Managing Maps, Making Territory:

Geographic Information Systems and Karuk Eco-Cultural Resource Sovereignty

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ABSTRACT

The Karuk Department of Natural Resources (DNR) is the primary administrative body for natural resource management on the Karuk Tribe's scattered allotment, trust, and fee simple properties, centered in the valley between present-day Orleans and Happy Camp, California. These properties are not contiguous enough to be managed as a whole and in keeping with their ecological and cultural traditions. Some argue that Geographic Information Systems (GIS) mapping provides a way for indigenous peoples to communicate their management goals to the federal agencies who manage their ancestral lands, while others contend that the embodied and holistic "indigenous" relationship with the land is incommensurable with the "Western," reductive and positivist approach of GIS. I challenge this theoretical dichotomy through an exploration of the historical context of American Indian territorial sovereignty; as well the practical ways tribes in the Klamath region choose to use GIS today. While the Karuk Tribe does not have a GIS program, the Hoopa and Yurok Tribes use GIS to manage their reservation lands, and to collaborate with Federal agencies. I explain issues of GIS access and applications for three tribes in the Mid-Klamath Basin. I explore how maps are tools for "producing territory", but also argue that territory, or sovereign claim to land, produces the capacity to map. This interplay is relevant to questions about knowledge production through GIS, for it acknowledges the political and social worlds at work in Geographic Information Systems. Tribes employ a variety of strategies within natural resources management and within GIS, so one must acknowledge a flexible interplay between these knowledge systems and the tools used to articulate them.

Key words:

Geographic Information Systems, territory, Karuk Tribe, Hoopa Tribe, Yurok Tribe, resource management

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PREFACE

My work with the Karuk Tribe began as a basic exploration of fire occurrence – a question I found more difficult to answer than I had anticipated, due in large part to the range of fire datasets I encountered, each with its own methodology. I soon realized how essential data *generation* capacity is to the progressive and productive application of GIS technology. I had also presumed that the Karuk Tribe had an operating GIS department – and when I found out that their only GIS staff person had been employed under a short-term grant in the late 1990s, my questions about "indigenous knowledge production" became much more difficult to answer.

Expanding my inquiry to two tribes in the region, both of which have GIS staff, illuminated a broader range of GIS use and perspectives. What I had regarded as an opaque meeting of "Western" and "Indigenous" knowledge indeed proved much more complex that I had anticipated, and led me to question my initial framing altogether.

My project was first entitled, "GIS and Indigenous Knowledge: Mapping the Karuk Eco-Cultural Resource Management Plan." Through my research and consultation with insightful colleagues on campus, particularly my thesis mentors Sibyl Diver and Kurt Spreyer, and professor Kim TallBear, I reconsidered the questions I was actually capable of answering within this project. In conversations with the GIS staff working for the Yurok, Hoopa, and Karuk tribes, I realized that, in some circumstances, my questions about "indigenous knowledge" were irrelevant to the way these staff saw their work for their respective Tribes. In speaking with their counterparts at the Forest Service and US Fish and Wildlife Service, I came to actually see more parallels than differences in the way Tribal and Federal GIS technicians approach their work. Ultimately, I saw that this as not a problem of "indigenous knowledge" lacking in Tribal GIS work, but rather that my assumptions about what signifies "indigenous knowing" might be faulty in this particular context. Most simply, tribes are producing GIS maps. Does this basic fact constitute indigenous mapping? Or are there separate requisites about content or method that justify such a categorization? And is such a category even useful for thinking about how Tribes use maps in a practical context? I include these here as a guiding tool, exploring the broadest questions that undergird this work in its current iteration.

The history of the tribes in the Klamath Basin provides context about the circumstances in which these tribes now interface with other management agencies in the interest of their ecological, cultural, and economic sovereignty. There are certainly connections between this

history and each tribe's unique approach to GIS technologies today; however, it would be unduly speculative to provide much causative analysis in this regard. It is not my intention to draw conclusive reasoning for the disparate levels of GIS use by these tribes today, but rather to point out the usefulness and necessity for a multitude of critical approaches to mapping methods.

My project is designed be a document that is informative both in a practical sense, as a juxtaposition of methods and approaches to GIS technology, and a theoretical sense, bringing critical cartographic literature into recent conversations concerning GIS use as well as American Indian self-determination. I have avoided seeing this technology as a panacea for development and progress, but I am equally reluctant to discount how it may exert real power, both discursively and practically. To this end, I draw heavily on cartographic representations in explaining the history of American Indian relations in the Klamath basin, California, and nationally. In examining contemporary GIS use I focus primarily on GIS data structure and staff organization for two reasons. First, GIS data management, rather than map documents, seems to be the most pressing concern for mapmakers today. Second, the contemporary nature of this part of my project affords me the simple luxury of actually speaking to the minds behind the maps.

MAKING TERRITORY: CARTOGRAPHIC HISTORIES

> *Outside of the world of maps, states carry on a precarious existence; little of nature, they are much of maps, for to map a state is to assert is territorial expression, to leave it off to deny its existence.*
>
> *-Dennis Wood & John Fels, 1986.*

The lower mid-Klamath River basin is home to the Karuk Tribe, who, according to their World Renewal beliefs, have cultivated and inhabited this landscape since time immemorial. The Karuk myth *Coyote's Journey* includes reference to a number of sacred sites, where Coyote falls in love, steals fire, fights with other animals, and lives morally instructive stories that form a basis for the Karuk religion (A Kroeber, 1972). A recent cartographic adaptation of Coyote's Journey, as told by Karuk Elder Charlie Thom, demonstrates how the prominent sites in this myth correspond with the aboriginal territory boundaries to which the Tribe refers today (Bruce-Hostler & Hostler, 2001). Many native peoples also made maps in the contexts of communication, planning, recording, understanding the world, and to divine (Lewis, 1998).

The maps that indigenous peoples produced were not as much for the navigational purposes that Western maps often serve, but rather broader, often spiritual conceptions of cultural and historical processes (Brody, 1998). When claims to spiritual and cultural conceptions of the land challenged settlers' desires to expand their land holdings, these geographical conceptions were often not granted the same legitimacy as geo-physically surveyed political claims. Physiographic survey projects were often tied into national power and prestige, because the cost was high and most often borne by the US government as a public benefit project (J. W. Crampton, 2001; Goodchild, Fu, & Rich, 2007a). Courts often granted these geographies more legitimacy, reducing indigenous claims to cultural anecdotes simply because they were articulated differently (Bryan, 2009).

Blank Spaces on the Map: Dispossession and Allotment of American Indian Lands

Euro-American settlement of present-day California required and reinforced the perspective that lands were empty. Surveying processes were instrumental to crafting this imagination – as explorers commissioned by the Federal government began to better chart the land, so too did policy makers need to contrive a way to limit indigenous rights to it (Deloria, 1985)(Deloria, 1985). JB Harley argues that maps are particularly powerful as tools for dispossession, because they can eliminate or mask particular truths (Harley, 1989). At the same

time, maps exert material power through physical enforcement (Wood, 1991). The cartographic forms and expansionist policies of the mid-19th century illustrate the interplay between the physical and psychological dispossession of the American West.

Maps were a language of conquest. In the American West, they were tools for navigation, but more so "a means of obtaining information about the political relationships between groups of frontier Indians and about the sources of and native trade in precious metals (Lewis 1998)". The maps themselves were tools for understanding resources, but they were also underlain by specific power relations that dictated the application of the information they provided (Churchill, 1998). Although processes of mapping and physically asserting land claims are interrelated, the physical ability to make land grabs often came before the philosophical justifications for doing so (Churchill, 1998).

The Doctrine of Discovery was expressed in Justice Marshall's decision in *Johnson v. McIntosh* (1823). Though the attitude was not new, the doctrine further justified American expansionist land claims that ignored indigenous rights (Deloria 1985). Simply referred to as *territorius res nullius*, any land that an explorer found uninhabited could be claimed for the United States. American leaders' feelings they could be manipulate the power disparity between themselves and American Indians motivated this justification for taking indigenous lands (Churchill, 1998). The American shifts in attitude between conciliation and aggression toward indigenous land claims reflected both how the landscape itself was framed and the military force settlers could exert.

The geography of Euro-American expansion arguably carries its own mythology. Propelled by the Manifest Destiny, the dispossession and discrimination faced by the Indigenous peoples of the American West was mobilized and reinforced by the myth that this land was unknown, uninhabited, and ripe for settlement (Anderson 2005). They used the 'Norman Yoke'; a doctrine in English philosophy, to assert that land that is considered wild and undeveloped must be "improved" to be "truly owned" (Churchill 1998). One might infer that indigenous peoples were constructed as a fixture of this wild landscape – a cultural prejudice American Indians still endure. Some early accounts even join the two in metaphor: "The Indians, like the redwoods, are doomed to fall before civilization (Huntsinger, 1994)."

Modern postcolonial theorists expand on the notion of *territoria res nullius*, suggesting that not only indigenous land claims, but also indigenous knowledge forms, were de-legitimized by

this expansionism (Bryan 2009). Joel Bryan uses "boundary objects" to explain how the indigenous point of view has been constructed at the American frontier, and measured against the "civilization" of Western society. However, many researchers have countered this claim, arguing that the "wild" American landscape was in fact carefully managed with rather sophisticated methodologies (Anderson, 2005; Pyne, 1997).

