in the FCODE Tables ACODERANGE field should be intuitive, so when users use the coded value domains in the geodatabase, they see a logical, sensible listing of feature types in ArcGIS's applications.

Implementing a semantic model or feature-coding standard using a VVT approach effectively ensures the integrity of the model or standard. This approach ensures that two different feature classes will not contain the same feature types (at least for a single scale model), and it assures that there are no ambiguous feature type descriptions.

Database Use. The VVTID or its easy to use descriptions can be used for selection, specifying definition queries, rendering features, editing and creating new features, and data extraction [McDonald, 2002].

Multi-scale Use. Using VVTIDs does not require the data to be in a particular format in the GIS (point, line, polygon). This is especially useful for multi-scale databases in which features may change geometry through scales (e.g., a building is an area at one scale, becomes a point at a smaller scale and is aggregated to an area at an even smaller scale, then disappears altogether at a still smaller scale). The VVT approach is not representation-dependent and can be applied regardless of the format of the data.

Multi-purpose Use. VVTs could be used for multiple products as well as multiple scales. For example, the VVT could be used to define features that are shown on different types of maps and to help define different symbology for different products. It should be possible to include in the VVT, or a table related to the VVT through the VVTID, the scales and/or products for which each VVTID is appropriate.

Conclusion

While there are potentially hundreds of thousands of possible combinations of possible feature types, in reality there is a much smaller subset of valid code combinations, and even fewer of these that may actually exist in the database. The VVT approach is a good database design because it reflects the logic of the coding standard; it compresses the data representation to only deal with valid combinations; it supports quality assurance (QA), editing, and queries; and it supports multi-scale multi-purpose GIS use.

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reviews

The Salton Sea Atlas

By The Redlands Institute, Redlands, CA: ESRI Press, 2003. Hardbound (ISBN 1-58948-043-0), $79.95. 127 pp., index, bibliography.

Reviewed by Judith A. Tyner, Ph.D.
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California State University, Long Beach

To those outside of California the Salton Sea is not a familiar place, so why one would want to spend nearly $80 on an atlas about a shallow lake in the middle of the desert?

The Salton Sea is the largest lake in California, covering 376 square miles with a surface elevation of minus 227 feet and a maximum depth of 51 feet. It was formed when the Colorado River flooded in 1905 and 1906 and breached an irrigation diversion dam. While not as familiar as Lake Tahoe, it is a significant recreational area of great ecological importance rich in flora and fauna. These are the basic facts. Over the years, there have been arguments stating that the Sea is an endangered ecosystem or an artificial body of water destined to dry up and, therefore, not worth saving. This atlas provides probably the most complete information about the Salton Sea.

The Salton Sea Atlas was a monumental undertaking, 4 years in preparation, with a team of dozens of geographers, biologists, limnologists, GIS specialists, illustrators, and cartographers. It is divided into two main sections with five subsections plus an index and bibliography. The main sections are the descriptive text and the maps. The subsections include introductory materials that explain the project, use of GIS and the processes involved in creating the atlas. "Physical Geography" describes landforms, hydrology climates (both modern and paleo), and biomes. "Cultural History" treats the human occupance of the area. "Limnology/The Sea Today" focuses specifically on the Salton Sea; "Ecology" deals with life in the sea divided into birds, animals, and fish; and "Future of the Salton Sea" briefly notes the problems. The final section consists of 39 pages of maps totaling 98 individual maps.

Text is not set solid in the usual way, but is often in the form of blocks or boxes interspersed with striking graphics. The pages of this section are a blend of high tech GIS, satellite imagery, and artwork. There are numerous paintings of plants, animals, birds, fish, and reptiles. Using paintings rather than photographs of flora and fauna eliminates the sterile look that one finds with some computer-generated works, and certainly is a major factor in the overall attractiveness of the work.

The maps cover every mappable aspect of the area. Although many focus on the Sea itself, there are some, such as earthquake epicenters that deal with Southern California, while others, such as climate and political districts, show

all of California. Especially interesting is a series of maps showing the Sea's sediment contaminants and the map of earthquake epicenters. The latter uses proportional circles for quakes over 5.5 on the Richter Scale and dots for 5.5 and below. The resulting dot map is a dramatic explanation of why California is called "earthquake country."

