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Research

Securing a Future: Cree Hunters' Resistance and Flexibility to Environmental Changes, Wemindji, James Bay

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ABSTRACT. Accounts of the adaptive responses of northern aboriginal peoples include examples of purposive modification and management of ecologically favorable areas to increase resource productivity. Practices include clearing of trees, burning of berry patches and construction of fish weirs. This paper examines the adaptive capacity of the northern aboriginal community of Wemindji, east coast James Bay, in relation to long term landscape changes induced by coastal uplift processes. Associated changes are noticeable within a human lifetime and include the infilling of bays, the merger of islands with the mainland, as well as shifts in vegetative and wildlife communities. In response, generations of Cree hunters have actively modified the landscape using a variety of practices that include the construction of mud dykes and the cutting of *tuuhiikaan*, which are corridors in the coastal forest, to retain and enhance desirable conditions for goose hunting. We provide an account of the history, construction, and design of these features as well as the motivations and social learning that inform them. We reveal a complex and underappreciated dynamic between human resistance and adaptation to environmental change. While landscape modifications are motivated by a desire to increase resource productivity and predictability, they also reflect an intergenerational commitment to the maintenance of established hunting places as important connections with the past. Our findings support a revised perspective on aboriginal human agency in northern landscape modification and an enhanced role for aboriginal communities in adaptive planning for environmental change.

Key Words: *adaptation; Cree; environmental change; flexibility; indigenous resource use; goose hunting; James Bay; landscape modification; resilience; resistance*

INTRODUCTION

Environmental variability is a defining feature of northern ecosystems (Overpeck et al. 1997, ACIA 2005). As a result, the survival and persistence of northern aboriginal people has required the development of distinctive life ways capable of accommodating and responding to change (Balikci 1968, Langdon 1995, Turner and Clifton 2009). Numerous studies attest to the detailed place-based knowledge and beliefs of these long-term residents (Reidlinger and Berkes 2001, Nickels et al. 2002, Adger et al. 2003, Ford and Smit 2004) and to the importance of mobility and flexibility in their adaptive response (Steegman et al. 1983, Freeman 1996, Berkes and Jolly 2001).

For many aboriginal groups, enhanced resilience or adaptive capacity are often linked with habitat and natural resource diversity (Berkes and Folke 1994, Berkes and Davidson-Hunt 2006) which, according to Turner et al. (2003:442), "is often found to be at its greatest in ecological and cultural edge situations". Evidence from several sites within Canada (Anderson 1996, Peacock and Turner 2000, Turner and Peacock 2005) indicates that aboriginal peoples not only sought out and settled these ecologically favorable sites, but intentionally modified them to maintain and enhance the benefits they provided in terms of "livelihood flexibility and social–ecological resilience" (Turner et al. 2003:451). Practices involved in purposively managing these edges include clearing of trees and brush to increase edge habitat for berry growth (Turner 1999, Turner et al. 2003, Parlee et al. 2005), pruning and burning of berry patches to maintain their productivity (Turner 1999, Peacock and Turner 2000) and support small scale cultivation

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(Davidson-Hunt 2003), burning of river margins and low areas of the boreal forest to enhance habitat conditions for ungulates (Lewis and Ferguson 1988), mounding of soils and construction of rock walls to expand the areas of tidal marshes suitable for wild root vegetable production (Deur 2000) and construction of fish weirs (Stewart 1977, Rogers 1983). Most of these practices are succession management systems (Davidson-Hunt 2003) that represent distinctive cultural adaptations to local biophysical and ecological settings, as recently underscored by Natcher et al. (2007) in relation to fire use among Athabaskan groups.

With increasing evidence that the effects of global climate changes "will be felt earlier and more keenly" (Berkes and Jolly 2001) in northern latitudes, how northern aboriginal communities respond to change has in recent years become a focus for northern studies (Berkes and Folke 1998, Krupnik and Jolly 2002, Hassol 2004, Huntington and Fox 2005, Ford et al. 2006, 2008, Pearce et al. 2006, Armitage et al. 2007). The concept of resilience, as defined with respect to the ability to withstand shocks and perturbations, the capacity for self-organization, and the capacity to learn and adapt (Resilience Alliance 2001), is widely applied in these assessments of change (Peacock and Turner 2000, Turner et al. 2000, Turner et al. 2003, Parlee et al. 2005, Berkes and Davidson-Hunt 2006, Natcher et al. 2007). Documented responses include a range of strategies from adjustments in how, where and what people harvest (Peacock 1998, Ames 2005), to sharing through social networks and inter-community trade (Berkes and Jolly 2001), to new institutions, such as co-management arrangements, that help facilitate self-organization and the capacity for learning (Berkes and Jolly 2001).

Unfortunately approaches aimed at improving resilience in the North too often focus on the provision of financial, technological, and institutional support (Nickels et al. 2002). Interventions from external sources, while much needed, could have unexpected negative consequences unless channeled in support of local approaches to responding and adapting to environmental change. Projects that build upon established customary institutions of land and wildlife management, and the adaptive strategies they support, may be more appropriate to, and sustainable within, local social–ecological settings. Indeed Turner and Clifton (2009:181) suggest that many aboriginal peoples, because of their long history of involvement with constantly changing environments, "are likely to have the most robust strategies for facing unusual circumstances, and in the event that these occur, are less likely to be taken by surprise than those used to constancy and predictability in their lives".

In this paper we provide an account of social–ecological resilience practices of Wemindji Cree people on the east coast of James Bay, northern Quebec, specifically the strategies used to create, maintain and enhance the highly dynamic and productive range of ecosystems they inhabit. While the regional significance of the James Bay coast as both an ecological and cultural edge has been recognized (Turner et al. 2003), with the exception of brief acknowledgements that dyke building, shrub clearing and forest corridor cutting have been practiced (Scott 1983, Reed 1991, Forest 2006, Peloquin and Berkes 2009), no comprehensive account is available of how local Cree communities have manipulated or maintained these edges. To develop such an account and contribute to growing understandings of aboriginal landscape modification we take both an actor-based and system-based analysis (Nelson et al. 2007) by focusing on what motivates individual Wemindji Cree hunters in management decision-making while also examining Cree landscape management from a system's perspective. We ask: (1) What landscape modifications have Wemindji Cree hunters made and what form do they take? (2) What motivates Cree to construct landscape modifications? (3) How are these modifications, and associated harvesting practices, intended to function in the context of environmental change? We focus in particular on the construction and function of two major modification practices associated with coastal goose hunting: dyke building and the cutting of corridors, known as *tuuhiikaan* (*-an* is singular, -*aan* is plural), through the coastal forest.