Tribes in northwestern California had a unique early-contact relationship with miners from the north. Tribes traded shrewdly with the Hudson Bay Company, and fiercely protected their territory (Hurtado, 1988). Conflicts over mining rights and resource management quickly became violent. After a number of tense encounters with miners in the Klamath River valley, most of the Karuk people fled to the mountains as part of an "exodus" of northwestern California tribes. Though the 1852 census indicates that no American Indians resided in the region, it was likely that over two thousand Karuk had simply fled outside of the census boundaries (Hurtado, 1988).

The Hoopa Tribe, located southwest of the Karuk on the Trinity River, had a markedly different relationship with Euro-American settlers. A recent economic assessment credits the comparatively isolated geography of the Hoopa Valley with protecting the tribe from the incursion of miners, because "the supply lines for the Klamath and Salmon River mines lay to the north of the Hoopa Valley, through Yurok and redwood creek (Baker & Kusel, 2002)."

The military government in California prior to statehood maintained tenuous relationships with California tribes, but this quickly changed after statehood when miners treated American Indians with increasing aggression. California policymakers responded: Sylvester Woodbridge proposed small ranchos and missions as means of assimilation, John C. Frémont proposed three main Indian jurisdictions with sub-agents, and John Bidwell's bill ultimately created ten Indian districts governed by comparatively generous suffrage, land tenure and labor rights (Hurtado 1988). This bill was tabled, and the one eventually passed by the California legislature in 1850 – the Act for the Government and Protection of the Indians – cordoned American Indians into small reservations where they worked under exploitative labor conditions with few rights to their ancestral lands. The policy language deliberately excluded any mention of Aboriginal territory, or Spanish or Mexican land claims, and further entrenched notions of "Anglo" territorial sovereignty in the region (Hurtado, 1988).

In 1850, eighteen congressional treaties were drawn at the state level to establish approximately 7.5 million acres for American Indian use. Increasing violence between tribes and settlers in the region, known as the Indian Wars, prompted the establishment of these reservations. However, at the urging of the California legislature, the US Senate never ratified them (Frantz, 1999). Policymakers in the state argued that the negotiated reservation boundaries were too close to mining areas and would spark even more resource conflicts. In addition, others argued that Indians would be safer under the care of missionaries (Hurtado, 1988). These heavily biased claims gained traction in the US Senate, who in failing to ratify the treaties effectively allowed state and local interests to continue defining the settlers' relationship with American Indians in California. The California Land Grant Act of 1851, established shortly after the treaty of Guadalupe Hidalgo, required that all claims from the Spanish and Mexican governments be filed within two years. This act has later interpreted to include aboriginal title, so it extinguished all aboriginal title in California (Gates, 1971). In the same year, Siskyou County was incorporated irrespective of these drafted reservation boundaries.

Governor Burnett issued a statement to the State Legislature in 1851, outlining the state of California Indian affairs and the need for policy change. At this point, there was "no further west" available for Indian removal, and the only policy alternatives were "extermination or domestication" (Hurtado 1998). This reflects the broader territorial attitudes shaping relationships between the US government and indigenous peoples of this period. Eastern American Indians had simply been pushed farther west. But in California, there was no "farther west" and the consequences for Tribes were especially severe. In California, the native population in 1848 was about five times as large as the settler population. By 1850, when California became the 31st state, the settlers easily outnumbered the natives (Bell, 1991).

As violence in the region continued to escalate, Congress authorized the president to make the 1852 executive order to establish five military reservations in California. These treaties were designed to "effect a permanent peace between the native peoples of this region and the large influx of prospectors and settlers, with whom there were serious confrontations". (*Parravano v. Babbitt*, 70 F.3d 539, 545 (9th Cir. 1995)) Contemporary arguments maintain that this containment was designed as a permanent home. However, tribal members continue to resist this notion.

The Hoopa, Yurok, and Karuk tribes were designated to share the Klamath River reservation, which was to "commenc[e] at the Pacific Ocean and extend 1 mile in width on each side of the Klamath River . . . with the provision . . . that . . . a sufficient quantity be cut off from the upper end thereof to bring it within the limit of 25,000 acres" (*Pub. L. No. 100-580, 102 Stat. 2924 (25 U.S.C. 1300i-1 et seq)*. Though this law protected tribes, it also limited their access to sacred land and hunting ground (Huntsinger & McCaffrey, 1995). Particularly for the Karuk and Yurok, the Klamath Reservation was not well located in their ancestral lands. Moreover, the three tribes, each with a distinct cultural history and language, were forcibly aggregated in to one political unit. Indeed, the Hoopa Valley Tribe violently, and successfully, resisted relocation to the Klamath River reservation. Settlers then lobbied the Federal government to establish Fort Gaston by executive order in 1858 (Norton, 2001).

In 1864, the Hoopa Valley Tribe settled a separate treaty at Fort Gaston, providing the tribe with a larger land base than the other tribes in the region and access to vast timber resources. The 1864 settlement formed the Hoopa Valley Reservation, a twelve by twelve mile area to be under the jurisdiction of the Hoopa Valley Tribe. Hoopa tribal members would continue to violently resist relocation until the treaty was finally ratified in 1876. They have been able to maintain control of the reservation since. Though the Hoopa had fared better in terms of their resource sovereignty, they were not spared from strong assimilationist practices, including the relocation of children to distant boarding schools where they would be expected to refute their culture and traditions.

Ultimately a "connecting strip" joined the Klamath River Reservation and Hoopa Valley Reservation, settling the land claims for the tribes under President Harrison's 1891 executive order. Both the Klamath Reservation and the Hoopa Valley Reservation would be allotted under the Dawes Act, but the ultimate outcome for each tribe's land holdings would be very different.

American Indians were divested of their land claims both through overt physical removal, and cartographic elimination. A US Army Corps survey from this period shows a blank space in this Klamath region, largely because it was too rugged to survey (Wheeler, 1889). One may read more insidious intentions into this cartography – J.B. Harley wrote that military surveys "dispossessed by engulfing them [indigenous peoples] with blank spaces" (Harley 2002). Though he may be overstating the case, this notion draws attention to the fact that the platting

system was unconcerned with documenting existing populations, but geophysically surveying properties that the United States had already politically claimed.

After the Civil War, four separate agencies were conducting surveys the American West, and consulted with the US government to develop a more centralized model. With the Organic Act of 1879, the USGS was formed. Michael Palmer argues, "topographic maps resulted from multiple cycles of accumulation associated with the colonial processes of natural resource inventories, exploration, military surveys, biological surveys, ethnographic surveys, and public land surveys (Palmer, 2009)". A series of maps drawn under the direction of Alfred Kroeber emphasizes this point. The series, entitled "Cultural and Natural Areas of North America", provides a catalogue of land categories, grouping indigenous territories next to soil characteristics, climate, and biota. Here, tribes become another naturalized fixture of the landscape (Alfred Kroeber, 1939). The maps are a symbol of and tool for dispossession - both through the "cycles of accumulation" they facilitate, and through de-politicizing indigenous land claims.

The General Allotment (Dawes) Act of 1887 was inspired by the land-division practices of the Homestead Act, and designed to allot collectively owned tribal lands to individual owners. Overall tribal land holdings decreased dramatically as a result of this act, from 138 million acres to 52 million acres by 1933, when it was repealed by the 1934 Indian Reorganization Act. The act "destroyed the land base and culture of a people for the sake of a market economy… By the time the Dawes Act was officially abolished, many Native Americans had become… marginalized and landless paupers (Huntsinger & McCaffrey, 1995)". The working definition of land ownership at the time was in terms of "productive use". American Indians were allotted land as head of household. If they intended to manage livestock, they were granted 320 acres, and if they intended to use land for agriculture, they were granted 160 (Ibid.).

Unique to this region in California, however, were the particularly vociferous interests of mining communities, which strongly influenced land use negotiations. In the Klamath region, the decision between allotment and reservation of timberlands was particularly important for Tribes. The most valuable timberlands would often be allotted. Un-allotted lands not on reservations would simply returned to the public domain, instead of being sold to the tribes (Ibid.). This further fragmented the land claims of the Karuk and Yurok, but actually strengthened individual title on the Hoopa Valley Reservation, because the tribe had an existing land base (Baker, 2003).

In other cases, tribal members sold their allotted lands because they could not afford to pay property taxes (Margolin, 1993).

According to Churchill (1998), the Dawes Act simply formalized the existing inequities that were institutionalized by these land grabs. Nabokov refers to the late 19th century project of cultural assimilation as "territorial reinscription," or a corporeal violence that dissociated the land from the body (Lewis, 1998, p. 248). While American Indians were dispossessed of the land through racial violence, land possession and allotment was also defined in racial terms. "Reservation boundaries formed a frontier line that amounted to a *racial barrier*, which whites and Indians could cross only with federal permission (Hurtado 1988, my emphasis)." Reservations provided some safety from settler's violence, but also delimited American Indian land claims in places and through policies that were not their own.

The Hoopa Valley Indian Reservation Plat, surveyed in the 1870s and published in 1887, delineates the exterior boundaries of the Hoopa Valley Indian Reservation (Bissel & Smith, 1890). The landmarks notated on the map include wagon roads, military trails, and garrisons. The map also denotes a boulder with "traces of copper." Tributary streams are carefully detailed on three sides of the surveyed boundary. These entirely disappear inside of the reservation area, which portrayed as empty of tribal villages. This map demonstrates the interests of settlement cartography; in simply producing a boundary line and documenting resources of interest within it.

