EcoHealth
DOI: 10.1007/s10393-011-0707-9

ECOHEALTH

Original Contribution

Promoting Wellness in Alaskan Villages: Integrating Traditional Knowledge and Science of Wild Berries

Courtney G. Flint,[1] Ewan S. Robinson,[2] Joshua Kellogg,[3] Gary Ferguson,[4] Lama BouFajreldin,[1] Mallory Dolan,[5] Ilya Raskin,[6] and Mary Ann Lila[3]

[1]*Department of Natural Resources and Environmental Science, University of Illinois at Urbana-Champaign, 1102 S. Goodwin Ave, S510 Turner Hall, MC 047, Urbana, IL 61801*
[2]*Department of Geography, University of Illinois at Urbana-Champaign, Urbana*
[3]*Department of Food, Bioprocessing & Nutrition Sciences, North Carolina State University, Raleigh*
[4]*Wellness and Prevention Department, Alaska Native Tribal Health Consortium, Anchorage*
[5]*Cooperative Extension Service, Purdue University, West Lafayette*
[6]*School of Environmental & Biological Sciences, Rutgers University, New Brunswick*

Abstract: People draw upon multiple forms of environmental knowledge, from scientific to highly contextual local or traditional forms of knowledge, to interpret problems and gauge risks in complex socio-ecological systems. In collaboration with three remote Alaska Native communities, and using an interdisciplinary, participatory, and mixed methods research approach, we explored traditional ecological knowledge and scientific aspects of wild berries and the broader context of community health and environmental change. Combining site visits, key informant interviews, focus groups, survey questionnaires, portable field bioassays, and laboratory follow-up analyses, our research revealed the importance of local subsistence resources for community wellness. Multiple berry species were found to have powerful bioactive health properties for ameliorating metabolic syndrome as well as importance for community wellness. Communities differed in the degree to which they characterized berries as healthy foods and perceived environmental risks including climate change. Findings suggest the importance of incorporating locally available foods and socio-cultural traditions into community wellness programming. This article also discusses challenges and opportunities associated with transdisciplinary, participatory research with indigenous communities.

Keywords: traditional ecological knowledge, wild berries, environmental change, participatory research, youth, health, community wellness

INTRODUCTION

Indigenous Arctic communities face major socio-cultural transitions and environmental changes. Alaska Natives and others across the circumpolar north are experiencing declining health status as traditional subsistence foods are replaced with modern and less healthy foods, physical activity declines, and drug and alcohol problems increase (Bersamin et al. 2006; Samson and Pretty 2006). Yet despite these threats, rural Alaska communities have local resources which have supported healthy diets and lifestyles

Correspondence to: Courtney G. Flint, e-mail: cflint@illinois.edu

Published online: 14 September 2011

for generations. Changing communities and environments have energized Alaska Native people to search for better ways to adapt and survive. Funded by the EPA Science to Achieve Results program, our 3-year project was conducted with participation by community residents in three villages that are, to varying degrees, home to Alaska Native people. Our project focused on the bioactive health properties of wild berries, local, and traditional environmental knowledge regarding berries and community wellness.

The term wellness lacks definitional rigor (Miller and Foster 2010). However, literature suggests its holistic and multidimensional nature, going beyond physical health of individuals and communities to include social, psychological, environmental, economic, and spiritual dimensions (D'Abundo and Carden 2008; Kral and Idlout 2009; Miller and Foster 2010). Aligning with this broader understanding of wellness, Parlee et al. (2005) described ecohealth for far northern indigenous communities as composed of a broad range of values, including harvesting food from the land, environmental stewardship, self-governance, spiritual relations, individual and family well-being, social connectedness, and cultural continuity. Local subsistence foods play key roles in the lives of northern rural and indigenous people (Teitelbaum and Beckley 2006; Berman 2009), but this relationship is increasingly challenged by climate change, growing ties to global economies, and environmental contamination (McNeeley and Shulski 2011; Nuttall et al. 2005).

Wild berries are a common and highly valued resource in the far north (Moerman 1998; Viereck 2007). Working with the Gwich'in in Canada, Parlee et al. (2005) found local understanding of healthy elements of berries included the ability to live off the land, stewardship of berry sites, pride in self-governance, spirituality, and sustaining community relationships in addition to nutrition. Variable ecological conditions and local institutions or rules of use affected how Gwich'in knowledge was generated (Parlee et al. 2006). Inupiaq and Alutiiq traditions also emphasize berries as nutritious food and symbols of indigenous heritage (Burch 2006; Crowell et al. 2001).

In contrast to the longevity of local knowledge of berries, modern science has only recently articulated biomedicinal properties of the natural components in berry fruits (Szajdek and Borowska 2008; Grace et al. 2009; Kellogg et al. 2010a). These health properties are important given the rapidly growing incidence of health problems, particularly diabetes, among Alaska Natives (Burrow et al. 2000; Gahagan and Silverstein 2003). Emerging biomedical research reveals berry fruits—particularly the wild indigenous species which thrive in austere environments—contain a unique and potent complex of natural phytochemicals capable of interacting with human therapeutic targets to alleviate symptoms of hyperglycemia, inhibit fatty tissue accumulation, and address other problems related to metabolic syndrome (Tsuda 2008; Grace et al. 2009; Schreckinger et al. 2010). These health benefits of berries are under threat by widespread environmental risks in Alaska such as air and water pollution (Jewett and Duffy 2007), lingering effects from radioactive military waste (Cassady 2007), and climate change impacts such as loss of snow cover, permafrost and tundra changes, and transitions in distributions of vegetation and wildlife (Berkes 2002).