Our case is instructive in several respects. Firstly, it provides a previously undocumented example from James Bay of purposive maintenance of ecological edges with respect to landscape modifications and enhancements, modes of self-organization, and social learning. Secondly, it documents how local knowledge and cultural connections to past practices and places are negotiated within the context of contemporary realities of change, with important implications for resilience. While the importance of local knowledge and flexibility for resilience in northern native communities has been acknowledged, the degree to which commitments to place and connections to the past are negotiated for achieving or maintaining resilience has not been recognized. Thirdly, our case demonstrates that aboriginal peoples, such as the James Bay Cree, with an extended history of landscape change, recognize and respond to change as an ongoing and inevitable phenomenon, and are well positioned to contribute to policy discussions and decisions concerning environmental and resource management as well as appropriate responses to climate change.

STUDY AREA

Wemindji is a Cree First Nations community located on the east coast of James Bay, northern Quebec. The Wemindji territory is bounded by latitudes 52˚30’ N and 53˚10’ N, and extends about 300 kilometers inland (Fig. 1). The community is comprised of about 1,300 people (Cree Nation of Wemindji 2006) who are engaged in a mixed economy incorporating formal wage-labor, income subsidies, and subsistence harvesting (Scott 1988, 1996). While many families work as full-time hunters/fishers/trappers, others partake in so-called bush activities on weekends and holidays or after the wage-labor day is done. Others receive bush food through a culture of sharing and gift giving (Scott 1988, 1996).

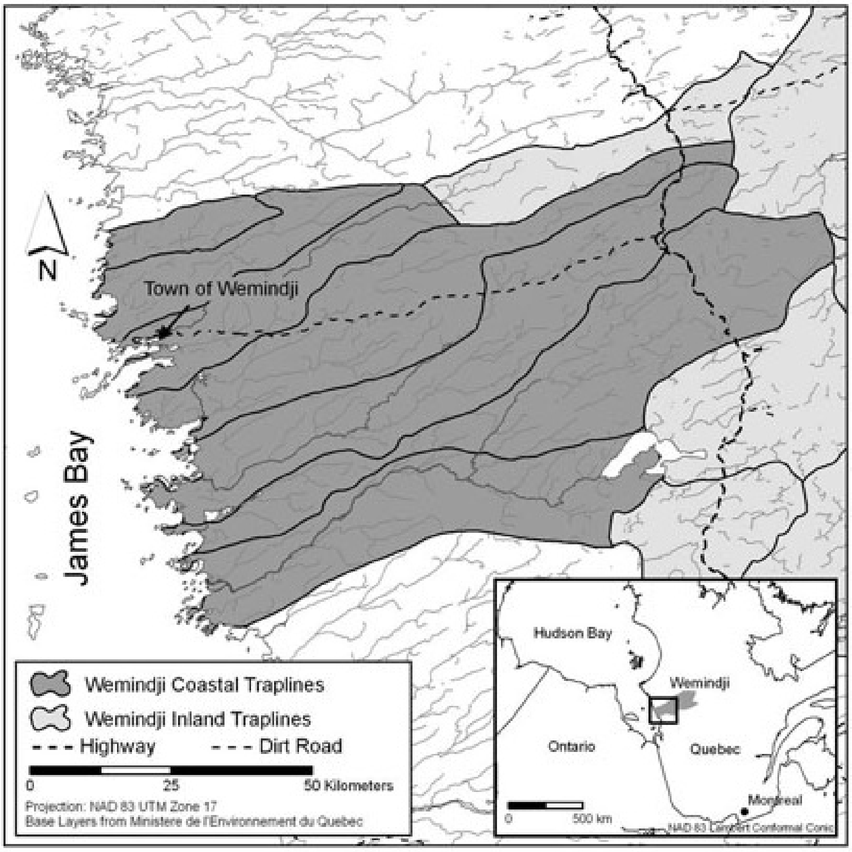
Along James Bay, salt marshes develop in low energy coastal environments while boulders and cobbles, fringed with vegetation, are found in high energy settings. The most common marsh plants include *Carex* spp., *Hippuris* spp., *Eleocharis* spp., and *Triglochin* spp (Dignard et al. 1991). Willows (S*alix* spp.) also grow along many rivers and within the marsh–forest fringe (Dignard et al. 1991). Lichens, heaths (dominated by lichens and/or ericaceous shrubs), and white spruce forests (*Picia glauca*) characterize the mainland and interior of many islands (Dignard et al. 1991). The dense white spruce forest on the coast, as opposed to the black spruce (*P. mariana*) inland, results in part from the thick marine fog that frequently blankets the area (Reed et al. 1996).

Eastern James Bay is undergoing coastal land emergence of around one meter per century as a result of isostatic rebound of land that was depressed by the enormous weight of ice sheets during the last glacial period (Andrews 1970, Hillaire-Marcel 1980, Begin et al. 1993, Lajeunesse and Allard 2003). As new terrestrial surfaces are exposed, upland vegetation (*Salix* bushes, for example) invades seaward at a roughly equivalent rate (van Moris and Begin 1993). Given the relatively low gradient (slopes of 1˚ to 2˚) of this emerged coastal plain (Dionne 1980), isostatic uplift renders this coastal environment among the most dynamic in the world, with channels closing up, islands attaching to the mainland, and new islands emerging within a person’s lifetime (Sayles 2008). Thus, land emergence functions as a disturbance event that contributes to the diversity and productivity of this coastal setting (Davidson-Hunt and Berkes 2001).

Numerous multifamily hunting territories constitute the basic land and sea tenure unit of the James Bay Cree (Scott 1988). There are seven coastal territories within the Wemindji territory (Fig. 1), each of which encompasses a complex of coastal bays, estuaries and offshore islands which include an array of suitable hunting locations. Each hunting territory is under the stewardship of a senior hunting boss or tallyman, who is given responsibility for ensuring the productivity and sustainability of the land (Scott 1986). Under the guidance of the tallyman, a non-hierarchical system of resource management has evolved based on respect, reciprocity and sharing (Scott 1986). Within this system, Cree hunters are said to view themselves as part of a larger ecological “community-of-beings” (Berkes 1995:107).