In 1988, the Hoopa-Yurok Settlement Act would sever the extension between the Hoopa Valley Reservation and the Klamath River Reservation, making it a reservation for the Yuroks. The square would remain a reservation for the Hoopa Valley Tribe (*Hoopa-Yurok Settlement Act*, 1988). Even though the original reservation was intended to serve all three tribes, the Karuk tribe did not receive land as part of this settlement.

Ethnographic Maps and Ancestral Claims: Re-producing Indigenous Geographies

The encroachment on Whites on Indian lands meant that, "their [American Indians'] concept of ownership of territory [was] materially sharpened through contacts with Whites who were interested in obtaining land for their own uses (Jones 1978)". Kroeber's early reservation maps contrived territorial delimitations that were ethnographic, but not intended to be political. Conversely, legal boundaries are regarded as conceptual tools to aid in court processes, with often very little correlation to real geographic or cultural phenomena. The work of surveyors,

who mapped the physical landscape irrespective of indigenous claims, was thus complemented by the work of ethnographers, who mapped indigenous peoples irrespective of their political agency.

T.T. Waterman wrote *Yurok Geography* during the 1920s, as a part of Alfred Kroeber's effort to document the declining native populations in California. No such ethnography was conducted for the Karuk Tribe, but Waterman's ethnography includes some general statements about tribes in the region. Waterman's geography includes his own construction of ethno-linguistic boundaries for the Yurok tribe and a visual adaptation of the Yurok spiritual geography. The Yurok Tribe, as well as the Hoopa and Karuk, assigned place names to places of interest to the Tribe, which included significant locations for neighboring tribes. Waterman's account described the Yurok universe as an area roughly 150 miles in diameter, with the Klamath River bisecting a disc of land that floated on top of the ocean (Waterman, 1920).

Rather than cardinal directions, the fundamental organizing concept for tribes in this region is "upriver" and "downriver" (Waterman, 1920). According to his record, tribes had little interest in naming large geographic features in the way that American settlers would name whole mountains. Rather, in most cases the Yurok would "designate one spot on it" (Waterman 1920, pg. 197). The place names were often both a descriptive relative expression and a proper name.

For ethnographers, place names, rather than distinct boundaries, indicated the presence of indigenous peoples. Today, ethnographic maps are actually useful for ascertaining contact dates with tribal groups (I. Sutton, 2002). This mapping, even though it is framed as a documentation of Native spatial organization, is also a conceptualization of tribes as cartographic subjects. The goal of Kroeber's school of ethnographic mapping was to estimate cultural and ethno-linguistic regions, rather than political land claims (I. Sutton, 2002). This was wrapped up in the efforts to document the "disappearing Indian", re-constructing the ostensibly indigenous geographic perspective in Western academic terms, rather than through forms endemic to American Indians. Some argue that this process persists today, in the form of centralized Bureau of Indian Affairs geographic data, and the preservation of traditional place names through Geographic Information Systems (Palmer, 2009; Sappington, 2008).

Waterman's attempt to document the regional geography of the Yurok, Karuk, and Hoopa peoples might be considered both a process of knowledge construction and subtle political argumentation. He draws boundaries *for* the tribes, placing their history and relationships in a

fixed geographic array. By expressing land claims as inherently localized – operating at a smaller scale than Western surveyors – Waterman's geography creates a catalogue of places, but only in comparison with Western cartographic conventions. Waterman wrote, "Geography and myth among the Yurok are closely associated. Mythical stories are frequently localized very definitely (Waterman 1920, pg. 198)." The only broader scale expressed in Waterman's account is that of the ethno-linguistic aboriginal territory – presented as a naturalized feature of the landscape rather than a political domain.

Records of aboriginal territory were, and in most cases still are, framed as cultural, rather than legal-political, entities. The complex policy shifts resulting from the 'Marshall Trilogy' of Supreme Court cases in the early 19th century effectively redefined indigenous sovereignty in forms that suited the needs of a the continually expanding US territory (1985). Constructing political units for American Indians, in the form of tribes, allowed American Indian territories to also be re-drawn. Though the Supreme Court ruled in 1831 that tribes were "domestic dependent nations" – neither foreign nations nor states, in 1832 the Court also affirmed tribal sovereignty over its territories (*Cherokee Nation v. State of Georgia*, 1831; *Worcester v. Georgia*, 1832). In both of these cases, aboriginal land claims figured little into the court decisions. Rather, it was simply a matter of creating political definitions for tribes that, in many ways, suited the mentality of US expansionism (Deloria, 1985). Through the Dawes Act of 1887, the US legal system developed a territorial allotment scheme based on population numbers and estimates of land needed to "usefully cultivate" – a highly individualized form of land ownership that was quite distanced from notions of ancestral rights or collective ownership. Today, aboriginal territorial boundaries appear largely in historical contexts, with few notable exceptions in tribal GIS applications (Sappington, 2008).

Maps of aboriginal territory could be what David Turnbull refers to as "assemblages." Turnbull borrows "assemblage" from Deleuze and Guattari, preferring it to other terms for "the amalgam of places, bodies, voices, skills, practices, technical devices, theories, social strategies and collective work" that constitute knowledge spaces (Turnbull, 2000, pp. 43-44). An assemblage is contingent, rather than fixed. Assemblage, taken loosely, could also be a point of connection among knowledge systems. Aboriginal territory boundaries, in their incarnations spiritually, physically, and cartographically, both inhabit and are constituted by multiple forms. They have been characterized as ephemeral, abstract, and metaphorical – often communicated

through paintings, carvings, or songs (Turk 2007). When explained spatially, these boundaries are often a compilation of watershed boundaries, linguistic boundaries, and traditional hunting or spiritual sites.

At first, tribes certainly did not draw cartographic boundaries of their aboriginal territories in the way we see them today– in most cases ethnographers did this work. The process of creating spatial boundaries is fraught with postcolonial ambivalence of the cartographer, anthropologist, and aboriginal people being documented or seeking documentation (Sutton 2005). Yet today these boundaries work in important ways for many GIS practitioners within tribes. They often form the area of geographic focus for tribal data organization, and a key part of their arguments for interagency collaboration.

Fire data: A case of natural and informational resource management

Challenges to Karuk territorial sovereignty came both in the form of explicit land appropriations, as well as forms of behavioral control. They lost sovereignty over their tribal land and settlers encroached upon their former hunting and gathering ranges, which encompassed much of the Mid-Klamath valley. Historically, the Karuk would set fires needed to tend the forest and create proper growing conditions for basket weaving materials, hunting grounds, acorns, and other food (Margolin, 1993). Frequent fire manipulated Douglas fir stands allowed for oak growth, and increased understory diversity, creating an exceptionally complex pre-settlement landscape mosaic (Huntsinger & McCaffrey, 1995).

Fire has long been intimately linked with human communities in the Klamath region, and shifts in human interactions with fire parallel the history of settlement and political control. Policies that mandated against traditional burning challenged the ecological integrity of the region, and barred the Karuk from this religious practice (Kimmerer & Lake, 2001). The legacy of fire regulation speaks to the broader challenges the Karuk Tribe has faced in managing its traditional lands. Though the forms of conflict and negotiation have changed – from violent control by settlers to complex environmental management protocols and funding mechanisms – the Karuk Tribe still struggles to maintain its ability to manage the forest with fire.

The 1850 California Act for the Government and Protection of Indians criminalized burning lands used for livestock grazing, in order to protect settler's economic interests. Unable to conduct the burns they knew increased landscape productivity, American Indians had to adapt

to living on meager parcels of land with scant resources (Hurtado, 1988). From 1850 to 1910 native fire use was severely curtailed, with miners and settlers responsible for up to 95% of all anthropogenic burns. The 1911 Weeks Act severely limited Native fire use, and fire fighting infrastructure and propaganda campaigns led by the Forest Service brought controlled burning to a standstill.

Early critiques by the National Conservation Association accused the Forest Service of being inimical to the interest of homesteaders, inefficient, and poorly attuned to the unique ecological needs of Western forests (Holmlund, 2006). The well-documented onslaught of new settlers to the region encouraged road construction, intensive mining, and the eventual damming of the Klamath River in order to generate hydroelectric energy. Agriculture and industrial fishing came to dominate the region's economic growth (Busam, 2006). During the Great Depression, the Civilian Conservation Corps worked with the National Forest Service to build more extensive infrastructure in the National Forests, including roads and telephone wires. This intensified efforts to protect forest resources. During World War II, Smokey the Bear became a patriotic icon for 'protecting forest resources' through complete fire suppression (Most, 2006).

Today, about 60 percent of the forest in the Mid-Klamath basin is publicly owned, and managed primarily by the Forest Service. Another 30 percent are owned by industrial logging operations, and the remaining 10 percent by private owners (Agee, 1996). The western and eastern sub-regions are warm and moist or dry, respectively, and climate contributes to a particularly intense fire environment in the eastern region during the summer months. The region is particularly vulnerable to rapid spread of fire given its unique topography and vegetative composition. Fire regimes have been severely curtailed since Euro-American settlement, resulting in "too much burning with too little fire" (Pyne, 1997). Though fires are less frequent, they are much more intense today.

The Wilderness Act, passed in 1964, was designed to "secure for the American people of present and future generations the benefits of an enduring resource of wilderness" (Wilderness Act of 1964). Originally, it had been proposed that the Wilderness Act include roadless areas of Indian reservations, "since Indian cultures had evolved in wilderness… it seemed consistent with the Indian New Deal to deem some reservation lands roadless (Glover 1986, as cited in Sutton 2002)". However, tribes heavily criticized this notion as simply another attempt to wrest American Indian lands from tribal control.