Environmental risks are inextricably linked to community wellness. Within complex socio-ecological systems, people draw upon multiple forms of knowledge, from scientific to highly contextual local or traditional forms of knowledge, to interpret possibilities and problems within their environments (Irwin 2001; Berkes 2008; Ostrom 2009). Traditional ecological knowledge (TEK), the knowledge and practices related to people and their environment evolving through generations, is dynamic and multidimensional (Berkes 2008). TEK is heterogeneous across individuals and communities and often blended with other types of knowledge. It can change, fragment, or coalesce over time (Menzies and Butler 2006). Our collaboration with three Alaska communities explored the role of wild berries in promoting community wellness through scientific inquiry in the context of traditional knowledge.

Our investigation utilized multiple methodologies to incorporate the knowledge of local residents, community wellness practitioners, and social and biophysical scientists with the goal of building relationships and partnerships with communities (Agrawal 1999; Wilcox and Kueffer 2008). Highlighting local voices can give typically marginalized groups a chance to express their values, concerns, and ways of knowing and can generate new and unexpected insights for researchers (Pierotti and Wildcat 2000; Greene 2007).

This article outlines the scope of our engagement with three Alaska communities. While, we highlight the general methods and findings from the biophysical sciences, more detail is published elsewhere (Kellogg et al. 2010a, b). Our emphasis here is on social science and community engagement dimensions of the research, and how these help bridge science and community wellness promotion. We also highlight our experiences with participatory research.

Methods

Participatory research drawing on mixed methods engages local stakeholders as co-researchers and aims to produce collaborative relationships and increase the potential for mutual understanding among community members and researchers (Purcell and Onjoro 2002; Davidson-Hunt and O'Flaherty 2007). American Indians and Alaska Natives are increasingly skeptical of research particularly related to health (Buchwald et al. 2006). In this context, we aimed to involve residents at multiple stages of research, including conceptualization, information gathering and interpretation, and building trusting relationships throughout the project (Christopher et al. 2008).

Study Communities

Representatives from the Alaska Native Tribal Health Consortium (ANTHC), a non-profit health organization owned and managed by tribal governments, helped select three communities based on four criterion: (1) community leaders' willingness to participate; (2) the presence of blueberries, mossberries (aka crowberries or blackberries), and salmonberries (aka cloudberries) as important local foods; (3) common coastal settings with varying latitudinal and climatic conditions; and (4) substantial Alaska Native population. The first three communities meeting these criteria were selected.

Seldovia on the Kenai Peninsula in south central Alaska has a population of approximately 420 people, is approximately 20% Alaska Native, and has an active Native village and corporation (Alaska Department of Commerce, Community, and Economic Development 2010). The Seldovia Village Tribe operates a commercial berry processing business making and selling jam and other berry products. The second site, Akutan, is a village in the Eastern Aleutian Islands with a population is approximately 80 people, most of whom are Alaska Native. Akutan also contains the Trident Seafood Processing facility, housing over 900 seasonal workers not included in this project. The third site, Point Hope, is a remote, traditional whaling village on the Chukchi Sea in north western Alaska, north of the Arctic Circle with a population of approximately 624 people (90% classified as Alaska Native).

The blueberries we studied in Alaska (*Vaccinium uliginosum* and *Vaccinium ovalifolium*) are different species than those found in the rest of the continental United States. The "blackberries" (aka crowberries/mossberries or *Empetrum nigrum*) are different species from those available in US markets and are known only in AK and circumpolar regions. Salmonberries (*Rubus spectabilis*) found in Seldovia, AK, are also found in the Pacific Northwest, but are not typically commercial nor appear in mainstream markets. Salmonberries known as in other parts of Alaska cloudberries (*Rubus chamaemorus*) are unknown outside of the region. Except for a few published papers from Finland and Norway, there is scant literature on these berries, their phytochemical content, and health effects.

Site Visits and Interviews

Numerous site visits, interviews, informal focus groups, and conversations were conducted to understand the local context and perspectives. Researchers made three visits to Akutan and Seldovia and four to Point Hope, supplemented by communication via telephone, email, and video conferencing. Researchers and community leaders decided to involve youth as much as possible, to hold annual open community meetings, and to tailor survey administration to community preferences. Meetings were held early and annually so that community leaders and teachers could influence research design and generate dialog within the communities. Guides and teachers assisting with the research were paid and we provided refreshments, food, and raffle prizes at community meetings. Students received t-shirts, notebooks, and pencils. Students and teachers in each community were trained to interview community residents about their uses of berries and perspectives on environmental changes. Youth-led interviews were audio-recorded and sent to researchers for transcription and analysis. The lead author conducted additional on-site interviews with community residents, which were also audio-recorded and transcribed. Eleven formal interviews were conducted in Akutan, 24 in Point Hope, and 30 in Seldovia. Interviews were conducted with community leaders, elders, and other residents using a snowball sampling scheme along multiple lines of community representation. All procedures were reviewed by the lead author's university Institutional Review Board and by community leaders. Unrecorded informal conversations were also common during site visits. Anonymity and confidentiality were high priorities. Inclusion of youth in the research process was central to facilitating community support for the project and facilitated broader dialog than would have been possible otherwise. Local residents were regularly asked to help interpret ongoing findings.