Coastal activities include waterfowl hunting and fishing, as well as small game hunting, berry picking, egg and water collecting, and the gathering of firewood. Hunting of migrating geese is the major harvesting activity requiring an elaborate system of social coordination that includes rotational strategies of hunting to ensure optimal harvests while reducing goose population disturbance (Scott 1986). Geese stage in Wemindji during spring and fall migrations (Reed et al. 1996). Although the total populations of both the Lesser Snow Goose (*Anser caerulescens caerulescens*) and Canada Goose (*Branta Canadensis*) have experienced dramatic increases in recent years (Hass 2002, Abraham et al. 2005, CWS 2005, Harvey and Rodrigue 2007), Cree hunters have experienced a sharp downturn in their goose hunt over the same period (CRA 2005). Changes in goose behavior and migration patterns, related to a combination of biophysical and socio-cultural factors, provide the most plausible explanation for these changes (Peloquin and Berkes 2009).

Fig. 1. Location map of the Wemindji coastal hunting territories plus regional inset.



Geese feed in high marsh wetland areas during spring and in low marsh areas during fall, with bulbs and rhizomes as the major diet constituents (Reed et al. 1996). By grazing on the low marsh, geese maintain an attractive feeding area and suppress the establishment of coarser, less palatable high marsh vegetation (Hik et al. 1992). If maintained, this negative feedback can last from ten to fifty years, but if broken the expanded low marsh succeeds to high marsh in as little as two to five years (Hik et al. 1992, Handa et al. 2002).

As long-term inhabitants of this dynamic ecological edge, Cree hunters have learned to respond to environmental change by modifying local ecosystems and adjusting their harvesting practices as a means of maintaining or enhancing the productivity of the area and the predictability of their resource harvesting.

METHODS

We combined various methods to gain multiple insights about Cree land and resource use in the context of environmental change. We complemented an ethnographic-based methodology involving semi- and unstructured interviews with key informants and participant observations, with field surveys and remote image measurements and interpretations. Ethnographic work provided us with detailed accounts of where, how and, why Cree modify the landscape for resource harvesting. Ethnographic methods were also our primary vehicle for understanding environmental/ecological change over time. Field surveys and remote interpretations provided context and perspective on the location and extent of Cree's modification practices and revealed larger spatial–temporal patterns. The research involved seventeen weeks of field work over a two year period and was part of a larger collaborative interdisciplinary research team project involving a partnership of university researchers with local and regional Cree entities as well as provincial and federal government agencies (see http://www.wemindjiprotectedarea.org).

We worked with fifteen key informants, including seven coastal tallymen as well as other senior men and women and the director of the local Cree Trappers Association (CTA) who is also a senior hunter. Informants were considered experts by the community and were selected purposefully and/or through referral by other informants. More formal interviews were conducted in people's homes in town or in bush camps with less structured interviews arising spontaneously during participant observation. Spatial data were recorded on 1:50,000 or 1:30,000 topographic maps (formal interviews), or with a Garmin e-trex GPS (less formal interviews). Interviews and field surveys focused on: (1) locating and describing dykes and *tuuhiikaan* sites on each coastal hunting territory, (2) documenting the approximate date of their construction and the length of time particular modification practices have been in use (reported by decade, with reference to major life events, or when very old, in relation to past generations) as well as identifying changes and continuity in those practices over time, and (3) documenting the motivation behind particular modifications, as well as their function in resource harvesting and management in the context of environmental change.

Eight of ten dykes visited and nineteen *tuuhiikaan* were measured in the field using the GPS and/or a measuring tape. Ecological and geomorphic descriptions were also recorded for each site. Satellite imagery (2006, one meter panchromatic IKONOS; 2007, ten meter panchromatic SPOT; and 2001, fifteen meter panchromatic Landsat) and air photo imagery (1958/59) were interpreted using Arc GIS 9.2 to verify field measurements as well as to measure an additional six *tuuhiikaan* and evaluate the landscape context of all dyke and *tuuhiikan* sites.

RESULTS

Our findings indicate that Wemindji Cree have a long history of modifying the coastal landscape of eastern James Bay. Stone fish weirs, for example, were created generations ago, "before the white man came," "before there were nets," or during an elder's "grandfather's time." These bowl-shaped stone structures created a pool in which fish aggregated and were harvested by hand or spear. The practice continued into the early 1900s by a few fishers, if only as an addition to gill net fishing. Another historic practice, described only in general terms by a couple of informants, was digging up marshes with shovels to make them more attractive to geese. Fire was also used in a limited capacity, mostly in small-scale experiments to improve the grasses geese feed on, to promote the growth of berries, and to clean up around camps. Several elders expressed reservations about fire management and emphasized the importance of not interfering too much. We "just let nature do the work," stated one elder woman (*personal communication*). "Willows would grow over where the berries were," said Anne Shashaweskum, another elder woman ". There is not much [we] could do, so [we] would just go to another place." (*personal communication*).

Among the most important landscape modifications practiced by Wemindji Cree however, both in terms of land area affected and human investment, are the construction of dykes and the cutting of *tuuhiikaan*. Both are concerned with the maintenance or enhancement of preferred goose hunting areas and both have a historical legacy and contemporary reality that manifests as a form of resistance to coastal change.

Resistance to change

The construction of dykes dates back beyond living memory. On several hunting territories, Cree spoke of dykes built as early as the 1600s. Dykes are constructed of logs, rocks and sod dug up in the marsh and range in width from four to 269 meters and in height from six to 30 centimeters (Table 1, Fig. 2). Dyke construction has been carried out on all seven coastal territories in recent decades, illustrating the continuity and widespread application of this management practice.

In early spring, when geese first arrive, James Bay is still covered with snow and ice. Pools in the high marsh are the first places to thaw and geese land in these to feed. The construction of dykes across these pools helps to maintain and/or enhance wetland areas that would otherwise dry out under conditions of coastal emergence, a process referred to by Cree as "land growth". As explained by elder Sam Hughboy, "maintaining the pond makes it so the land does not grow" (*personal communication*). The

Table 1. Dyke lengths (meters), heights (centimeters), creation dates, and use status inventoried during interviews and/or field visits organized by hunting territory. Hunting territory or trapline codes have no relation to spatial distribution of traplines.