In response to the 1928 Merriam Report, which documented the terrible conditions American Indians were enduring, the Indian Reorganization Act ended the allotment of tribal lands, extended the trust period for existing allotments, and authorized the formation of tribal governments (Reynolds, 1996). This act, among the policies known as the Indian New Deal, sought to economically support tribal economies through lending programs. This reform period was thus characterized by more generous support of Tribes, along with more strict stipulations about allowable Tribal governance (Bruyneel, 2007). However, not all tribes, including the Hoopa Valley Tribe, accepted this legislation.

The emergence of more progressive environmental policy in the 1970s dramatically shifted attitudes about resource management and conservation. The National Environmental Policy Act (1969) required environmental impact analyses and public comment for any development project. Under the Clean Water Act (1972), National Historic Preservation Act, and the Native American Graves and Repatriation Act, tribes were able to set management standards for their own lands (Stumpff, 2006). The Endangered Species Act (1973) was passed to protect the environment and wildlife. However, some tribes felt targeted by ESA regulations on their lands, which often curtail development (Sutton & Clow, 2001). Though these environmental policies were generally positive for tribal self-determination, they were not unanimously accepted.

The Indian Self-Determination and Education Assistance Act (1975) allowed tribes to create their own natural resource departments (Stumpff, 2006). This policy defined a way for tribes to use BIA funds to support their own governance structures, and take on BIA responsibilities. Under this act, and with more academic and institutional motivations behind ecologically sensitive fire management practices, the Bureau of Indian Affairs provides funding resources to tribes who wish to manage fire on their trust, allotment, and fee simple properties. Tribes with large contiguous land bases are able to justify arguments for holistic resource management, and will often set environmental regulations higher than their state counterparts (Imre Sutton & Clow, 2001). These policies created a new framework for Native Americans to advocate for their resource management practices, but also changed the language and procedures that they needed to assimilate in order to do so. Furthermore, these policy venues for tribes to assert their rights to environmental and cultural self-determination are not just a function of federal policies – they are deeply embedded in the historical geography of the region, and are

just as much a "reformulation" of the asymmetrical relationship between tribes and the federal government (Jojola 2001).

The framing of this act allowed for a "meaningful participation", but not necessarily control (Imre Sutton & Clow, 2001). According to Jannette Wolfley, "Environmental assessments often neglect to identify the effects public or private development will have on trust lands, or for that matter, on former Indian lands where treaty right hunting or fishing may still persist (As quoted in Sutton & Clow, 2001)".

The Karuk Tribe has created the Eco-Cultural Resource Management Plan as a way to manage restoration practices in its aboriginal territory and tribal-owned properties. It serves as a reference for the tribe's management goals through collaborations with the Forest Service, Environmental Protection Agency, and US Fish and Wildlife Service. In this plan, fire is a particularly significant landscape factor. The Eco-Cultural Resource Management Plan explains the detrimental effects of fire suppression:

> "Fire suppression policies prevented the Karuk traditional burning that maintained open forests and encouraged diverse landscape mosaics, while preventing intense wildfires. Without frequent fires, open meadows became choked with dense conifer trees. Plant communities changed as non-native grasses and invasive blackberry bushes replaced native plants. Animal communities changed as habitat disappeared or became fragmented, and salmon spawning grounds were filled with sediment from hydraulic mining and logging roads." Karuk ECRMP, 2010

Today, federal agencies have begun to cultivate the notion that "successful ecological integrity in the Klamath Mountains depends on the extent to which fire is allowed to play its essential role in the ecosystem" (Frost, Sweeney, & Consulting, 2000). The Karuk Department of Natural Resources, established in 1989, is working to use contemporary research to support its ecological and cultural resource management goals. With regard to fire, the Karuk DNR has been historically excluded from the Forest Service's fire fighting decisions, which often jeopardize lands that are spiritually significant to the tribe. In order to garner more power in fire management, the department relies on outside funding sources to conduct traditional burns and respond to wildfires.

The Bureau of Indian Affairs fire management funding is often determined by the extent to which fire already affects the lands that a tribe legally owns. The BIA Fire Occurrence Reporting System (FORS) is designed to allow tribal fire managers to provide information about the extent and severity of fire on their lands. The BIA uses this information to proportionally allocate fire management funding to tribal management groups. For tribes, this requires working with the best

available spatial fire data, ideally collected from internal research, to examine the extent to which fire is burning on to tribally owned or managed lands. Without strong internal capacity to record fire events and independently generate information, the Karuk DNR relies on external data and analytic resources to make the case for more fire management autonomy.

My initial project for the Karuk Department of Natural Resources was to conduct a basic spatial analysis of where fire had burned on to Karuk lands, at what severity, and to what extent. However, I quickly encountered issues with data accuracy and relevancy. The Forest Service record is taken to be the clearest and most standard depiction of fire. Forest Service data is publicly available, and is often re-posted on secondary sites.

I used basic GIS layers downloaded from the Cal-Fire database, state-wide data source for fire managers and scientists (www.fire.ca.gov), and clipped them to the allotment polygons for the Karuk Tribe. The Forest Service Region 5 fire dataset is quite frequently used for fire analysis, though the metadata states that, "Due to missing perimeters… this layer should not be used for statistical analysis and reporting" (CA R5 Fire History metadata, 2009). Furthermore, the metadata instructs users that the data is draft form, and not the final record.

In order to cross - check this data set I used the Rocky Mountain Geographic Science Centers' data set as well as Monitoring Trends in Burn Severity (MTBS) data. The metadata for the Rocky Mountain Geographic Science Center's information is not kept updated for each file. Users are referred to a centralized and more regularly updated metadata source. The accuracy metadata claims that "the final official perimeter should be obtained form the host unit… [which] is responsible for producing official and final perimeters for all incidents in their jurisdiction" (RMGSC metadata, 2010). Fire managers submit RMGSC data the Geospatial Multi-Agency Coordination Group by fire managers. However, this data is not always reliably vetted for accuracy, and redundancies and gaps between fire data sets are very common at the interagency level.

A recent study of FORS also points out several flaws with interagency fire reporting. The BIA is just one of several agencies that solicit fire reports, and each agency uses different data standards, categories, and interpretations. The initial fire reporting itself is highly subjective, and is apt to contain errors of omission, accuracy, and timeliness (Commonthread Incorporated, 2007). The study concluded that, "Geographic Information Systems (GIS) offer significant opportunities to enhance the timeliness, accuracy, completeness, and usability of fire occurrence

data. However, there remain many technical and operational hurdles to be overcome before the fire community can fully implement the technology on a national basis (Ibid.)". The study also called for a standardized interagency identifier system for fire events, a stewardship group to collectively manage data, as well as a "single, immediate point of access" for fire data on the web (Ibid.).

For a tribe without resources to collect primary information, reliable surrogate data is essential, but not always readily available. The Commonthread Incorporated (2007) study of FORS recommends a centralized approach to vetting data for accuracy and making it readily accessible to outside interests. While this data regulation model is potentially useful in theory, some are skeptical of ability of a single agency or group to accurately and consistently distribute data (Goodchild, Fu, & Rich, 2007b). Some go as far to suggest that a centralized data model reinforces a post-colonial information dependency between indigenous peoples and federal agencies (Palmer, 2009).

In 2009, Diane Lockwood presented a model for the Bureau of Indian Affairs Geospatial Portal Program. The proposed DOI Enterprise Geospatial Information Management (EGIM) program was designed to "standardize and coordinate GIS activities across the department's bureaus, sharing data and data analysis tools (Lockwood & Fetridge, 2009)". The Bureau of Indian Affairs would then provide standardization for staff, procedures, and data to the Field Advisory Committee and to Enterprise GIS Users, the high level GIS managers within tribes. Finally, the BIA Geospatial Portal Program (GPP) would provide bureau-wide data for any authorized users. The report summarizes the portal as follows:

> "A Geospatial portal offers a single point of entry to the geospatial information, data services and computing processes that provide management and administration of the portal. It enables authorized users to access geospatial information instantly and securely – increasing communication and productivity." (Lockwood 2009)

This proposal is emblematic of the broader federal attitude toward GIS technologies and data management. Economy of scale and a desire to avoid duplicate data motivate centralization efforts (Goodchild, Fu, & Rich, 2007b). At the Forest Service level, GIS staff is currently working to migrate all Forest Service data to a center in Kansas. This form of centralization ostensibly allows for greater oversight, data accuracy, and metadata quality, but Tribal users also have found it to invite unnecessary bureaucracy into local data management. Michael Palmer criticizes GIS as a federal project imposed on tribes, writing that "Information technologies like

GIS are not endemic to indigenous communities, but they can emanate from them (Palmer 2009)".

Goodchild's (2007) term "information communities" may begin to explain how GIS use happens both within federal agencies and within tribes on the Klamath River. Each has its "common language, common set of definitions, or a common set of data format standards". Sharing across these communal standards can be difficult, especially if it involves converting across scales or definitions. With the "Geospatial One-Stop" (GOS) model, federal data managers would work as "geospatial data librarians":

> Just as a traditional library employs staff to exert control and direction over its collection of books, journals, and monographs, so GOS involves administrative staff in determining whether or not to accept GIObjects offered to it by their providers." (Goodchild et. Al 2007)

However, controls are already applied to the materials that are submitted to libraries - by editors and publishers. The librarian is not necessarily in charge of regulating the material itself, but organizing it. This is one of the many reasons behind the GOS' ultimate inefficacy. For ease of access, organization is as important as the data itself – and as such it should take forms particular to the group for which the information is intended.