Surveys

Midway through the project (winter 2009), household surveys were administered in each community to collect perceptual data and quantify attitudes. The 12-page survey included questions on berries, health, environmental risks, and community wellness. Surveys were nearly identical across the communities; local names were used for berries. A community wellness question was included, modified from World Health Organization indicators (Hancock 1993). In Akutan and Point Hope, surveys were hand-delivered to an estimated number of households by students (36 in Akutan and 190 in Point Hope). In Seldovia, surveys were mailed to all 169 households in three waves including two survey mailings and a reminder postcard (addresses obtained from USADATA). Raffles were held for all who returned surveys with prizes including gift certificates for local stores, city services, fuel, and air tickets. Nineteen of 36 surveys were completed in Akutan (58%), 61 of 169 in Seldovia (36%), and 36 of 190 in Point Hope (19%). Poor weather and the end of the school year limited survey pick up in Point Hope, leading to a lower response rate. While, two of the response rates are high for Alaska (Reed and Brown 2003), we acknowledge the limitations of the low response rate in Point Hope. However, survey findings reflect perspectives identified in interviews, thus reducing response bias concern. Survey analysis emphasized descriptive statistics, community differences, and open-ended response summaries. Dominant themes from interviews, observations, and survey analysis are presented below with representative quotes and analytical results. Statistical comparisons across communities were conducted using ANOVA in SPSS.

Screens-to-Nature (STN) and Laboratory Analysis

A customized "STN" portfolio of field-deployable bioassays and practical training was introduced in each community to engage local students and community members in biodiscovery (Kellogg et al. 2010b). The STN bioassays are tests or screens measuring how a plant's chemicals inhibit human disease. They provided simple and expedient tools to detect bioactive, health-protecting properties in local berries. The relatively inexpensively constructed screens were created by the university researchers and used on site. The communities provided common solvents and local berries. Local participants and researchers collected wild berries at peak ripeness, followed by a multi-day training session on the screens and how to interpret results. The STN elucidated the biomedicinal properties of the berries during the initial site visits and were used by local teachers in subsequent years.

The STN assays provided "first hits" information or simple preliminary data about the biologically active components available in berries. They were used as a guide to narrow down selection of plants brought into the lab for in-depth testing and analysis. All STN bioassays were lab-validated. They did not contribute to final biochemical analysis, but guided decisions about which candidates went on for in-depth analysis. In this case, the field STNs ensured that community members were integrally involved in the scientific research and retained ownership of any discoveries that came forward.

Subsequent to initial STN analysis on site, at least 500 additional grams of berries were collected, frozen, and transported on dry ice to the laboratory at the University of Illinois for in-depth phytochemical analysis and bioactivity assays which gauged ability of the berries to inhibit lipid deposition in vitro, or to enhance levels of an enzyme that would inhibit formation of fat cells. Berry extracts were also tested in a hyperglycemic mouse model to demonstrate the ability of the berries to modulate blood glucose levels (Kellogg et al. 2010a).

Results

This project was well received and supported by local leaders eager for community-based research and providing opportunities for youth. Community members often mentioned that project support was high because we involved youth in science as well as traditional knowledge. In interviews, though one or two individuals from each community indicated skepticism about science based on past negative experience with researchers, the majority of participants were either ambivalent or curious about science. The following sections highlight findings regarding perceptions and measurements of berries and health, observations of environmental change, and perceptions of environmental and community wellness.

Perceived Health Status in Communities and Impacts of Berries

In Point Hope, participants indicated health concerns about cancer, diabetes, obesity, and dental health. Some health risks were attributed to environmental contamination in prominent berry picking areas from mining or the

nearby Project Chariot site, where radioactive waste was deposited for experimentation by the US military in the 1960s. Many respondents also linked increasing health risks to local diets shifting from traditional foods such as berries, toward processed foods:

> "I would say the major health problem in Point Hope is lack of nutrition in our younger generation today. Today we see…kids eat mostly junk food, which can lead to diabetes, which can lead to obesity and that all comes from all drinking a lot of soda. Too much pop. For each can of pop you drink I notice like maybe forty teaspoons of sugar in a can of soda. That's why we see a lot of kids that are malnourished, like not enough vitamins and a lot of 'em are obese. Too much pop which can lead to heart problems and diabetes and other health problems. [These problems] are increasing a lot, especially with the preservatives they add to the canned foods in the store."