	Trap line	L (m)	H (cm)	Date made	Still used?
1	A	269	6-9	Generations ago (1800 to 1900s)	Yes
2	A	44	15-30	Generations ago	Yes
3	A	-	-	Will build in fall 2007	Yes
4	A	-	-	No Data	Yes
5	B	24	30	1988 or 1989	Occasionally
6	B	180	16-25	1981	Yes
7	B	-	-	1988 or 1989	Yes
8	B	-	-	Early to mid 1900s	No
9	C	91	20-30	Early 1960s, youngest of 3 in marsh	Yes
10	C	87	10-20	Early 1960s, 2nd oldest of three in marsh	Yes
11	C	-	-	Early 1960s, oldest of three in marsh	Yes
12	C	-	-	1940s	Yes
13	C	-	-	Early 1900s	No
14	C	-	-	No data	No data
15	D	-	-	Late 1700s, early 1800s	No
16	D	-	-	2000	Yes
17	D	-	-	2000	Yes
18	E	24	15-30	2001 or 2002	Yes
19	E	4	15-30	Early to mid 1980s	Yes
20	F	-	-	Grandfather's time (1940s - 1950s)	Yes
21	F	-	-	1999 or 2000	Yes
22	G	-	-	Mid to late 1900s; temporary	No

Fig. 2. A large dyke used for hunting geese. This dyke is 180 meters long and extends beyond the photo.

late Lot Kakabat, a former tallyman, expressed this in similar terms: “when you make a dyke for a pond, when you cut off ground from the earth, the earth would turn into mud; it was like it [land emergence] was all starting over again” (*personal communication*). Dyke creation serves to maintain desirable hunting areas by preventing the draining of coastal wetlands and the seaward invasion of high marsh plant species driven by land emergence.

Dykes function at three nested scales. At the smallest scale dykes maintain or enhance a wetland that is attractive to geese, both in terms of the impoundment created and the plant species supported. The latter include species and genera known to be palatable to geese, such as *Carex paleacea*, *Hippuris tetraphylla*, *Eleocharis acicularis*, and *Triglochin palustris* (Reed et al. 1996) in sharp contrast to species that dominate adjacent areas outside the pond. At a larger landscape scale dyke construction maintains important topographic and ecological conditions for goose harvesting. The spatial relationships between the dyke and the pond or impoundment it creates or maintains, the size and shape of the pond, and the proximity of hills, ridges, and shrub lines all affect how geese approach the pond and the ability of hunters to strategically position themselves for a successful hunt. Dykes are thus built with this larger spatial context in mind so that dyke construction is not just about impounding a specific wetland but ensuring the maintenance of a desirable hunting location. Finally, dyke construction is informed by the knowledge and experience Cree hunters have accumulated about geese in the region, particularly with respect to their migration paths and habitat preferences.

The maintenance of these hunting areas against the inevitable, ongoing forces of land emergence is driven by the subsistence and cultural significance of the goose hunt. With respect to the latter, dykes play an important role in maintaining links with the past as well as in providing for the future. When asked about the long-term prospects of a particular hunting location that has been actively maintained over the last half century by a set of dykes, Lot Kakabat explained: “The routine is going to keep going. People will keep hunting there, where people used to hunt; we might just upgrade it a bit I guess” (*personal communication*). Another tallyman, when asked why he was planning to build a new dyke in a specific bay, replied: “It will be a good spot for the young generations; they will have a place to hunt here” (*personal communication*). Thus, it is with an eye to both the past and the future that Cree hunters invest energy to create, maintain and enhance goose hunting sites.

Tuuhiikaan cutting started in the early 1900s with the most active cutting periods in the 1930s through to the 1960s and again from the 1980s to the mid-1990s. While some of the older *tuuhiikaan* are no longer in use, *tuuhiikaan* are being used and maintained on all seven coastal territories today

(Fig. 3, Table 2). *Tuuhiikaan* are large features (Fig. 4, Fig. 5), ranging from 80 to 1,100 meters long and 30 to 270 meters wide (Table 3), and represent significant investments of time and energy for goose harvesting. They are located on headlands and ridges bordering the north side of coastal wetland complexes and tend to be oriented southeast to northwest, or south to north in accordance with goose flight paths (Table 2).

The purpose of the *tuuhiikan* is to enhance the predictability of certain goose hunting locations. Geese are known to fly low to the ground and pass through gaps in the coastal forest, thus the cutting of *tuuhiikaan* increases the predictability of intercepting these geese as they pass over a ridge; senior hunter Leslie Kakabat credits *tuuhiikaan* with an eighty percent success rate in terms of channeling geese (*personal communication*). On the few occasions that geese do not pass through, *tuuhiikaan* enhance the visibility of the approaching flock allowing hunters to reposition themselves and improve the chance of a successful hunt. Prior to the construction of these *tuuhiikan*, we were informed that hunters would position themselves on the ridge where they predicted an oncoming flock would pass. There was little the hunter could do however, if that flock passed elsewhere. By the time the hunter could see this, there was no opportunity for repositioning because the geese were too close.

Tuuhiikan cutting activity coincides with a period when geese shifted their migration route and were less available on the coast, as discussed above. According to 11 informants across the seven territories, Lesser Snow Geese started to decline from the coast in the 1950s and 1960s through to the 1980s at which point they were effectively gone from a resource harvesting perspective. Canada Geese have frequented the coast less since the 1980s and 1990s. Cree hunters may have been motivated to invest more energy cutting *tuuhiikaan* in the hopes of improving hunting success as geese disappeared from the coast. *Tuuhiikan* cutting may also have contributed to goose redistributions away from the coast, but our discussions with Cree hunters do not support this. Our informants always spoke of *tuuhiikaan* as facilitating hunting. Cree hunters are astute observers of local ecology (Scott 1996) and we do think that Cree would have recognized and responded adaptively had *tuuhiikaan* use negatively affected goose hunting. The extent to which increased numbers of hunters, along with numerous other variables (Peloquin and Berkes 2009) have contributed to the spatial redistribution of geese is unknown. Further study into the relationship between *tuuhiikaan* building and geese patterns is needed to further clarify these dynamics. Additional support that *tuuhiikan* cutting activity was motivated by redistributions of geese in the area is provided by statements made by elder Sam Hughboy. According to Sam, goose decoys were not needed in the period prior to *tuuhiikaan* cutting because: “there were so many geese you just needed to call them ...People knew where to hunt geese simply by looking at them” (*personal communication*). This comment suggests that geese were more plentiful and easier to harvest in the past with less incentive to use decoys and also one could infer less incentive to cut *tuuhiikaan*.