A broader criticism might cite a failure inherent to the process of collecting spatial data about a phenomenon as temporally, geographically, and culturally sensitive as fire. As an alternative to static demarcations, traditional burning practices could be interpreted through Hormund's (1995) notion of "incorporated territorial expressions". Incorporated territory is established by lived practice and experience with the land, as opposed to documented or "inscribed" spatial claims (Hormund, 1995). Indeed, the production of inscribed territories through modernist cartography is designed precisely to abstract away from bodies, social relations, and history (Sparke 2005).

Though many policy measures are in place for the Karuk DNR to eco-culturally manage its properties, the practical data needed to spatially communicate these goals is lacking. Centralized approaches to improving data access are a useful starting point. However, with sufficient resources, tribes do successfully address data problems at the local level. The following chapter explores strategies for organizing and utilizing GIS capacity at the Yurok and Hoopa Valley Tribes.

MANAGING MAPS: GIS AT THREE KLAMATH RIVER TRIBES

In recent years, tribes and first nations in North America have been increasing their use of GIS for land management in their territories. Since the early 1990s, GIS has been praised as a tool to support litigation, for tribal jurisdiction hinges upon the delineation and measurement of trust lands, allotted land parcels, and reacquired lands (Imre Sutton & Clow, 2001). In the Mid-Klamath region, Tribes must communicate with two separate county governments (Humboldt and Siskiyou), two national forest management agencies (Klamath and Six Rivers), and other federal agencies including the Environmental Protection Agency, US Fish and Wildlife Service, Department of Transportation, and Census Bureau. As GIS use has prevailed at the federal level, this technology is often becomes a language of management collaborations between tribes and federal agencies (Shaw, 2010).

Tribes also apply GIS to projects of their own origination. A few tribes, particularly the Coeur d'Alene, Cherokee, Chickasaw, Seminole, among others, have especially well-developed GIS programs (Sappington, 2008). Funding for GIS is increasing out of claim award money, special congressional appropriations, or gaming revenues (Sutton 2005). With the goal of understanding approaches to GIS use among tribes in the Mid-Klamath basin, I conducted a series of interviews with GIS staff. The Karuk Tribe does not have a formal program or dedicated staff in the way that the Hoopa and Yurok Tribes do, but rather uses GIS incidentally. The interview process was, in part, designed as a way to provide information about other GIS programs to the Karuk DNR in order to facilitate their GIS capacity building.

For the tribes I interviewed, GIS staff were either reluctant to or unable to speak to the legal applications of their mapping work. The land claims situation between the three tribes is politically sensitive. I primarily discussed GIS applications for relatively modest land management purposes, rather than for acquiring property outright. From the perspective of staff, GIS is as much an internal system for organizing information as a method for publishing maps. It seems most useful for intra-tribal communication, and collaborative, rather than oppositional, land management projects with federal agencies.

Karuk Tribe: Project – Based GIS

Currently, Scott Quinn is the only fully trained GIS user employed by the Karuk Tribe. Scott received the majority of his GIS training through his undergraduate program at Humboldt State University, where he studied Natural Resource Planning and Transportation. He was originally hired in May 1998, through an ANA (Association for Native Americans) project grant to conduct field documentation of historical village sites on Karuk lands. Since this project grant expired in February 2000, no staff has been hired by the tribe specifically to conduct GIS work. Scott uses GIS to conduct Boundary and Annexation Surveys (BAS) of Karuk properties for the US Census Bureau. Though GIS analysis is not his formal responsibility, Scott occasionally helps other departments with their GIS mapping needs. He keeps GIS data on his computer for his work in the Land and Transportation Planning Department.

In the past, Scott and a former Karuk Tribe Natural Resources Specialist, April Conrad, received a weeklong GIS training in TNT GIS, an alternative to the ArcGIS program, standard in most federal government applications. However, after free Environmental Sciences Research Institute (ESRI) licenses became available through the BIA, staff decided to use solely ESRI ArcGIS products. Computers at the Karuk DNR have been recently updated to ArcGIS v. 10. Scott was originally trained in ArcInfo, but has since updated his training with a short course in Portland in 2000, as well as some online training through ESRI.

Because the tribe has been without a dedicated GIS staff person for over ten years, data is collected and used on a project-by-project basis. Though the tribe recently acquired a GIS workstation, because there is limited staff knowledge of GIS, as well as a disorganized data structure, only two staff members (Scott Quinn and Bill Tripp) currently use GIS mapping in their work. In the past, the tribe has contracted GIS work out to local GIS experts, including Jim Villepanteaux at the Klamath River Restoration Council, and Tony O'Rourke at Yurok Tribe.

Geographic Information Systems: Practices at Hoopa Valley and Yurok Tribes

Department Structure

At the Hoopa Valley Reservation, three departments utilize GIS: Fisheries, Forestry and Land Planning. Within each department, GIS data is organized in an ArcSDEsystem (Arc Spatial Database Engine), a central relational database system on the Tribe's server. All staff may access to the server and copy and edit data freely, but the GIS manager is the only person

with editing privileges on the master server copies. Inter-departmental data sharing requires manual transfer of files from the separate physical servers. Each department's GIS manager structures their data catalog in a format that is informed by his or her applications. The Forestry department uses Arc 9.3, and the Land Planning department is currently using ArcGIS 9.2. They have hesitated to update their version because of the time-consuming file conversion process (Ted Oldenburg, personal communication, 2011).

At the Yurok Tribe, the GIS program, rather than composing a constituent part of one of the Tribe's applied offices, is housed in the Information Services Department. It is grouped alongside staff in charge of web development, network support, and hardware support. GIS capacity first developed as a project within the cultural department, documenting historic village sites, and then expanded to fisheries. After staff spoke with other tribes about best practices, GIS capacity was finally transferred to the Information Services and Technology (IT) department, in order to be more integrated with the entire tribal organization. The staff in the IT department frequently defend their central position in the tribal structure, seeing it beneficial to autonomously work on projects rather than being tied exclusively to one department's work (Elly Supahan, personal communication, 2011).

Licensing: ESRI Enterprise License Agreement and The Bureau of Indian Affairs

The Hoopa, Yurok and Karuk take advantage of the free licensing provided from the Environmental Sciences Research Institute (ESRI) to the Bureau of Indian Affairs, through the National Geospatial Resource Center. Currently, this program offers ArcGIS version 10, and a number of packages for servers and developer use. Generally, ESRI requires tribes to keep software updated to at least the current version minus one. This is stipulated as a part of the Enterprise License Agreement between the Bureau of Indian Affairs and tribes, but tribes may petition to keep using an earlier version if they so desire. However, in doing so, tribes may lose access to technical support.

From the late 1990s to 2005, the BIA and Environmental Protection Agency provided GIS software to tribal governments, with over 230 tribal offices receiving GIS software by 2005 (Palmer 2009). Today, ESRI negotiates a contract with the Department of Interior (DOI) and US Geological Service (USGS) under the Federal General Services Administration. The ESRI Enterprise License Agreement (ELA) is a fixed price agreement with the DOI. The Department

of Interior is able to administer GIS license files to its sub-departments, one of which is the National Geospatial Resource Center (NGRC). The NRGC, in turn, administers the licensing program for the Bureau of Indian Affairs. In the early years of this licensing procedure, there would often be delays in software distribution. David Gadsden, who works for the non-profit division at ESRI in Washington State, attributes these lags to the fact that tribes don't deal directly with ESRI to get license updates. He emphasizes that the licensing process is actually quite time-consuming, and the centralized program under the BIA, in Alberquerque New Mexico, often is overwhelmed with backlogs of license and support requests.

Gadsden sees ESRI's role as largely a support system for professionals. Other mapping utilities, including Google Maps and Open Street Maps, cater to consumer-class map users and not necessarily data analyzers. Lack of meta-data precludes much sophisticated analysis. ESRI's "community –based maps", for Gadsden, provide an alternative to the Open Street Map format, one that may not be very well vetted. Communities are free to upload their geographic information to ESRI's servers, which will then make the data freely available to the public, as a raster base map, rather than distributing the data itself. This works around difficulties associated with storing and transmitting large datasets, as well as the security issues that may arise form giving the public full access to personal spatial information. Gadsden also supports the ESRI model for disseminating information – the data itself still lies in the hands of the community that originally generated it. (David Gadsden, personal communication, 2011)

Training

ESRI and the BIA offer free trainings at the National Geospatial Resource Center campus in Albuquerque, New Mexico. Participants must pay their own transportation, lodging, and food costs. However, NGRC also hosts GIS training sessions at "field locations" on reservations or at BIA offices. This year they offered six such trainings, in California, Minnesota, Montana, Oklahoma, Oregon, and Alaska. Scott Quinn, at the Karuk Tribe, recalls having traveled to one such training in Happy Camp, California. However, staff I spoke with at Hoopa and Yurok Tribe had not and did not know of anyone who has used this training. One staff person at the Hoopa Tribe remarked that she often found the trainings were poorly advertised, using fax rather than email. She often wouldn't notice the trainings were being offered until after-the-fact.

For the Hoopa GIS staff, the transportation and hotel costs of attend free BIA-sponsored trainings was economically inefficient. The land planning staff person had attended a training in his early years working for the tribe, but he maintained that most of his GIS knowledge was self-taught. For the Forestry department, trainers from ESRI had been brought to the reservation to conduct a training a few years ago. All of the staff I spoke with received their formal training in academics, generally through graduate education. In both cases, the Tribe has hired staff based on pre-existing GIS skills, rather than training existing staff.