Concerns about declining physical activity and increasing drug and alcohol problems were also voiced in Point Hope and linked to deteriorating community connectedness and loss of traditional ways. In Akutan and Seldovia, health concerns were more moderate, though concerns about diabetes, cancer, and alcoholism were mentioned by at least half of those interviewed. Participants in these sites also linked health problems to changing diets and the loss of traditions.

Over 75% of household survey respondents in all communities indicated that they regularly or occasionally picked or ate berries in season. Berries were highly valued as a source of natural food by residents, though fewer references were made in interviews to specific physical health properties. In Point Hope and Seldovia, participants highlighted specific healthy properties of berries such as vitamin C, antioxidants, or help with digestion. In Akutan, however, it was more common for berries to be thought of as food without a sense of being "healthy". Instead, berries were simply "something to do, something to eat."

Picking berries was valued across communities as something to do outside and to share with others, both as food and as an experience. Thus, berries contributed to a broader notion of well-being, including interaction with the environment, community, and family as indicated in this quote from a Seldovia resident:

> "Picking berries has always been important. When there was a whole bunch of young mothers and we'd take our kids out, it was just like going out and picnicking with the kids so we'd just go out and pick berries and visit, socialize. It was a very social gathering and even now I still consider it a social gathering, whether go out with friends or just go out in nature and have the quiet time around you."

In Seldovia, despite appreciation for berries by all participants, non-tribal community participants resented recently restricted access to berry picking areas imposed by the native association as part of a commercial berry product operation. From the tribal perspective, commercialization incorporated culturally valued traditional resources into efforts to provide employment and revenue for members. This use of berries differed sharply from Akutan and Point Hope where there was no berry commercialization. The Seldovia Village Tribe was eager to highlight and market health properties of local berries.

Survey data provided rankings for why people picked berries and revealed variation across communities (Table 1). Food was the top reason for berry harvesting in all three communities. In Point Hope, other factors ranked

Table 1. Mean scores from surveys for reasons for picking berries (from scale where 1 = not important and 5 = very important) and ANOVA results from statistical community comparisons

Reasons for picking berries[a]	Point Hope	Seldovia	Akutan	ANOVA (F value/P-value)
For personal or family food	4.56	4.29	4.18	0.748/0.476
To be outside or close to nature	4.48	4.13	3.64	2.649/0.076
To be with family and/or friends***	4.45	3.33	3.21	13.253/0.000
For traditional reasons***	4.33	2.57	3.50	8.136/0.001
For fun	4.29	3.67	3.53	2.948/0.057
For health or medicinal purposes	4.03	3.74	3.00	2.902/0.060
To sell or for employment	1.21	1.50	1.17	0.700/0.500

[a]Significant differences across communities denoted by $^{\star}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$.

highly as well, supporting interview findings that berry picking was connected to multiple values. In Seldovia, ''to be outside or close to nature'' was also highly ranked, whereas in Akutan, all other reasons were rated much lower. Selling berries ranked very low in importance in all three communities, despite Seldovia's commercial berry operation. Health and medicinal values from berries, while ranked as moderately important, were not as high as other factors in each community. Comparisons showed Point Hope to have statistically higher scores for traditional reasons for picking berries and to be with family and/or friends. Other reasons neared statistical difference, while regarding berries as food or something to sell were not statistically different across communities.

Measured Health Benefits from Berries

The STN assays from each community indicated strong antioxidant capacity of local berries and the ability to regulate an enzyme involved in diabetic pathology. Subsequently, from the in-depth phytochemical analysis and bioassays conducted in the laboratory, the Alaskan wild berries were clearly shown to possess complex phytochemical content and capacity to combat metabolic syndrome (Kellogg et al. 2010a). Berry extracts proved capable of inhibiting adipogenesis (formation of new fat-accumulating cells), and in particular, proanthocyanidin-rich fractions reduced lipid accumulation in 3T3-L1 adipocytes. The complex phytochemical composition of these berries was able to modulate specific cellular targets relating to metabolic syndrome and obesity. Accumulation of bioactive natural compounds within berry species (including proanthocyanidins and anthocyanin pigments) varied to some degree by geographic location.

Perceived Environmental/Climate Impacts on Berries

Interviews and conversations illuminated varying local concerns about the impacts of environmental factors, contaminants, and climate change on berries, human health, and well-being. Survey respondents rated their concerns about environmental factors, loss of traditional knowledge, and overharvesting (Table 2).

Concerns varied considerably across the communities, with Point Hope respondents clearly more concerned about threats to berry resources than Akutan or Seldovia respondents. Point Hope respondents were significantly more concerned about berry contamination in general and contamination from air pollution, radioactivity, mining, and waste disposal specifically. Seldovia respondents were slightly more concerned about overharvesting than those from other communities, though this factor was not highly ranked or significantly different. Point Hope respondents were significantly more likely to rate loss of traditional knowledge as a threat to berry resources.