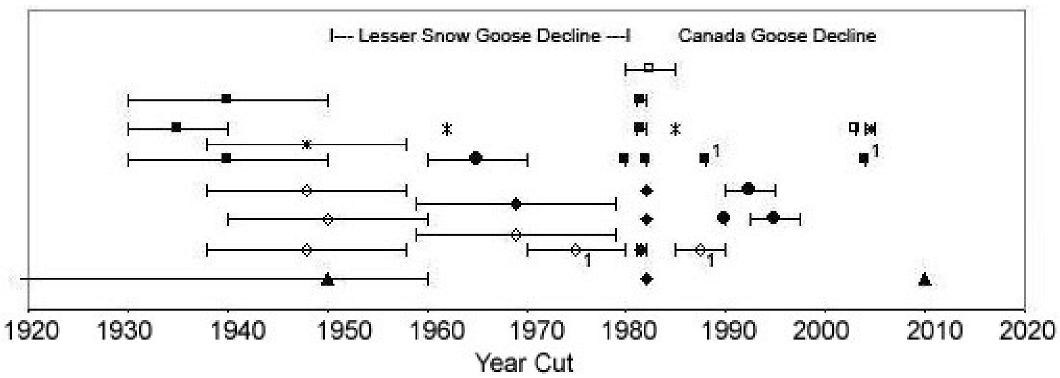
The establishment of a remedial works program in 1979 (SOTRAC 1980) may account for a spike in *tuuhiikan* cutting in the early 1980s. This program was part of an economic settlement package associated with regional hydroelectric development by the Quebec Government. The program aimed to offset some of the negative consequences to Cree natural resource use following hydro development and, among other provisions, included financial compensation for labor to build dykes and *tuuhiikaan* (SOTRAC 1980).

Similar to dykes, the *tuuhiikan* also serves to retard coastal succession. “Cutting [the] trees keeps it the same. If you don’t cut them, they will grow back,” explained Sam Hughboy (*personal communication*). *Tuuhiikaan* are cut on ridges that have long been used as goose hunting locations. As coastal land emerges and upland species invade seaward, trees become established on the ridges. Yet the coastal bays and wetland complexes south of these areas often remain important goose feeding areas. Thus, cutting *tuuhiikaan* extends the usefulness of established and familiar hunting sites, retaining an important cultural link with past generations of hunters in the context of a rapidly changing coastal landscape.

Flexibility to change

While Cree hunters expend significant efforts in retarding or resisting coastal emergence, resistance is just one approach within a broader strategy of response to ongoing coastal change. Cree recognize when larger temporal–spatial changes render their resistance impracticable. For example, a particular

Fig. 3. *Tuuhiikan* cut dates displayed by hunting territory. X–error bars represent the range of date reporting. For example, a *tuuhhikan* cut in the early 1980s is centered at 1982.5 ± 2.5 yrs. A *tuuhiikan* cut in the 1980s is centered on 1985 + or – 5yrs. n = 32 (30 +2). Cut dates were recorded for 30 *tuuhiikaan*, however, two *tuuhiikaan* were re-cut and increased and are represented as a second cut date in the Figure. The labels “Lesser Snow Goose decline” and “Canada goose decline” are situated to indicate the time periods at which these events were reported. Hunting territory or trapline codes have no relation to spatial distribution of traplines.



coastal wetland subjected to emergence and plant invasion will eventually become so unattractive as a goose feeding area that continued dyke maintenance is futile. Or, the feeding grounds adjacent to a *tuuhiikan* may succeed to upland vegetation and create conditions that result in a shift in the flight path of geese such that the *tuuhiikan* loses its utility. In such cases, Cree abandon and then relocate their modification efforts.

Of the 22 dykes inventoried, four are no longer in use (Table 1). Larger scale changes have rendered these areas undesirable to geese and thus, poor hunting sites, which in turn prompted a resource management decision to abandon their use. Another example we encountered of this type of adaptive resource management involved deliberations between a tallyman and elders about whether to cease maintenance of a particular dyke, the utility of which was being undermined by changes in goose flight patterns. Thus, we witnessed and heard other reports of openness to relocation once a certain threshold of change has been reached. Notwithstanding this, the longevity of hunting sites, many of which extend back over several generations of hunters, indicates that the commitment to established sites is a powerful one.

Tuuhiikaan cutting over time reflects the dynamic between maintaining and shifting particular hunting sites in the context of ongoing coastal emergence. Figure 6 provides an example of an old *tuuhiikan* that was cut in the 1960s/1970s, subsequently abandoned, and then replaced by *tuuhiikaan* cut farther west. The old *tuuhiikan* was on a ridge long used as a hunting site. As the coast emerged, and shorelines retreated westward, the marsh seaward of the old *tuuhiikan* was invaded by upland species and became unattractive to geese. The dramatic rate of change over a fifty year interval is illustrated by a comparison of high resolution satellite and historic air photo imagery. According to our informants, a similar scenario occurred in a shallow bay just north of this location. A *tuuhiikan* first cut in the 1930s was abandoned in the 1980s and new *tuuhiikaan* were constructed to the west. Unfortunately high quality remote images are not available for this area so visual representation is not possible. Thus,

Table 2. Selected *tuuhiikan* metrics for all inventoried *tuuhiikaan*. Many *tuuhiikaan* tend to be wider at one or both ends thus a minimum and maximum width was measured for each. n = 31. Hunting territory or trapline codes have no relation to spatial distribution of traplines.

Trapline	Angle	Cut date	Last maintenance	Area (ha)	Width (m)	Length (m)	Still used?
A	S-N	Time immemorial	Late 50s, & again in 2003	3.00	230	370	Yes
A	SE-NW	Will cut in next few years	n/a	n/a	n/a	n/a	n/a
B	SE-NW	1981 / 1982	No data	2.73	100 to 150	250	Yes
B	SE-NW	1982	2006, hadn't cleared for a few years	4.37	130 to 230	300	Yes
B	SE-NW	1982 late spring	2003	3.50	115 to 150	250 to 300	Yes
B	SE-NW	1982	Informant did not remember	5.89	130 to 150	415	Yes
B	S-N or SE-NW	After 1958, cut w/ axe	No data	No data	No data	No data	No
C	SE-NW	1990	Never	2.83	100 to 110	280	Yes
C	SE-NW	1960s	Never	1.01	30 to 50	300	No
C	SE-NW	Mid 90s	Never, but needs to be done soon	11.99	100 to 260	790	Yes
C	SE-NW	Early 90s	Never	4.02	50 to 70	665	Yes
D	SE-NNW	1980	Never	10.89	230 to 240	470	Yes
D	SE-NW	1982	2004, extended N to lake	6.17	90 to 200	430	Yes
D	SE-NW	1930s	No data Last used 1980s	No data	No data	No data	No
D	S-NNE	1988	No data	2.24	30-80	450	Yes
D	No data	1930s, 40s or 50s	No data	0.34	40 to 45	80	No data
D	SE-NW	1981 or 1982	No data	2.03	60 to 110	260	Yes
D	No data	1940s	No data	n/a	n/a	n/a	n/a †
D	No data	1979	No data	n/a	n/a	n/a	n/a †
E	SE-N	Early 80s	Informant was not sure	1.10	70 to 100	150	Yes
E	SE-NW	2003	Never	7.50	50 to 80	400	Yes
F	S-N	Before 1958	Around 2000	7.27	70 to 160	615	Yes
F	No data	Before 1958	No data	No data	No data	No data	No
F	S-N	1970s, was smaller	Late 1980s, made bigger	4.00	130	345	Yes