At Yurok Tribe, few had participated in the training programs offered by ESRI and the Bureau of Indian Affairs, and their remarks suggested that these training programs were not fundamental to their understanding of the software. Staff at the Yurok Tribe received GIS training as a part of their university programs. The staff is comprised of two members, one with a degree in Geography, and another in Natural Resources Management. The GIS work is roughly split between the two, with one staff member focusing on social and infrastructural information, and the other biological and geophysical information.

The Yurok IT Department also provides ArcReader training for tribal members in other departments. ArcReader is a simplified version of ArcMap software that includes basic identification, measurement, and cartographic tools, and allows map users to view spatial information in the ArcGIS format. In addition, they have conducted GPS and GIS training at local high schools. They are interested in expanding this training to community members so that they may participate in the data collection process. Currently, tribal members occasionally ask for data, especially relating to their own properties.

Data Management

The Hoopa Land Planning department generates almost all of its data. The only outside data they use are satellite images, air photos, and digital elevation models. Any data collected is clipped to the reservation boundary. The staff at the land planning department does its own land classification based on satellite photo interpretation, using land use categories adapted from the USGS classification system. They have added ceremonial lands as a separate category, and also defer to the cultural committee or higher-level tribal officials in determining what spatial information is appropriate to share on the servers.

The Hoopa Land Planning department prides itself on not using "process" data, or data that describes time sensitive or ephemeral physical phenomena like fire and weather. For example, in the case of fire, the staff at Hoopa will look at satellite images and generate its own polygons rather than relying on data from the Forest Service. The GIS personnel at Hoopa Tribe recommend that as much data as possible be internally generated. Staff report that, " every square inch of the reservation has been detailed somehow – either from going out in the field, or from satellite data, based on vegetation types or various land management criteria" (Oldenburg, 2011).

At the Yurok IT department, data is organized on the server by raster and vector categories, then by geographic scale. The IT department at Yurok Tribe gathers most of its usable base data from free, widely available information, and will amend it as necessary. The IT department clips any data it gathers from outside sources (such as NAIP imagery) to the ancestral territory boundary for the tribe. They will collect small-scale data for the whole ancestral territory, but most large-scale data is gathered in the reservation area.

Yurok Tribe GIS staff originally obtained parcel data from the US Census but have since privately updated it with subdivisions and ownership information. Some important information on the reservation is completely left out of federal surveys and must be generated on site. For example, CalTrans provides culvert information for Highway 196 (which runs through the Yurok reservation) but the department must collect their own information about culverts on local roads. In addition, the GIS staff must independently generate accurate road and address data for the reservation. They share address information with local emergency services under the agreement that it will not be published or distributed. The staff is wary of sharing information with publicly accessible databases, especially Google Maps, and defers to the judgment of the tribe's cultural department regarding what is appropriate to share.

Tribes use a hybrid of information, depending on the scale that is accessible and relevant to their project application. However, on occasion, issues of data incongruence arise, as with road information. These issues are not entirely unique to tribes, as my discussions with Forest Service GIS staff revealed. For example, data that covers roads spanning both Forest Service and Bureau of Land Management lands occasionally do not match. The absence of interagency oversight and poor metadata are both significant obstacles to data interoperability.

Underlying the superficial questions about data accuracy and access are broader questions about data generation capacity. A healthy GIS program requires both the capacity to transform and analyze existing geospatial information, but also the ability to generate local information when outside information is inapplicable. Generally, the local geographic information generated by tribes is supported by project-specific grants, usually through the federal government, and occasionally through outside research institutions.

Applying GIS: Data Generation and Collaboration

Hoopa Valley Tribe members rarely approach the Land Planning department for data, but will occasionally bring questions regarding parcel ownership. The Hoopa Land Planning department has created and maintains a file that details all land ownership and leasing of land on the reservation. The parcel polygons are linked to two databases so that multiple landowners may be tracked on a single parcel. The ultimate goal of this project is to make land ownership information available to all tribal members through a touch screen display, so that any questions may be easily resolved without directly consulting with the data manager. Community members at Hoopa Tribe are otherwise not involved in the mapping program. Though they ostensibly have access to most GIS data, staff do not recall having received queries from within the tribe.

Ted Oldenburg, Hoopa Land Planning GIS manager, is also hired through the US Environmental Protection Agency as a water quality monitor. He has set up a number of monitoring stations on reservation streams to keep track of sediment loads from logging. One special project the department conducted was an extensive mapping of every culvert on the reservation. According to Oldenburg, "As far as timber companies go, this is one of the few in California that knows the condition of every culvert on the reservation." The culvert survey process was initially completed as part of the Environmental Impact Reporting process to NOAA fisheries and Fish and Game.

The Yurok IT department accepts mapping requests from all other tribal departments, including Council, Executive Office, Human Resources, Fiscal, Public Safety, Fisheries, Cultural, Yurok Tribe Environmental Program (YTEP), Planning, Education, Tribal Enrollment, Watershed, and Forestry. They receive the majority of requests from the legal department. Outside of the tribe, they often complete requests from contractors, realtors, and architects. Both tribal members and non-tribal members know that the department is a resource. They often

receive from outside the reservation – ranging from a missing person's map to road information for Cal Fire.

The Yurok IT staff leads a GIS working group that brings together all people using GIS in the Tribe's departments in order to keep data shared between departments in a sensible and accessible structure. Individual projects are kept in working folders that track drafts, email correspondence, and any other pertinent information. The IT department recently implemented a project request form process for GIS projects. In the past, other tribal departments would contract GIS work to outside agencies that would often approach the Yurok IT department for data. Over the last few years the department has successfully made its presence known as a strong mapping resource for both the tribe and the general region.

One of the key projects underway in the Yurok IT department is an Integrated Resource Management Plan. The staff has developed an ArcReader version of the ancestral territory map, complete with a few key data layers. They have trained staff throughout the tribe's departments in how to use this simplified version of GIS software so that they may use it as a tool for inter-departmental communication and planning. The IT department will manage project site information that will be accessible to all departments. Data collection is still underway.

A key upcoming project for the department is a Hazard Mitigation Plan funded by the Federal Emergency Management Agency (FEMA). GIS staff will collect data about house building footprints, structure types, bridge types, water systems, septic systems, and more. They see this as taking an inventory of the reservation and building a strong archive of data on which they can draw in the future. Currently, they only generate such local data on an as-needed basis.

Cultural Information

None of the GIS staff I spoke with were members of the Tribes under which they were employed. One staff person at the Yurok tribe was a Karuk Tribe member. When I interviewed the staff, they were reluctant to provide information about applications of traditional or sacred knowledge in GIS. This may have been for security concerns, but their responses indicated most that they were cautious about over-speculating on the broader contexts of their work. As Elly at the Yurok Tribe put it, "We have to let our cultural committee deal with that" (Elly Supahan, personal correspondence, 2011).

The GIS capacity at Yurok Tribe originally grew out of cultural survey processes, originally conducted by hand. This information was kept on paper maps, a medium that was very secure and exclusive to the tribe. GIS and GPS became tools for completing these projects, and then eventually expanded to working on a broader set of projects for the tribe. Currently some efforts are underway to digitize these original maps, but time and funding are limiting factors.

Staff at the Yurok IT department have obtained approval from Tribal Council for digitizing cultural information. They are publicizing the possibilities for cultural applications of digital information, focusing on measures to keep sensitive information secure and password protected. They also use buffers and Public Land Survey quadrants to obscure the location of important sites, while still disclosing enough geographic information to protect them.

At the Hoopa Valley Tribe, cultural information is limited to use areas and ceremonial sites. The Forestry Department uses this information in its planning process, restricting cultural areas from timber harvesting. The forestry department has also done some incidental GIS mapping of culturally significant areas, such as a viewshed for the peak of Mount Shasta, a sacred place in Hoopa tradition.

Funding

The GIS division of the IT Department at the Yurok Tribe is partially funded through the tribe's indirect budget, which supplies about 50% of the supervisor's salary. The Tribe's indirect budget funds services used by all other tribal departments, such as accounting or Human Resources. The Yurok Tribe GIS program is included in the IT department because its services span all of the other departments. The other employee is paid solely through project-based funding secured by the tribal department requesting GIS services (usually from federal or state moneys or private grants). Occasionally the IT department will also service requests from outside agencies.

Yurok IT Department staff maintains that GIS services should receive more indirect funding from the tribe's budget. The supervisor remarked: "It's the same function of the indirect funding that tribes use toward their fiscal or HR departments - the IT department also works for everyone, and so my belief is that GIS should be a part of that (Supahan, 2011)".

The Hoopa Tribe is able to fund its GIS capacity through revenue from Forestry as well as EPA water quality management funds. Currently, there isn't a dedicated federal funding source for supporting tribal GIS. GIS is considered a tool that would be used by a particular department for specific projects, and not necessarily stand on its own. Indeed, it's often much simpler to apply for project-specific funding outside of the tribe than to allocate funding from within. In the Fisheries department, GIS is not necessarily the go-to tool for their analysis. For point-based monitoring stations, simpler database software such as Excel or Access are sufficient. However, GIS is the standard for communicating with federal agencies, especially on projects that are outside of the scale of the Hoopa Reservation. For example, the Fisheries Department collaborated heavily with both the Yurok Tribe and the US Fish and Wildlife Service to count salmon reds above the confluence of the Klamath and Trinity Rivers. This research figured prominently into the broader ecological arguments for the Klamath Dams removal efforts.