Surveys indicated climate change was the top concern among Point Hope and Seldovia respondents (though the Seldovia mean was lower than Point Hope), and the second highest concern in Akutan. Interviews and open-ended survey questions revealed considerable knowledge about weather and climate impacts on berry quality and abundance, varying perceptions of climate change impacts, and

Table 2. Mean scores from surveys for concerns about threats to berry resources (where 1 = not concerned and 5 = very concerned) and ANOVA results from statistical community comparisons

Concerns about threats to berry resources[a]	Point Hope	Seldovia	Akutan	ANOVA (F value/P-value)
Climate change**	4.16	3.12	3.11	6.450/0.002
Radioactive contamination***	3.81	1.84	2.42	23.921/0.000
Mining***	3.77	2.00	2.12	19.105/0.000
Waste disposal or incineration**	3.74	2.55	2.92	7.541/0.001
Loss of traditional knowledge**	3.71	2.68	3.29	5.680/0.005
Air pollution**	3.69	2.48	2.77	7.572/0.001
Soil contamination**	3.69	2.72	3.08	5.145/0.007
Water contamination**	3.69	2.77	2.78	4.914/0.009
Over-harvesting	2.83	2.93	2.18	1.245/0.292

[a]Significant differences across communities denoted by $*P < 0.05$, $**P < 0.01$, $***P < 0.001$.

uncertainty regarding potential future impacts of climate change on berries. Winter snow and a balance of summer sun and rain were seen as essential to berry development. Point Hope respondents widely agreed that local climate was changing, generally warming, and would continue to change dramatically. However, not everyone in Seldovia and Akutan agreed on the existence, source, or directionality of climate changes. Regardless of perspective on climate change in general, changing temperature and precipitation scenarios were seen as affecting berry harvests from year to year in Seldovia and Point Hope, with lower perceived effects in Akutan. Poor berry years occurred in each community and were lamented by community residents for the loss of a valued food resource and other values highlighted above.

Perceived Environmental and Community Wellness

Participants discussed a variety of community assets and vulnerabilities. Point Hope participants spoke of strong relationships between people, land and sea, an abundance of subsistence foods, Inupiaq traditions, and a willingness to help each other and share resources. On the other hand, many mentioned struggles with drugs and alcohol and environmental threats from contamination and climate change:

> ''Alcoholism is a challenge even though it's banned… It definitely has an effect on the health and the spiritual and emotional, mental wellness of the community.''

> ''Dealing with the environment, a lot of the community members believed that what happened in the sixties with Chariot and everything has a lot to do with the high cancer rate. I for one am a cancer survivor and there's just about, in every household, a person fighting cancer, or survived cancer, and most definitely someone died of cancer in every household. There was one guy, he was eating berries around that [Chariot] area and he got really sick.''

> ''The Arctic is hit first and [the climate] is changing. We notice that the ground is getting dry. You can see big cracks in the ground now, and it gets really hot here and stronger storms, animals migrating sooner, the whales and things. We're getting, um, there's a big change here in the Arctic.''

Perceived risks from mining, seismic testing, and oil and gas drilling were often voiced in Point Hope, particularly concern about effects on migration patterns of highly valued animals like caribou and whales.

In Akutan, positive sentiments focused on the access to a clean natural environment:

> ''We can hunt, fish, hike and enjoy our home anytime we want (weather permitting). I love the beauty, clean air, and water of my home.''

However, there were concerns about environmental contaminants, often linked to the nearby seafood processing plant. While most in Akutan appreciated the small, remote village life, others felt community relationships and traditional ways of life had deteriorated with the influx of processed foods and alcohol problems.

In Seldovia, nearly all participants mentioned the natural beauty and peaceful, small town life. Environmental concerns were not common, though a few had concerns about the local waste incinerator and declines in local shellfish quality. Tensions in Seldovia between non-tribal and tribal residents were cited by those lamenting a change in community interaction. However, most said people came together in tough times or for the town's children. One of the biggest community concerns was the local economy and lack of jobs making it hard to keep youth from leaving:

> ''It's tough. It's divided, the community is divided. And it's sad to see because we've all been here a long time and to have us divided is kind of tough on situations and things….We need to find a solution on how we can have folks live here. Some sort of survival of the community and try to find some sort of economy.''

Substantial differences in quality of life perspectives across the communities emerged from the survey and supported findings from qualitative data obtained using a modified version of Hancock's (1993) healthy community indicators (Table 3). Point Hope respondents valued cultural traditions, community interaction, and clean environment, but ranked health services and economy as problematic. In Seldovia, a clean and safe environment was a strong quality of life indicator, whereas community involvement in local governance and a prosperous economy were more elusive. In Akutan, respondents noted the clean and safe environment, availability of basic needs, and access to health services as high quality of life factors,

Table 3. Mean scores from survey on quality of life factors (where 1 = very low and 5 = very high) and ANOVA results from statistical community comparisons