(con'd)

F	SEE-NWW	After 1958	2001	0.36	30	150	Yes
F	SE-NW	Grandfather's time	No data	2.30	110 to 160	240	Yes
G	SSE-NNW	1985	No data	3.88	150 to 200	220	Yes
G	SE-NW	No data	No data	5.41	50 to 60	1,100	No
G	S-N	1962	Never	32.16	270 to 370	1,050	No
G	SE-NW	2004 to 2005	No data	3.70	160 to 190	290	Yes
G	SE-NW	Before 1958	Late 1990s	0.60	55 to 70	100	Yes

† Area burnt in mid 1980s destroying *tuuhiikan*

temporal–spatial shifts in *tuuhiikaan* correlate with coastal land emergence and associated changes in goose flight paths. Indeed, we identified half a dozen abandoned *tuuhiikaan* in settings that were no longer regarded suitable for goose hunting (Table 2).

Beyond these ongoing changes associated with coastal uplift processes, the marked decline in recent decades in the number of geese visiting the coast has been linked, by our informants, to the presence of large inland water bodies associated with regional hydro-electric development projects (see Peloquin and Berkes 2009 for more details). More and more geese fly inland these days in preference to the coast. In response, an increasing number of Wemindji Cree have shifted their hunting efforts inland to sites along the 90 km access road (Fig. 1), and trails associated with it, that connects the village of Wemindji to the James Bay Highway (Peloquin and Berkes 2009). Interestingly, gravel pits along the road are now being used in much the same way that dykes are used on the coast.

Another recent response to the decline in the coastal goose hunt has been the launch of restoration projects in previously important goose feeding areas which have become dense high marsh, dominated by willows and upland grasses that are unpalatable to geese. According to our informants, reduced numbers of geese along the coast have accelerated the rate of coastal plant succession through a positive feedback relationship between the decreased foraging activity of geese and the establishment of coarser upland marsh vegetation. The restoration projects, which are experimental in approach, aim to make previously important coastal feeding areas attractive to geese again. According to Edward Georgekish, CTA Director, the initial approach is to cut back the willows and then use heavy machinery, such as a mechanized backhoe or plough, to remove the top layer of soil so the willows and grasses cannot reestablish (*personal communication*). If tallymen and senior hunters are satisfied with the results, the CTA hopes to expand these projects to other areas along the coast. This example, similar to those discussed above, illustrates how Cree resource management is conducted as a process of on-the-ground adaptive learning under the guidance of experienced and knowledgeable resource users. Interestingly, this particular initiative represents a revival of the historic practice, mentioned earlier, of digging up and overturning marshes by shovel although there is widespread consensus that this approach is only viable today if heavy machinery is available. The CTA is currently reviewing what environmental permits would be required to support this. Other strategies to enhance areas for goose hunting include experiments with corn feeding and fire burning. Thus, resource management decision making is informed by past practices, is open to availing of modern technologies, and is sometimes subject to external regulatory requirements as a result.

DISCUSSION

The inherent variability of the boreal forest combined with the highly dynamic nature of the eastern James Bay coastline presents particular challenges and opportunities for Cree hunters; floral

Fig. 4. Two large *tuuhiikaan*. The left *tuuhiikan* is 115 to 150 meters wide and 250 to 300 meters long. The right *tuuhiikan* is 130 to 230 meters wide and 300 meters long. They were first cut in the early 1980s and were last maintained (re-cut) in 2003 and 2006, respectively.

and faunal progressions can change dramatically from year to year and from one area to another at a given time (Steegman et al. 1983). The accumulated changes can be substantial during an individual hunter's lifetime. The desire to reduce resource unpredictability while maximizing the productivity of these areas is thus a core feature of the adaptive management response taken by Cree hunters.

The construction of dykes and *tuuhiikaan* contributes directly to increased resource predictability by increasing the chances of a successful goose hunt. Both features are designed and constructed to alter coastal ecology at the pond or landscape scale, that is, local bay and headland scale. At the individual pond scale, a dyke can suppress or delay wetland succession, thereby creating or maintaining an attractive habitat for waterfowl to feed and rest. Dykes also impact on the success of the hunt at a larger scale by influencing goose flight paths relative to the location of attractive ponds. The cutting of *tuuhiikaan*, similar to corn dispensing, burning, and restoration projects, also contributes to maintaining and/or enhancing the predictability of the resource, in this case, geese and other wildfowl species, in the context of ongoing shoreline and coastal habitat changes.

Beyond maintaining and/or enhancing resource predictability, dykes and *tuuhiikaan* prolong the usefulness of established hunting locations. The maintenance of an established hunting site with a proven track record that extends back through decades to previous generations of hunters supports this by providing continuity in the setting of a primary hunting activity. The elaborate system of social organization and learning required to ensure an optimal, sustainable goose hunt must take account of numerous internal and external factors, including changing environmental conditions, goose abundance, and hunting pressure. The familiarity of an established hunting place that is imbued with the knowledge, experience and memories of generations of past hunters can go a long way towards providing a stable base in a broader context of uncertainty and unpredictability. Thus, the construction of a dyke can extend the lifespan of a pond as a core feature of a hunting strategy designed to maximize the number of geese killed while minimizing disturbance to other geese. In a similar way the cutting and maintenance of *tuuhiikaan* extends the usefulness of established hunting sites by influencing the predictability of geese flight patterns.

Our examination of Cree landscape modifications is also instructive in demonstrating how harmonization of resistance and flexibility, as adaptive responses to change, creates social–ecological resilience (Fig. 7). Crees oppose change; they retard wetland succession and coastal forest

Fig. 5. A small *tuuhiikan*, 55 to 70 meters wide and 100 meters long. It was first cut before 1958 and was last maintained (re-cut) in the late 1990s.

development. For them, there is security in the known and this opposition to change maintains continuity in harvesting locations over time. But change is inevitable and ongoing. Once a certain threshold of change is reached, Crees abandon existing modification sites and relocate to new ones, usually just seaward of the old sites although in recent years many hunters have relocated their hunting efforts inland and are experimenting with coastal restoration projects. Thus, the Cree response to change is one of harmonization. On the one hand they oppose predictable change and variability normal to the system, such as shoreline movement, subsequent habitat shifts, and uncertainty in goose behavior. On the other hand, they remain attuned to larger scale changes, such as spatial redistributions and availability of geese, regional land use changes, and climate change, and are willing to experiment and adapt. As such, this case demonstrates flexibility and responsiveness to various drivers and thresholds of change operating at a range of different interacting scales.