Pacific Northwest reservations, including the Confederated Salish and Kootenai and Hoopa Valley, were responsible for 75 percent of the total U.S. Indian land timber harvest in the 1950s.

GIS use took root in the Hoopa and Yurok governments in different ways. At the Yurok tribe, it grew out of cultural surveys. At Hoopa Tribe, it was adopted first as a tactic for managing its forest resources, and communicating with Federal agencies. In general, the knowledge system out of which GIS arises is a useful way to begin thinking about its community effects. However, the GIS itself seems to have relatively little bearing on how a tribe ultimately choose to integrate GIS into its programs. The value systems inherent to the program quickly become transformed by the ethics and strategies with which tribal GIS users choose to approach their work.

The need for tribes to integrate GIS technologies into their management practices, and the efficacy to which they do so, is a highly varied process that is unique to each tribe's needs and goals. Processes of GIS adaptation, as with many other technologies, require both technological adaptation; staff training, hardware and software; as well as a broader governmental and or community wide adaptation. The different approaches that the Yurok and Hoopa Tribes take to structuring their GIS departments simply speaks to the broader way they wish to use GIS within their tribal governments. Within an IT department, GIS seems to be much more visible, both to the tribal and non-tribal community, as an information resource, and to the tribe's government as

an analytic and presentation tool. Within a management department, GIS serves as an accessory to the broader departmental goals. Overall, the extent to which GIS capacity is utilized is generally left up to the data manager.

The graphical user interface in GIS has made it much easier for tribes to begin using it, and has considerably shorted the learning curve. However, on occasion tribes have attempted to adopt GIS technology unsuccessfully, investing much time and energy in building capacity but without contextualizing the goals of the program within the goals of the tribal government. David Gadsden at ESRI pointed out that "GIS itself isn't magic." Though it appears to be able to fluidly integrate different forms of knowledge in a shared format, it also requires careful maintenance. Even small issues like using the proper projection or keeping data well - organized takes incredible patience and staff resources.

As a result, those involved in GIS use at the tribal level, and in general, are not necessarily "traditional knowledge" holders themselves – they are interested in organization, analysis, display, and dissemination. My questions about traditional and cultural knowledge in GIS thus often fell flat. The largest problems for academics are often not so for practitioners. Lively debates about the politics of knowledge didn't diffuse readily into the realm of users and data managers. For the staff at the Hoopa and Yurok Tribes, indigenous knowledge didn't figure into their daily work in a self-conscious way. However, one cannot automatically assert that sensitivities to traditional knowledge systems were thus absent. Even if they kept careful records of sacred sites within GIS, this was not necessarily material they were open to sharing.

My initial framing failed to account for the multiple, and often heavily bureaucratic, ways that tribes pursue their self-determination goals through the resources that are available to them. However, the different approaches within the Hoopa and Yurok tribes are useful for the Karuk Tribe as staff contemplates the best way to expand its GIS use.

Implications for Karuk GIS

The prospects for the Karuk Tribe to develop internal GIS capacity are good. For Scott, staff education in basic GIS analysis is essential, in order to help them understand how they could utilize GIS. In Scott's opinion, the greatest potential beneficiary would be the Department of Natural Resources. For example, this department could use GIS to model salmon pool sediment loads in three dimensions.

One key application of GIS has been in constructing a digital aboriginal territory boundary for Karuk Tribe legal records and management efforts. Around 1979, a subcommittee developed an ancestral territory map by talking with tribal elders, referencing older maps, and ethnographic data. Bill Tripp, Biologist at Karuk Department of Natural Resources (DNR), digitized it off of a paper map, and developed the GIS layer in use today.

In the Land Planning department, Scott will use GIS to make maps for fee to trust applications, housing improvement projects, transportation projects, and for election committee use. For example, he has helped develop voting districts by calculating roads within 100 miles of the aboriginal territory, and counties within those areas. While working at the Karuk DNR, he will also crosscheck timber harvest plans released for the forest by overlaying the plan with another vegetation classification layer. In addition, there have been a number of projects to update tribal roads, including adding data to the BIA road system in order to access construction and maintenance funds. In general, the Land & Transportation Planning Department keeps updated maps of all Karuk trust and fee lands and allotments.

Scott acknowledges that about half of general mapping needs are fairly simple, and can be satisfied with Google Maps and basic digital illustration. For Scott, Google would ideally incorporate more geospatial analysis in their Google Maps and Google Earth tools, so that users could make basic maps without needing to use ESRI software. Scott also emphasized that the best option for securing this information would be with a THPO (Tribal Historic Preservation Officer). This would ensure that access to sensitive GIS data would be limited to those on a need-to-know basis, and this office could address questions regarding the origin and accuracy of the data.

I also spoke with Ron Reed, Cultural Biologist at the Karuk DNR, about his vision for GIS use in the Karuk Tribe. He sees the program as capable of demonstrating the interrelatedness he sees in the land. The technological format could also be a way to reach tribal youth. He drew a diagram explaining how ecological, social, economic, and spiritual factors influence one another. He was excited about how GIS could make this argument clear to federal managers, academics, and youth in the tribe.

Ron's goals for the Karuk DNR's potential GIS applications speak to the broader receptiveness the department has towards "integrating traditional knowledge with Western

Science" (Karuk ECRMP, 2010). This is one of the motivating tenets of the Karuk Eco-Cultural Resource Management plan.

GEOGRAPHIC KNOWLEDGE SYSTEMS?

"So, despite their apparent hegemony, modern scientific maps offer sites of resistance and the possibility of other ways of knowing the world." David Turnbull, 2006

The political and environmental history in the Klamath region is also a story about delineating territory, and thus producing powerful cartographic arguments behind a veil of neutrality (Sparke 2005; Wood 1992). For the Karuk, their history of dispossession can also be traced through the inscription of American managerial and political boundaries that ignored indigenous claims to the landscape. Today, GIS mapping allows tribes to leverage existing land claims to participate in important environmental and political discussions. Bryan Mazoras, GIS supervisor for the Bureau of Indian Affairs, writes: "A graphic representation or map is likely to enhance a court's understanding, synthesis, and resolution of a land dispute, simply because it allows the court to visualize the location and extent of the conflict (Mazoras 1991)". In a legal context GIS can also work to de-historicize indigenous geographies by making aboriginal land claims a part of contemporary negotiations. At the least, it is a useful tool for collecting and managing information about tribes' sovereign lands.

However, the use of GIS has prompted critiques concerning the power of maps, elicited questions about the epistemological biases of this software, and challenged the universalized cultural categories through which resource management conflicts are framed. GIS portrays knowledge about the landscape, but also produces it. Critiques of indigenous GIS emanate from critiques of the post-colonial relationship between tribes and the federal government, as well as notions of potentially incompatible "Western" and "indigenous" epistemologies.

Access to geographic information has profoundly changed environmental decision-making, re-territorializing the intellectual and managerial landscape (Fisher & Unwin, 2005). If territory is understood as a "social, political, economic, and cultural process that unfolds not only in place but through time (Delaney 2005)", 're-territorializing' is a useful way to conceptualize both the way the Karuk are proposing eco-cultural management strategies, as well as the modes of representation they might use to do so.

Territory and knowledge are connected through maps, both in practice and theory. Practically, maps have been essential tools for American resource management and settlement (Harris and Hanzen 2006). Baudrillard (Baudrillard, Foss, Patton, & Beitchman, 1983) made the dramatic philosophical claim that cartographic 'simulations' produce the territory itself. Critical cartographic theorists have emphasized the importance of understanding the political implications of maps, particularly as they may be used to control (Harley 1989, Wood 1992, Monmonier 1996). Even the processes of map and statistical production require intensive, and often bureaucratic, methods for collecting and organizing knowledge. In turn, states may use this information to generate totalizing, 'synoptic' views of territory that are compressed, denatured, and structural – rather than dynamic and complex (Häkli, 2001).

The "critical cartography" framework seeks to undermine the monolithic power of maps through careful deconstruction of maps as texts (Harley, 1989). My introductory sections drew on cartographic materials to demonstrate how maps describe and inform broader political dynamics. However, this deconstruction has not focused on the tools of knowledge generation, but on the map itself (Monmonier, 1996). As such, these critiques find a mapmaker, government, or agency at fault, criticizing the knowledge system for its effects rather than its origins.

It is thus equally important to explore the array of practices that constitute apparently unified knowledge systems. In *Masons, Tricksters, and Cartographers* (1996), David Turnbull shows that the early modern surveying methods used to produce maps were ad hoc, local, and contingent, even though the finished products appeared to be uniform and objective. It was in the interests of a nascent imperial consciousness, and a "scientific" worldview emerging at the same time, that they maintain this appearance. Attaching clearly demarcated boundaries to ambiguous spatial conditions is a problem universal to cartographic representation (Sui, 2004). Turnbull's argument can be readily applied to the ostensibly uniform worlds depicted through Geographic Information Systems.

Rundstrom (1995) stated the point particularly well: "GIS does not capture relatedness, but produces it". Intensive critiques of the positivistic qualities of GIS have drawn on previous sociological critiques of Western science (Schuurman & Pratt, 2002). Others cite its propensity to be rooted in the same imperial and territorial configurations as earlier cartographic technologies (Pickles, 1995). Because digital data is so easily transmitted, privacy issues also have particularly significant implications for tribal GIS data (J. Crampton, 1995). Digital

geographic information, as these theorists demonstrate, is not immune from Turnbull's critiques of scientific knowledge.