Quality of life factors[a]	Point Hope	Seldovia	Akutan	ANOVA (*F* value/*P* value)
Honoring traditions and cultural heritage***	4.29	3.04	3.64	15.941/0.000
Community supporting each other	3.97	3.63	3.67	0.926/0.399
Clean and safe environment	3.89	4.22	4.08	1.379/0.257
Community interaction and communication to share experiences and solve problems*	3.86	3.19	3.36	4.167/0.018
Conservation of natural resources*	3.59	3.07	2.92	3.911/0.023
Community involvement in local governance	3.58	2.98	3.36	2.923/0.058
Availability of basic needs	3.51	3.60	4.00	0.937/0.395
A healthy ecosystem	3.26	3.41	3.50	0.305/0.738
Access to health services*	3.00	3.02	4.00	3.442/0.036
A prosperous economy***	2.49	2.02	3.43	10.760/0.000
Overall quality of life index score	3.54	3.22	3.59	2.808/0.065

[a]Significant differences across communities denoted by $*P < 0.05$, $**P < 0.01$, $***P < 0.001$.

but conservation of natural resources was ranked low. Point Hope respondents rated honoring traditions and cultural heritage and community interaction significantly higher than those in Seldovia and Akutan. Akutan respondents rated prosperous economy and access to health services significantly higher than those in Point Hope or Seldovia.

Discussion

Results highlight variations in perceived health, risks, and well-being across study communities indicating that context matters in community and environmental wellness and production of local knowledge (Irwin 2001). Scientific exploration of bioactive health properties of wild berries revealed health benefits, complementing traditional ecological knowledge and health education efforts. We concur with Parlee et al.'s (2006) interpretations about healthy berry attributes: berries contribute more to community wellness than individual or family nutrition by providing outdoor activity and fun and helping to build and maintain interpersonal relationships and community traditions. In each community, we found evidence of traditional ecological knowledge possessed, not only by elders, but also by younger adults and youth. While some researchers see traditions as ''at risk'', we concur with Menzies and Butler who wrote:

> ''It is important to differentiate between situations where a community's TEK is adapting to new environmental and economic conditions and where TEK is being lost due to a disruption of transmission or population loss. Just because land use activities have changed or decreased does not necessarily mean that a community's TEK is deteriorating'' (2006, p. 8).

We found an eagerness to revitalize TEK and integrate it with science to adapt and adjust to change and foster community wellness. Community leaders integrated TEK with scientific and economic assessments and legal proceedings to promote community interests in regional development negotiations. Indigenous students navigated daily between traditional and Western knowledge systems and we found the STN system helped to bridge this divide (Kellogg et al. 2010b).

We found that observing environmental change does not necessarily lead people to identify associated risks, particularly with climate change. While, many local residents reported experiencing changes in weather and climate, some did not attribute these changes to global climate change or threats to well-being. Other residents saw climate change as imminently threatening their way of life. The relationship between scientific risk assessments and local risk perceptions is multifaceted and complex. Science plays a role in local risk knowledge, but so do shared experiences, stories, and observations handed down

through generations. Too often, TEK is seen in restrictive, static terms, underestimating the information people use to understand and respond to environmental threats (Irwin 2001; Cassady 2007).

Programmatic efforts to combine multiple knowledge via participatory approaches and incorporate TEK can support local initiatives to promote wellness. A participatory approach can help maintain community support for wellness initiatives. Similar to Thomas and O'Kane (1998), we found children, particularly in Point Hope, were able to express their views and articulate needs related to community and environment. Future efforts to engage communities on health and wellness might do well to center around youth and involve them in research and disseminating results (Hill 1997). Youth excitement about research motivates adult participation (Kral and Idlout 2009). Our participatory engagement efforts were most successful in Point Hope due to sincere youth and school efforts. However, adult involvement was somewhat limited in all communities, perhaps due to apathy, competing commitments, and research fatigue from other recent studies.

While, widely accepted as valuable and important, participatory research is challenging and objectives are not always met (Pain and Francis 2003). Engaging people in each phase of research is not always possible (Park 1999). Key people may move away or lose interest. It is difficult for researchers to engage an entire community, especially marginalized members, such as those who are housebound, disabled, or ostracized for various reasons. Conducting research from a distance is also difficult and inhibits development of trusting relationships that foster greater community participation (Christopher et al. 2008). And, certain sensitivities are inherent in research on health with Alaska Native communities (Buchwald et al. 2006; Christopher et al. 2008). We encountered all of these challenges. However, despite barriers to full participation, the participatory process nonetheless provided benefits, including mutual learning by researchers and local residents. In this project, both youth and adults enjoyed interaction with others, as well as the learning involved in science-based field research. Researchers learned a tremendous amount from engagement with community members which led to new research questions, better interpretations of findings, and our own professional development. We especially noted the powerful potential of engaging youth as researchers to integrate traditional knowledge with academic research.

Researchers often struggle to translate their work for local audiences. Research objectives rarely include helping locals plan or implement new practices based on research outcomes. As a result of this project, ongoing community wellness efforts by local practitioners in Akutan increased emphasis on berries as an important healthy food and activity. We found partnering with ANTHC, a regional entity with a wellness mission, provided a crucial bridge between research and local action. Findings are being highlighted in booklets on local healthy diets and lives for village residents. Our research team continues to collaborate with ANTHC, particularly on diabetes. However, researcher engagement with communities inevitably declined after the funded project ended and it is difficult to assess long-term local outcomes from afar.