It would have been useful if the maps had included more explanatory text. For example, the map of Public Lands shows numerous areas with distinct "checkerboard" patterns, especially around Palm Springs. A reader might assume that these alternating squares are symbols for areas of shared ownership whereas the squares actually represent a pattern of alternating square miles of Indian reservation land. A brief explanation and history would be useful.

Many smaller scale maps refer to "Southern California," but do not extend as far as Los Angeles, which is usually considered a part of Southern California. Since Los Angeles is generally not relevant to the subject of the atlas, I am not troubled by its exclusion, but the authors could perhaps have chosen a different name for the area shown.

There are profiles of various portions of the lake and the authors point out the usefulness of profiles as decision-making tools. However, these tools would be more useful if the vertical exaggeration was indicated. A rough calculation showed that the vertical exaggeration of these profiles was 40 times. If the user is not familiar with profiles, as the authors seem to assume, then some explanation is necessary.

The climate maps use data from the period 1961 through 1990. While another 10 years of data probably would not change the averages to a significant degree, I do wonder why data through 2000 were not used. There are some maps that compare 1999 and 2000, so the data would seem to be available. These complaints, however, are minor and do not detract from the overall interest and usefulness of the atlas.

My one major complaint concerns the page layouts. Most subsections consist of two-page spreads, often focused on the Sea. The introduction describes how the plates were designed and the sketches show that they were visualized as single pages. Unfortunately, this resulted in the page gutter cutting through the central object. Thus, the gutter obscures many of the representations of the Salton Sea. Whether the designers weren't aware of how the plates would be bound, or forgot to take that into account, the result is some frustration for the user and mars an otherwise exceptional work.

The atlas is an excellent reference and a spectacular "coffee-table" book that has as its stated objective "to make information available to decision makers, regulatory agencies, environmental organizations, stakeholders, and the concerned public..." This it certainly does, but there is an unstated subtext that becomes clear in the introductory material. The atlas is a showcase for GIS; early pages explain what GIS is, how GIS is used, and its importance in decision making. One two-page spread details the processes that were involved in creating the atlas from data gathering through storyboarding and plate design. The creators clearly wanted to show how GIS can be used for such projects. And that is why it is of interest to readers of *Cartographic Perspectives* and worth the $80—it serves as an excellent model and example of what can be accomplished when GIS, cartography, and art are combined.

Cholera, Chloroform, and the Science of Medicine: A Life of John Snow

By Vinten-Johansen, P., Brody, H., Paneth, N., Rachman, S., and M. Rip. NY and London: Oxford University Press. 2003.
ISBN 0-19-513544-X

Reviewed by Tom Koch (http://koch-works.com) is adjunct professor of geography at the University of British Columbia, Vancouver, Canada. His book, Cartographies of Disease and Health: Mapping the Relation between Disease and Health, is scheduled for publication in 2006.

Vinten-Johansen and his colleagues' study of John Snow, his life, and work presents a curious challenge to medical cartographers and geographers. It is the best study of Snow's work, including his maps, to date. It is comprehensive, rigorous, and intellectually complete. It also sees Snow's iconic maps as largely irrelevant to Snow's work and concludes more generally that medical mapping is a sloppy and largely irrelevant partner to the rigorous consideration of disease incidence.

The high quality of this 437-page tome makes the charge serious. The authors are serious dudes whose research is generally impeccable. And, heaven knows, the challenge is offered boldly. Here are the authors in their consideration of Snow's cartographic legacy, and especially the legacy of his Broad Street study:

"This mythical Snow seems an attractive figure to those GIS Aficionados who see themselves as standing up for the public health in the face of the jeering throng and as rushing out into the real world to save real lives while the stodgy, plodding scientists fussily demand more evidence before they are willing to act. Maintenance of this Snow myth also has survival for GIS. Advocates of disease map-

ping can point to no other incident in which the construction of a map played a pivotal role in identifying the cause and cure of a disease."

Ouch. They argue the myth of Snow as a pioneering cartographer is fostered for its survival value by well-meaning but clueless medical mappers who don't understand the "real" data. They insist the Broad Street map was a minor afterthought but even where it is critical to Snow's work it was "unique," the only map to date that actually served in disease identification.