I have drawn attention to irregularities in GIS, both on the scale of data, using the example of fire, as well as program implementation and organization, in the case of tribal GIS programs in the Klamath region. My research shows that GIS, though its historical roots are in forms of knowledge production often classified as Western or positivist, is still constituted by the practical limitations and philosophical ethics of those who use it. Criticizing GIS as a knowledge system that excludes "indigenous" perspectives relies on unduly broad assumptions about indigeneity – ones that can resemble the same cartographic generalizations American Indians have long been subject to.

Explanations of tribal resource management that draw distinct boundaries between "Western" and "Indigenous" knowing approach GIS with skepticism: "Technical capacities like Geographic Information Systems **(**GIS**)** may be part of the process as engines, but not guidance systems, in the restoration of place (Stumpff, 2006)". These critiques, though well – founded, often view GIS as an abstract tool that has uniform effects. I argue that "technical capacity" is far too blunt a term to explain the variety of ways GIS may be used. These critiques deserve consideration, as they provide a genealogy of thinking about GIS and scientific knowledge. However, they fail to provide a practicable agenda for possible tribal self-determination through GIS.

Counter-mapping posits that mapping may articulate understandings of the landscape that can challenge and shape hegemonic discourse. However, the philosophies underlying these practices risk reinforcing a bipolar understanding of resource management (Peluso, 1995). Indeed, some critics find that indigenous mapping efforts are still deeply embedded in not only an inequitable politics of statehood and sovereignty, but also the technological and social barriers to legitimate map discourse itself (Wood, 2010). Others criticize counter-mapping efforts for subscribing to a neo-liberal paradigm of land ownership (Wainwright & Bryan, 2009).

Among critical GIS scholars is also a pervasive concern that the worldviews of indigenous communities risk being assimilated into Western traditions when reduced to digital spaces. Even for tribes with their own GIS departments, tribal members may still be isolated from using this knowledge resource, or being able to share their own knowledge.

Michael Palmer (2009) argues that GIS technologies are simply a more recent iteration of assimilationist practices in the Bureau of Indian Affairs, designed to force indigenous knowledge holders to operate with a set of technologies that are incommensurable with their traditions. Palmer suggests that GIS "deskills" elders, and marginalizes cultural knowledge, particularly in Integrated Resource Management Planning applications. However, Palmer's critique, as he acknowledges, works from outside of how GIS is applied within tribes. His concluding questions: "What happens to GIS once it enters indigenous communities? ... How are indigenous communities using these technologies? Who owns GIS and IT in indigenous communities?" have formed a starting point in my research (Palmer, 2007 pg. 229).

Rather than accept the assumption that GIS use is a one-way assimilationist process, I have focused on the ways that geospatial information is used within tribes and the federal government in the specific context of the mid-Klamath River basin. In doing so, I have been able to work past the dichotomies that motivate much theoretical writing, and discovered that at finer scales, GIS can be understood through Turnbull's "assemblage". The assemblage "connot[es] active and evolving practices rather than a passive and static structure" (Turnbull, 2008). It challenges Latour's local-global tensions in technoscience and instead captures the inherently spatial nature of knowledge making-practices without applying a hierarchy of agency (Watson-Verran & Turnbull 1995). This is not to say that GIS an equalizing force. Rather, its effects are particular to the way it is used in a community.

One way to think about this particularity is through economic stability and resource sovereignty. According to Imre Sutton (2001), "tribes earning considerable revenue from natural resources tend to have greater success in dealing with business enterprises and the government". The policy legacy for each tribe is critical, for those whose properties have not been allotted have less difficulty establishing resource management than those on allotted reservations, where many landowners are non-Indians. Furthermore, for a tribe like the Karuk, without a reservation land base, obtaining control over contiguous land parcels is particularly difficult. Environmental policy at the federal, tribal, and state scales often have statutory conflicts, where it is unclear whose authority regulates particular environmental qualities on trust lands (Sutton 2001).
With little funding, it is also difficult to maintain full-time GIS staff. According to one case study, GIS technology is not suitable for part-time staff, because such complex computer systems management requires full-time operators (Marchand & Winchell, 1992). In addition, tribes must

uphold a broader mission than their US governmental counterparts, including the preservation of culture, language, and traditions (Marchand & Winchell, 1992). Palmer is dissatisfied with the ability for GIS to achieve this mission, because standardization practices in the BIA Nationwide Database have "erased the diversity of American Indian physical and cultural landscapes" (Palmer 2009). He writes:

> *"Although BIA maps are supposed to be cartographic representations of American Indian landscapes, the content consists primarily of reservation infrastructure, natural resources, and tribal land holdings. Most traces of native language and toponyms are not present"*

Palmer sees the BIA Geographic Data Service Center as a center for information that parallels the political relationship between the BIA and tribes. Though I agree with Palmer's lament that Native information is excluded from this institutional cartography, I am ambivalent about the idea that it should be included in a BIA format. To criticize the BIA for excluding native language and toponyms is to assume that it would be best to include them in some totalizing geography of Indian country. Expecting the BIA to play such a role in the knowledge of tribes may actually undercut his argument about the BIA's excessive control over tribal GIS. He writes that "GIS networks emanat[e] from federal government and flo[w] to American Indian tribal governments" (Palmer 2009, pg. 36). However, this flow of networks does not require tribes to participate, nor does it ensure that Tribes actually adhere to its "top down" stipulations. Indeed, much of the staff I spoke with were skeptical of BIA resources and used their own strategies for obtaining and organizing information.

It is perhaps suitable that tribes with strong GIS capacity can exert more control over their own spatial information. Support from federal agencies would perhaps best come in the form of GIS capacity building through staff funding, instead of creating an institutionalized data structure. At the same time, problems with staff shortages and data interoperability are pervasive throughout tribal, state, and federal agencies. For now, we must for the most part rely on critical and careful staff that ask questions of their data, and take the work with their communities seriously.

Boundaries, Peripheries, and Third Spaces:
Remaining questions about the geographies of knowledge

There are parallels between theories concerning physical space and knowledge spaces, which form fertile grounds for future inquiry. Boundaries, core-peripheries, and third-space are interesting ways of conceiving both of territory and knowledge. These theories might do well to better understand the questions about indigenous territory and indigenous knowing that I laid out in the preface.

Joel Bryan argues that not only the lands, but also indigenous peoples, were conceived of as "boundary objects" through which nature and nationhood are constituted (Bryan 2009). Bryan argues that indigenous counter-mapping efforts are complicated by the fact that they rely upon assuming a conventional notions about indigeneity in order to position their relationship with modern society (Bryan 2009). Star (1989) also uses "boundary objects", but to describe theories as, "objects that are both plastic enough to adapt to local needs and constraints of several parties employing them, yet robust enough to maintain a common identity across sites." (Verran & Turnbull 2009). Understanding how indigenous peoples are framed as "boundary objects" illuminates the material and epistemological tensions indigenous communities face when staking land claims. In some ways this is reflective of Star's sense of boundary objects, in that indigenous peoples also ascribe to broader theories about the power of maps in order to participate in the political possibilities counter-mapping offers.

Palmer explains the Tribal-Federal relationship as a form of core-periphery geography, with rationed knowledge and capacity flowing one-way from the Federal government center. Reading Palmer's work through Watson-Verran and Turnbull's argument that "all knowledge is local" (1995) raises some interesting questions. Can the agendas of the BIA and American Indians both be considered 'local'? And will doing so yield greater parity in the relationship between bureaucratic GIS and the knowledge systems of elders? Watson–Verran and Turnbull might suggest that these incompatibilities, rather than being inherent to different ways of knowing, are characteristic of each knowledge system in its own instantiation.

Finally, Turnbull (2000) uses third-space as an ideal way for knowledge systems to co-mingle and co-constitute one another: "A third space would be an interstitial space, a space that is created through negotiation between spaces, where contrasting rationalities can work together but without the notion of a single transcendent rationality". His claim that "all knowledge is local" attempts to challenge the local – global dichotomy produced by theories of technoscience, wherein particular technologies are used to challenge a hegemonic superstructure. While

Turnbull's third-space accommodates an assemblage of methods and perspectives that span diverse knowledge systems, I question if his use of 'local' translates into a particular geographic scale.

Kevin Bruyneel, in *The Third Space of Sovereignty* (Bruyneel, 2007), takes third-space more literally:

> This [indigenous resistance to American colonial rule] engenders what I call a third space of sovereignty that resides neither simply inside or outside the American political system, but rather on these very boundaries, exposing both the practices and contingencies of American colonial rule. This is a supplemental space, inassimilable to the institutions and the discourse of modern liberal democratic settler-state and nation."

Bruyneel's third space is quite parallel to Turnbull's. Both propose a space in which assumptions about knowledge or sovereignty are suspended – a space that is both outside and between theoretical or political dichotomies. How might these conceptions relate to one another in the context of mapping? Is it useful to call out the similar terminologies each employs to re-think colonial relationships between Western and indigenous peoples and their knowledge systems?

I would speculate that this divide, essentially between geographic epistemology and ontology, dissolves when one considers the work that maps do in the world, through the claims and actions they motivate or justify. One sees a map through their position in relation to it, through the work one does on it, and through the questions one asks of it. Meaning becomes material; the map produces the territory, and the territory produces the map.

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