Conclusion

A problem-oriented focus and real-world relevance are important in transdisciplinary research (Wilcox and Kueffer 2008). Berkes describes threats to far northern indigenous communities, particularly from climate change, saying, "Impacts of environmental change are stripping arctic residents of their considerable knowledge, predictive ability, and self-confidence in making a living from their resources. This may ultimately leave them as strangers on their own land" (2002, p. 339). There is no doubt that this is a time of rapid change and high vulnerability for Alaska Native communities, but our project experiences lead us to be more optimistic.

If we think of environmental knowledge as a process by which people make sense of patterns and processes in a socio-ecological system, there will undoubtedly be challenges in interpreting rapid and unprecedented changes. However, we found clear signs of resilience and adaptation in these three Alaska communities. TEK is dynamic and readily combined with other knowledge to make sense of changing environments and empower action toward wellness. Hippocrates said, "Let food be your medicine." In this respect, Alaska Natives in rural villages have a medicine chest and store at their doorsteps. Harvesting wild foods can positively affect wellness in multiple ways (Teitelbaum and Beckley 2006). Reinvigorating traditional knowledge of local resources and community wellness, blending TEK with academic science, and tapping into available resources for community development can support wellness-oriented initiatives and encourage resilience in the face of climate change, environmental and health risks, and socio-economic change. In Point Hope in particular, young

people were eager to acquire TEK and maintain their peoples' 2000-year-old relationship with the land and ocean. They also sought scientific knowledge to navigate their community's growing global economic connections and confront accompanying environmental, social, and health threats. Creative, interdisciplinary, and participatory efforts can provide lessons for future initiatives. The success of health-related research with indigenous communities requires commitment to long-term community engagement, inclusion of local perspectives, and the general wellness of the communities with which we work.

Acknowledgments

This project was supported by fund from the US Environmental Protection Agency's Science to Achieve Results program (EPA R833707).

References

Agrawal A (1999) Dismantling the divide between indigenous and scientific knowledge. *Development and Change* 26:413–439

Alaska Department of Commerce, Community, and Economic Development (2010) *Community Database Online—Community Info.* [online] Available from: http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.htm. Accessed 14 Jan 2011

Berkes F (2002) Epilogue: making sense of Arctic environmental change?. In: *The Earth Is Faster Now: Indigenous Observations of Arctic Environmental Change*, Krupnik I, Jolly D (editors), Fairbanks, AK: ARCUS, pp 335–349

Berkes F (2008) *Sacred Ecology: Traditional Ecological Knowledge and Resource Management*, Philadelphia: Taylor and Francis

Berman M (2009) Moving or staying for the best part of life: theory and evidence for the role of subsistence in migration and well-being of Arctic Inupiat residents. *Polar Geography* 32(1):3–16

Bersamin A, Luick BR, Stern JS, Zidenberg-Cherr S (2006) Diet quality among Alaska Natives living in the Yukon Kuskokwim River Delta is low: the CANHR pilot study. *Journal of the American Dietetics Association* 106:1055–1063

Buchwald D, Mendoza-Jenkins V, Croy C, McGough H, Bezdek M, Spicer P (2006) Attitudes of urban American Indians and Alaska Natives regarding participation in research. *Journal of General Internal Medicine* 21:648–651

Burch ES Jr (2006) *Social Life in Northwest Alaska: The Structure of Inupiaq Nations*, Fairbanks: University of Alaska Press

Burrow NR, Engelgau MM, Geiss LS, Acton KJ (2000) Prevalence of diabetes among Native Americans and Alaska Natives, 1900–1997: an increasing burden. *Diabetes Care* 23:1786–1790

Cassady J (2007) A tundra of sickness: the uneasy relationship between toxic waste, TEK, and cultural survival. *Arctic Anthropology* 44(1):87–97

Christopher S, Watts V, McCormick AKHG, Young S (2008) Building and maintaining trust in a community-based participatory research partnership. *American Journal of Public Health* 98(8):1398–1406

Crowell AL, Steffian AF, Pullar GL (2001) *Looking Both Ways: Heritage and Identity of the Alutiiq People*, Fairbanks, AK: University of Alaska Press

D'Abundo ML, Carden AL (2008) Growing wellness: the possibility of promoting wellness through community collective garden education programs. *Community Development* 39(4):83–94

Davidson-Hunt IJ, O'Flaherty RM (2007) Researchers, indigenous peoples, and place-based learning communities. *Society and Natural Resources* 20:291–305

Gahagan S, Silverstein J (2003) Prevention and treatment of type 2 diabetes mellitus in children, with special emphasis on American Indian and Alaska Native children. *Pediatrics* 112:328–347

Grace MH, Ribnicky DM, Kuhn P, Poulev A, Logendra S, Yousef GG, Raskin I, Lila MA (2009) Hypoglycemic activity of a novel anthocyanin-rich formulation from lowbush blueberry, *Vaccinium angustifolium* Aiton. *Phytomedicine* 16:406–415