Before considering the judgment, and the challenge it presents, consider the book itself.

Cholera, Chloroform, and the Life of John Snow begins with the little that is known of Snow's birth and early years. It really takes off when it describes the early training of Snow, the son of a Yorkshire farmer, as a medical apprentice in Newcastle in the early 1830s. It was here that Snow first encountered cholera, here that he learned the habits of both medicine and science that would advance his life's clinical and intellectual work. In York and Newcastle, he cared for miners and their families affected in the first cholera pandemic of 1831-33, never forgetting the relation he perceived between the lack of sanitation, crowding, and the spread of that disease. Geographers interested in the social context of illness are here provided with a superb example, alas one few cite or have carefully considered.

The authors then track Snow through his varying apprenticeships into London and his qualifying exams, and eventually his medical degree. Again there is a sense of place in the writing, a familiarity not only with the medicine of the nineteenth century but the intellectual life with which it was entwined. These were the years of the then developing medical societies and journals in which the debate between miasmatic and transmissible disease advocates would be played out. Snow was a habitué of the medical societies then forming, a familiar who presented papers and critiqued those of others. His first publications were in the new medical journals then being published in London, beneficiaries of new printing technologies and the Crown's liberal mail system of the 1840s.

Where the book really shines intellectually is in arguing the relationship between Snow's early fame as an anesthesiologist and his historical fame in terms of his cholera studies. Anesthesiology made Snow's name in the later 1830s through the 1840s. He authored the first critical textbook of the use and administration of ether, for example. All this was preparation, however, for the work that began with the second cholera epidemic of 1849 and the first edition of his book, *On the Mode and Transmission of Cholera*. Largely ignored by modern writers, here that short tract is given the attention it deserves.

Vinten-Johansen and his colleagues argue, correctly, I believe, that Snow's theory that cholera was water-, not airborne sprang from his background with anesthetic gases. The pattern of disease appearance in towns where there were concentrated outbreaks was not that of an airborne phenomenon, not evenly distributed along air currents. And here Snow gives the evidence. He argued clinically that the disease was "in the gut," diarrheic, and not pulmonary, in the lungs. It had to be from something ingested rather than something inhaled.

Thus, before the epidemic of 1854, Snow had published a theory based on clinical evidence that the disease was water- and not airborne. The theory did not spring from his 1854 studies and the maps that resulted. They instead provided a medium to distill the research he carried out in an attempt to test the hypothesis earlier formulated. This is a critical point, one that insists upon Snow (and the mapping he did), in a broadly scientific rather than narrowly cartographic frame.

The authors do great service to an understanding of the 1854 Broad Street outbreak, even mapping Broad Street and the cases that occurred upon it. They carefully, lovingly detail Snow's "shoe-leather epidemiology," the way he traversed the neighborhood in search of the survivors whose information would could help him determine whether the deceased had drunk from the pump he believed complicit. The work was not easy and, for any who think mapping determines medicine without careful investigation, the authors are right. The research that went into Snow's "topography" of the outbreak was hard, exemplary, and critical.

The authors do an inestimable service in considering other maps by Snow's contemporaries, especially the one by Rev. Henry Whitehead, which joined his in an official parish report. They do an almost equally impressive job in considering Snow's great South London study, one in which he and colleagues considered the potential complicity of water companies supplying South London in the greater epidemic. Here, alas, they make little mention of the map Snow included with that report, the most comprehensive of his studies. And, no wonder. The map is difficult, even confusing. Its colors are muddied and its details obscure. Still, it would have been nice had it been more carefully considered, its analysis given an attention similar if not equal to the Broad Street map.

The whole is a terrific corrective to the simple-minded use of the iconic map and the fairy tale story of Snow-as-Discoverer that many if not most geographers accept. He wasn't the only man who used maps. He was one of many. Snow

was a collegial if not a gregarious man. He was not a lone genius generations ahead of his time but quite simply a man of his time. Nor, of course, did he convince his contemporaries of his theory of disease origin. That would take decades of frustrating work and the dawn of bacteriology in the 1880s.