The impact of dykes and *tuuhiikaan* on the ecological integrity of the broader region was not addressed by our study. Both features are sufficiently large to be seen from satellite imagery. However, the limited length of the *tuuhiikaan*, which are usually less than 1 km, is unlikely to result in landscape fragmentation and habitat alienation issues associated with transmission lines, roads and pipelines. Similarly, drainage alterations of coastal wetlands through the construction of dykes, while not insignificant at the local landscape scale, mimic natural processes and likely have an imperceptible impact in a broader regional context of a drainage system that has been significantly modified as a result of extensive dam building, river diversion and reservoir creation associated with the James Bay hydroelectric project. Notwithstanding this, population numbers and technology would have limited the extent and impact of these practices in the past. In the unlikely event that Crees would consider expanding the scale of these landscape modifications in the future, an assessment of the possible impact on the region, such as in terms of biodiversity or carbon budgets, would certainly be needed.

Cree landscape modifications provide irrefutable evidence that Crees have not only occupied and used their traditional lands but have been and continue to be active agents in managing and modifying the land and its resources. Furthermore the level of self-organization and social learning required to construct and subsequently maintain these features, particularly in a context of limited access to technology in past decades/centuries, has interesting implications for conventional descriptions of Cree as highly mobile hunters engaged in diffuse foraging. Notions of Crees as active human agents of landscape change run counter to the dominant narrative of the north as a pristine wilderness, untouched by human agency (Hulan 2003). This

Table 3. Summary statistics for *tuuhiikan* dimensions. Minimum, maximum, average, and standard deviation are reported for width (meters), length (meters), and area (hectors). Many *tuuhiikaan* tend to be wider at one or both ends, thus a minimum and maximum width was measured for each. n=25.

	Minimum width (m)	Maximum width (m)	Length (m)	Area (ha)
Minimum	30.00	45.00	80.00	0.34
Maximum	270.00	370.00	1100.00	32.16
Average	120.60	149.80	399.80	5.17
Std Dev	65.10	78.00	264.03	6.37

narrative, through the erasure or marginalization of aboriginal peoples has supported the expansion of state control under the guise of development and conservation programs (Sandlos 2007). The recently launched “Plan du Nord”, of Quebec Premier Jean Charest, which hinges around “occupying the north” and the exploitation of “northern riches” (German 2009), was initially crafted with no input from northern aboriginal peoples suggesting that the legacy of the north as a hinterland for resource extraction, rather than a homeland for aboriginal peoples (Berger 1977) persists. Recognition of Crees as active and adaptive agents strengthens the case for northern aboriginal peoples to take a lead role in decisions concerning the environment and their future more generally.

Finally, aboriginal landscape modifications may have implications for environmental management approaches. While current scenarios for human adaptation to climate related changes are based on sea-level rise rather than coastal land emergence, the consideration and accommodation of multiple scales of ecological interaction in the design and construction of dykes and *tuuhiikaan* is instructive for planning approaches everywhere. Holistic planning that takes account of past experience and observation and that works with, rather than against, the functioning of nature underscores the value of low cost, soft engineering approaches as an adaptive strategy. For example, such approaches may offer temporary alternatives to expensive, highly disruptive relocation programs with the added benefit of recognizing and enhancing the capacity of northern communities to cope with change.

CONCLUSION

Several studies have shown how northern aboriginal peoples purposely modify and manage local ecosystems, particularly the more biodiverse and dynamic habitats associated with ecological edges, to increase the productivity of these sites and enhance social–ecological resilience. We strengthen this understanding through our exploration of the strategies used by Cree hunters to create, maintain and enhance desirable areas and conditions for goose hunting. The construction of dykes and cutting of *tuuhiikaan* represents a particular adaptation to living in a highly dynamic coastal setting in which the shoreline shifts and islands join the mainland within a person’s lifetime. Cree observations and understanding of multiple scales of ecological relationships inform the location, design and function of these features through a process of adaptive management, which in turn is dependent on the ability of Cree hunters as members of a coastal hunting territory to self organize, learn from experience and innovate (Berkes and Folke 1998). While these landscape modifications are motivated by a desire to increase resource predictability and productivity, our case indicates that they also reflect an intergenerational commitment to the maintenance of established hunting places as familiar, culturally important sites imbued with meaning through their connections with the past. At the same time, Cree hunters are pragmatists, recognizing thresholds of change as cues for resistance to give way to acceptance of change. The balance or harmonization achieved in managing these dual imperatives is a hallmark of

Fig. 6. Temporal–spatial shifts in *tuuhiikaan*. The top two scenes compare a 1959 air photo and 2006 Ikonos image. Below is a vector overlay presented at double the scale of digitized tree and shrub lines used as proxies for shoreline movement because tidal variation between the two scenes cannot be controlled for (Grey 1983). The overlay shows the rapid rate of shoreline movement. The south-eastern *tuuhiikan* was cut in the 1960s or 1970s. Landscape change rendered the area poor for hunting, so four new *tuuhiikaan* were cut to the north-west, on the point, in the 1980s. The 1959 air photo was scanned at 6000 dpi and georeferenced to the Ikonos image using boulders, buildings, and other stable features as pass points, with a total RMS error of 8.09276m in Arc GIS 9.2. Digitizing was done at a 1:5,000 scale.