Greene JC (2007) *Mixed Methods in Social Inquiry*, San Francisco: Wiley

Hancock T (1993) The evolution, impact and significance of the healthy cities/healthy communities movement. *Journal of Public Health Policy* 14:5–18

Hill M (1997) Participatory research with children. *Children and Family Social Work* 2:171–183

Irwin A (2001) *Sociology and the Environment*, Cambridge: Polity

Jewett SC, Duffy LK (2007) Mercury in fishes of Alaska, with emphasis on subsistence foods. *Science of the Total Environment* 387(1–3):3–27

Kellogg J, Wang J, Flint C, Ribnicky D, Kuhn P, Gonzalez de Mejia E, Raskin I, Lila MA (2010) Alaskan wild berry resources and human health under the cloud of climate change. *Journal of Agricultural and Food Chemistry* 58:3884–3900

Kellogg J, Joseph G, Andrae-Marobela K, Sosome A, Flint C, Kormarnytsky S, Fear G, Struwe L, Raskin I, Lila MA (2010) Screens-to-nature: opening doors to traditional knowledge and hands-on science education. *NACTA Journal* 54:41–48

Kral MJ, Idlout L (2009) Community wellness and social action in the Canadian Arctic: collective agency as subjective well-being. In: *Healing Traditions: The Mental Health of Aboriginal Peoples in Canada*, Kirmajer LJ, Valaskakis G (editors), Vancouver: UBC Press, pp 315–334

McNeeley SM, Shulski MD (2011) Anatomy of a closing window: vulnerability to changing seasonality in Interior Alaska. *Global Environmental Change* 21:464–473

Menzies CR, Butler C (2006) Introduction: understanding ecological knowledge. In: *Traditional Ecological Knowledge and Natural Resource Management*, Menzies CR (editor), Lincoln, NE: University of Nebraska Press, pp 1–17

Miller G, Foster LT (2010) *Critical synthesis of wellness literature.* Retrieved from: http://dspace.library.uvic.ca:8443/bitstream/1828/2894/5/Critical_Synthesis%20of%20Wellness%20Update.pdf. Accessed 30 Nov 2010

Moerman DE (1998) *Native American Ethnobotany*, Portland, OR: Timber Press

Nuttall M, Berkes F, Forbes B, Kofinas G, Vlassova T, Wenzel G (2005) Hunting, herding, fishing, and gathering: Indigenous peoples and renewable resource use in the Arctic. In: *Arctic Climate Impact Assessment*. New York: Cambridge University Press, pp 649–690

Ostrom E (2009) A general framework for analyzing sustainability of social-ecological systems. *Science* 325:419–422

Pain R, Francis P (2003) Reflections on participatory research. *Area* 35(1):46–54

Park P (1999) People, knowledge, and change in participatory research. *Management Learning* 30(2):141–157

Parlee B, Berkes F, Teetl'it Gwich'in Renewable Resources Council (2005) Health of the land, health of the people: a case study on Gwich'in berry harvesting in northern Canada. *EcoHealth* 2:127–137

Parlee B, Berkes FTeetl'itGwich'inRenewableResources Council (2006) Indigenous knowledge of ecological variability and commons management: a case study on berry harvesting from northern Canada. *Human Ecology* 34:515–528

Pierotti R, Wildcat D (2000) Traditional ecological knowledge: the third alternative. *Ecological Applications* 10:1333–1340

Purcell T, Onjoro EA (2002) Indigenous knowledge, power, and parity. In: *Participating in Development: Approaches to Indigenous Knowledge*, Stillitoe P, Bicker A, Pottier J (editors), ASA Monograph no 39. London: Routledge, pp 162–188

Reed P, Brown G (2003) Public land management and quality of life in neighboring communities—the Chugach National Forest planning experience. *Forest Science* 49(4):479–498

Samson C, Pretty J (2006) Environmental and health benefits of hunting lifestyles and diets for the Innu of Labrador. *Food Policy* 31:528–553

Schreckinger ME, Wang J, Yousef G, Lila MA, de Mejia E (2010) Antioxidant capacity and in vitro inhibition of adipogenesis and inflammation by phenolic extracts of *Vaccinium floribundum* and *Aristotelia chilensis*. *Journal of Agricultural Food Chemistry* 58:8966–8976

Szajdek A, Borowska EJ (2008) Bioactive compounds and health-promoting properties of berry fruits: a review. *Plant Foods for Human Nutrition* 63:147–156

Teitelbaum S, Beckley T (2006) Harvested, hunted and home grown: the prevalence of self-provisioning in rural Canada. *Journal of Rural and Community Development* 1:114–130

Thomas N, O'Kane C (1998) The ethics of participatory research with children. *Children and Society* 12:336–348

Tsuda T (2008) Regulation of adipocyte function by anthocyanins: possibility of preventing the metabolic syndrome. *Journal of Agricultural Food Chemistry* 56:642–646

Viereck EG (2007) *Alaska's Wilderness Medicines: Healthful Plants of the Far North*, Anchorage: Alaska Northwest Books

Wilcox B, Kueffer C (2008) Transdisciplinarity in ecohealth: status and future prospects. *EcoHealth* 5:1–3