The authors are correct as well to savage, as they do in their last chapter, those who use versions of the Snow map, altered for editorial purposes, as if they were Snow's own. Here, in a partial list, one can name geographers as diverse as Gilbert (1958), Monmonier, (1991), Tufte (1972), and the US. Center for Disease Control (2000) whose Epi Info software package includes a vastly incorrect version of the Snow map.

Here, then, is the challenge the authors present: Are they correct in their marginalization of medical mapping, and the potential of medical cartography? A partial and personal answer based on my own research and publications follows.

Their argument that Snow's famous 1894 map was an afterthought is among the weakest in the book. The map was certainly important to the 1854 and 1855 publications. Indeed, in the mid-1850s, mapping was a critical part of almost every cholera study and of many disease-related studies generally. They ignore the cost and time Snow spent on the maps, and especially the one published in an 1855 parish report in which he included an irregular polygon defining the "cholera area" of the Broad Street area. The cost alone of the map accompanying the South London study—and a colored map in those days was not inexpensive—suggests an importance that Snow gave to the mapping that the authors do not recognize. At best, their devaluation of the Snow map is debatable, at worst simply wrong.

The suggestion that this is the only map that ever served practically is one easily dismissed. Against their position stands a wealth of maps beginning with one I know made in 1690. There were the maps of Seaman (1790) and Pascalis (1820) that argued the origin of yellow fever in New York City. Later, one might add MacClellan's maps of the 1870s cholera outbreak in the USA, maps that detailed its progress up the Mississippi and in individual towns can be noted. So, too, one might note in passing Burkitt's mapping in the 1960s of the lymphoma named after him. In a more modern vein, there is a range of studies of the diffusion of diseases like influenza, and the work of Gould et al. on AIDS, modeling that remains, well, a model of rigorous medical cartography.

The authors are right, however, that medical cartography requires a real knowledge of medicine and disease ecology that is too often absent in much of the contemporary work. They may be right that mapping often is used today by those with a social agenda but without the necessary background, or the inclination to hard work, that disease studies require. But bad work by individuals does not necessarily mean an approach is invalid. Vinten-Johansen and his colleagues earned the right to their over-blown assessment about medical mapping through the otherwise careful detailed research that pervades the body of this work. I think they are dead wrong on medical mapping generally, but I applaud their criticisms of what they perceive as shoddy, uninformed work. Medical cartographers and geographers can now prove them wrong through the careful, slogging, often exhausting research that substantive disease studies require, or not. My guess is that, if the work warrants it, these authors will then cheerfully admit their error.

Color Figures

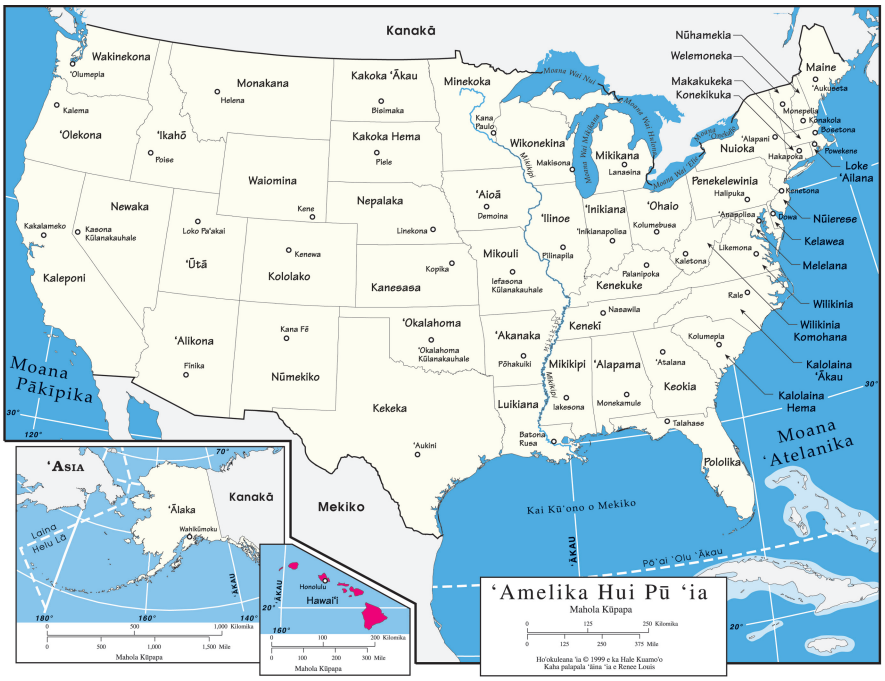

Figure 1. United States of America. Printed with permission of the Hale Kuamo'o.