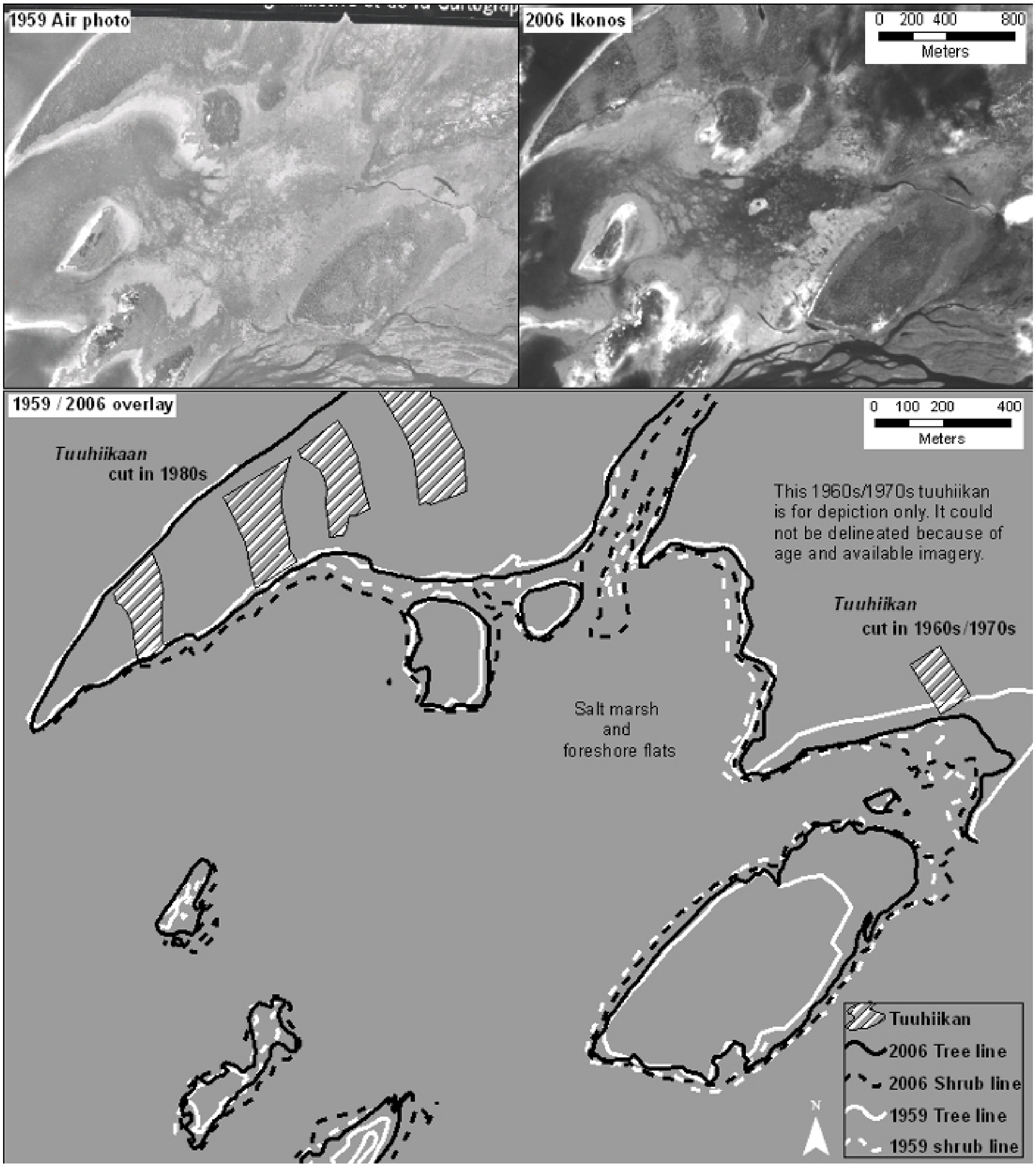
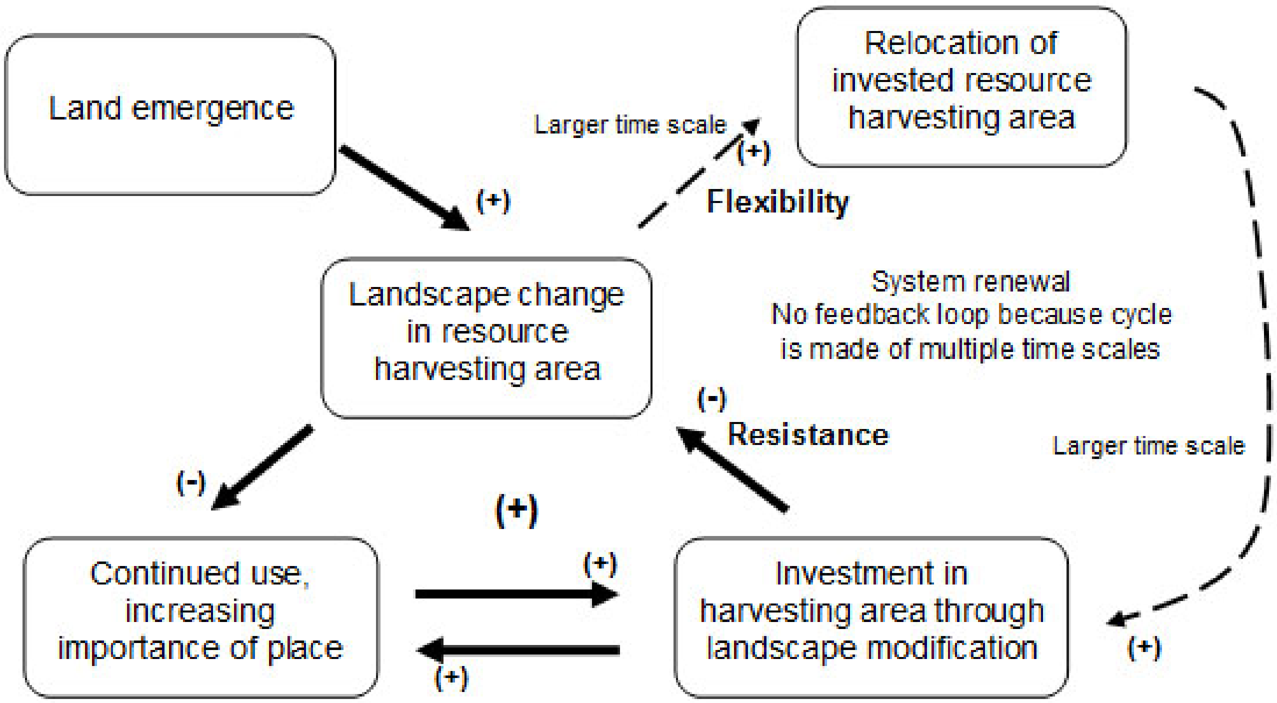


Fig. 7. Feedback diagram depicting resistance and flexibility in context of landscape modification for resource harvesting. Plus signs indicate a positive relationship, or a direct relationship of increase or decrease between one parameter and the parameters it influences. Negative signs indicate a negative relationship, or an opposite relationship of increase or decrease between one parameter and the parameters it influences. Solid arrows and dashed arrows represent two different temporal scales with the latter being larger. Dashed arrows and solid arrows do not create closed feedback loops because of their different scales.



Cree adaptive strategies and of their resilience as a society.

Our study shows that members of the Cree community of Wemindji have not only occupied and used their traditional territory but have been active agents of landscape change. Recognizing these adaptive landscape modification practices confronts timeworn fallacies of the north as an unoccupied wilderness, supports the value of designing landscape modifications that respond to local ecological conditions, and highlights the potential capacity of northern aboriginal peoples to take a lead role in decisions concerning their future, particularly in the context of adaptations to climate change.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol15/iss4/art22/responses/

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