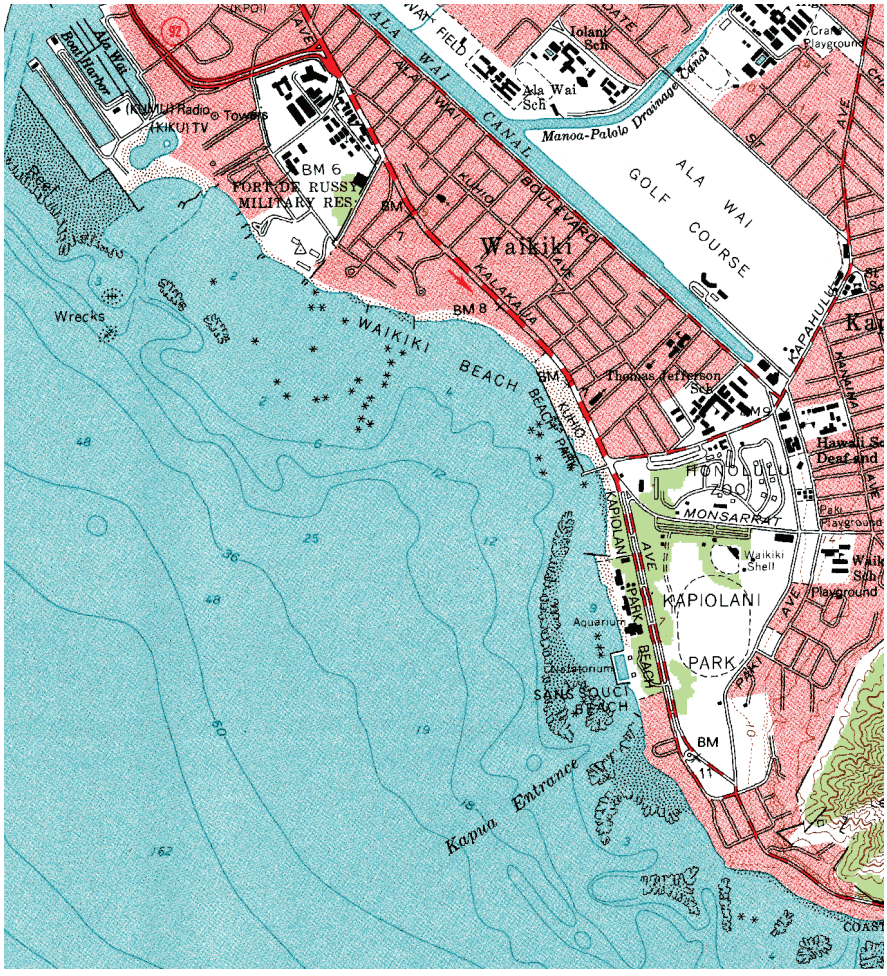

Figure 2. Section of the Honolulu 1980 Series U.S.G.S. 7.5-minute Topographic Quadrangle of Waikiki.

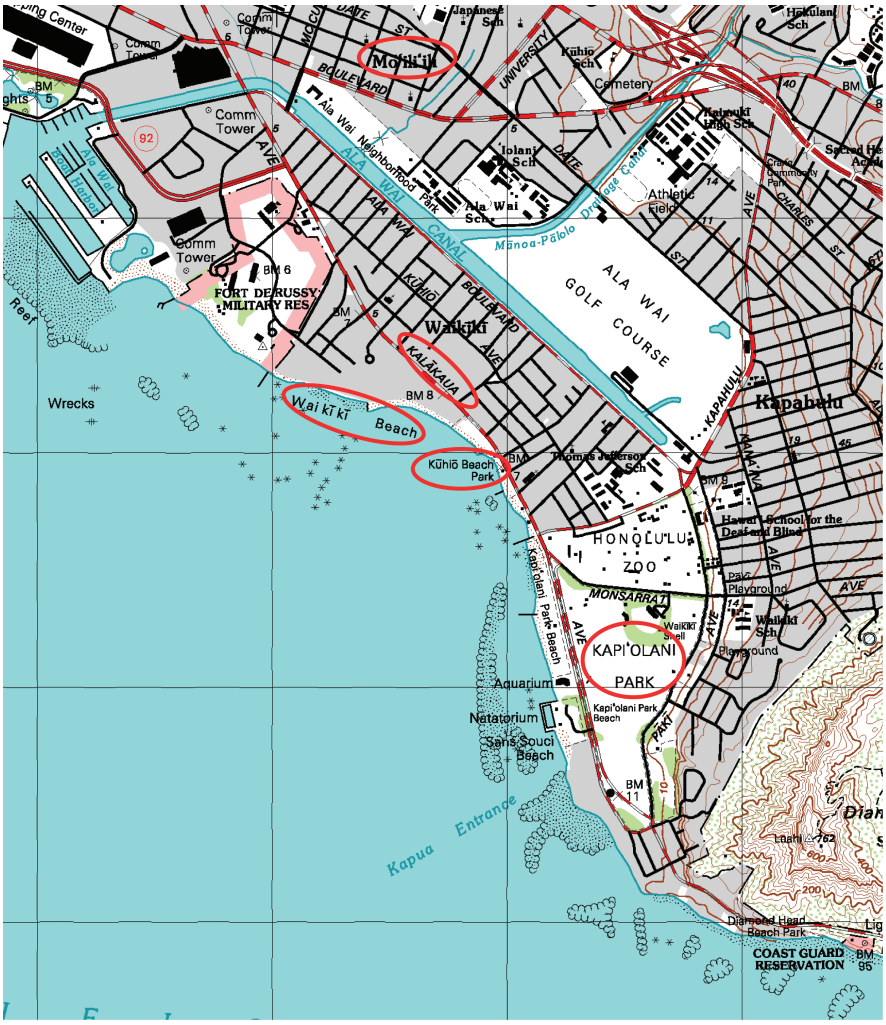

Figure 3. Section of the Honolulu 1980 Series U.S.G.S. 7.5-minute Topographic Quadrangle of Waikiki.

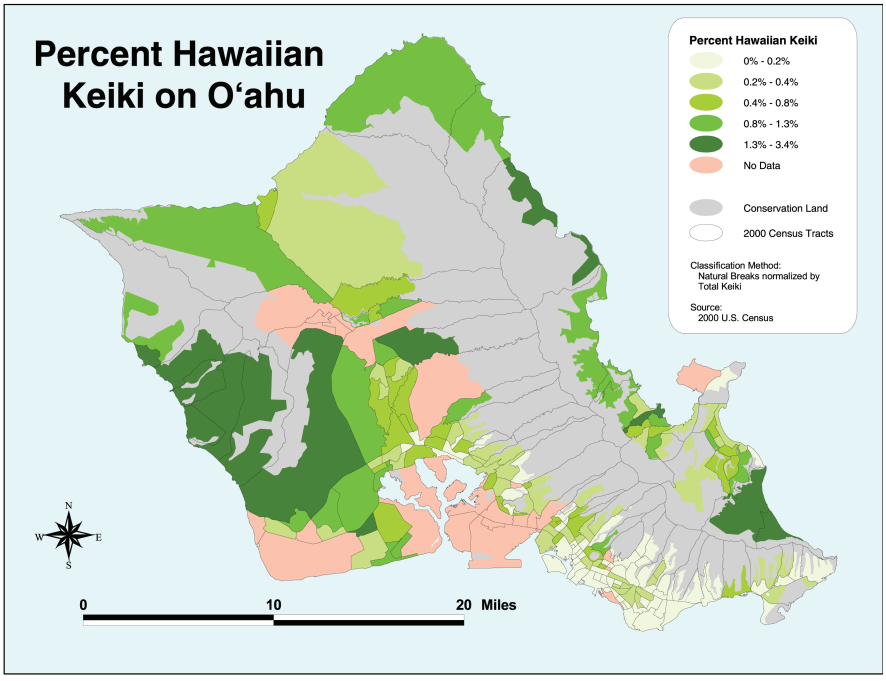

Figure 4. Percent Hawaiian children on Oʻahu per 2000 census.