Supporting Culturally Responsive Practices

REACH

REACH UP

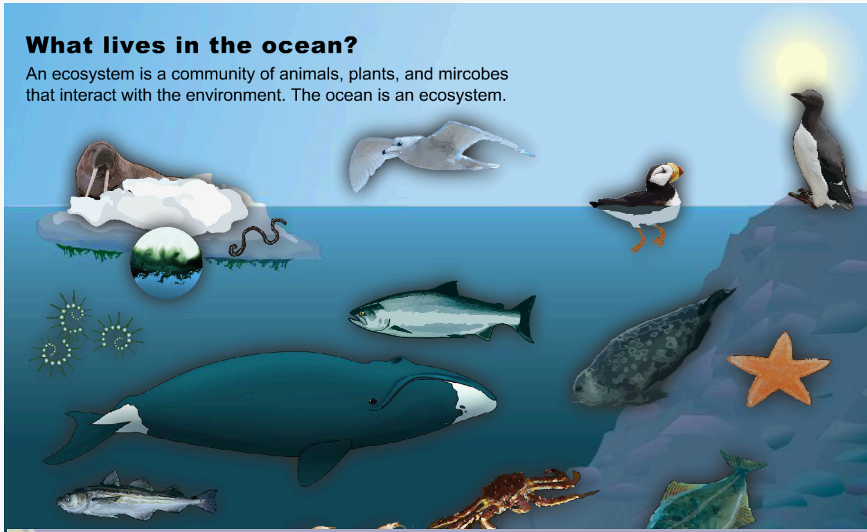
TASK

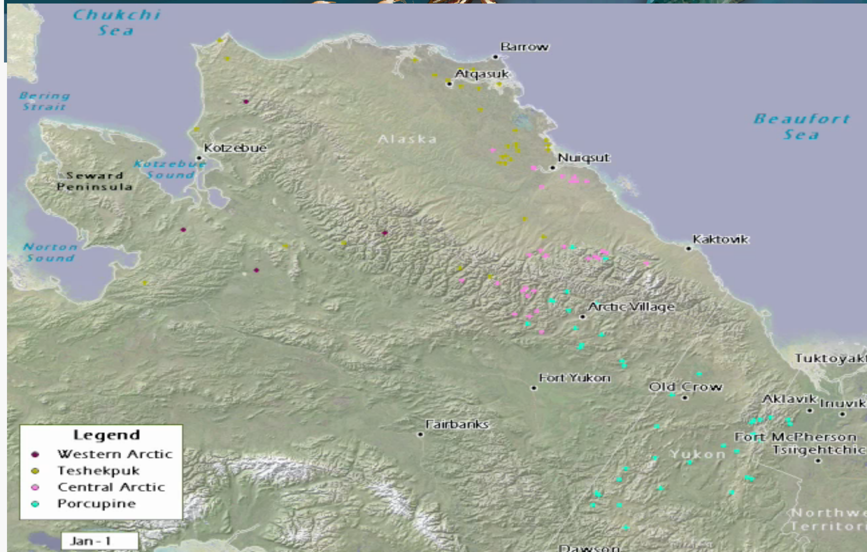
Supporting Culturally Responsive Practices

- Place based, culturally relevant supplementary STEM curriculum and educator training
- Professional development workshops, online courses and culture camps

Supplemental Science Curriculum

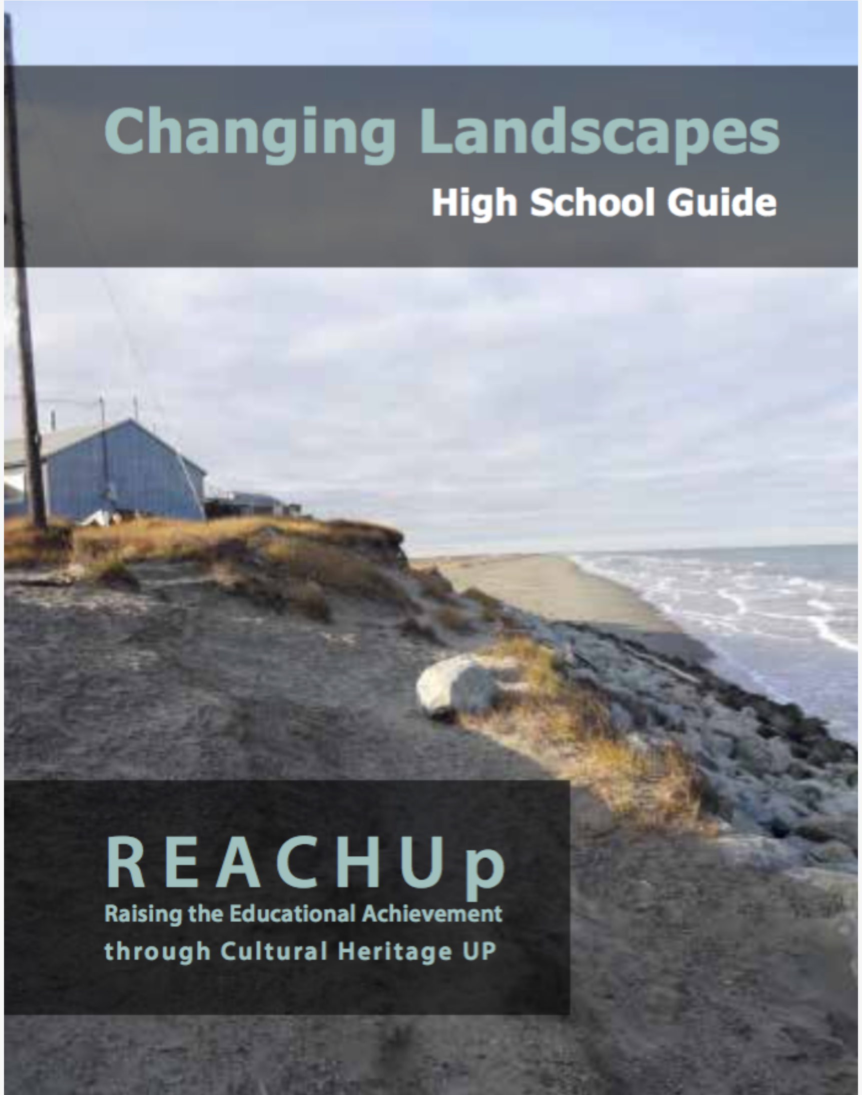
- Supplemental curriculum aligned to State and Local standards
- Place based and culturally relevant material
- Developed with Cultural Knowledge Bearers
- Online multimedia and video
- Free to access for all teachers at k12reach.org





CURRICULUM DESIGN

- Seek community input
- Audience
- Phenomenon
- Education goals
- Relevance
- Development
- Implement and revision



LESSON DESIGN

Community

- Listen to the community, and educators
- What are their needs
- How can we address them

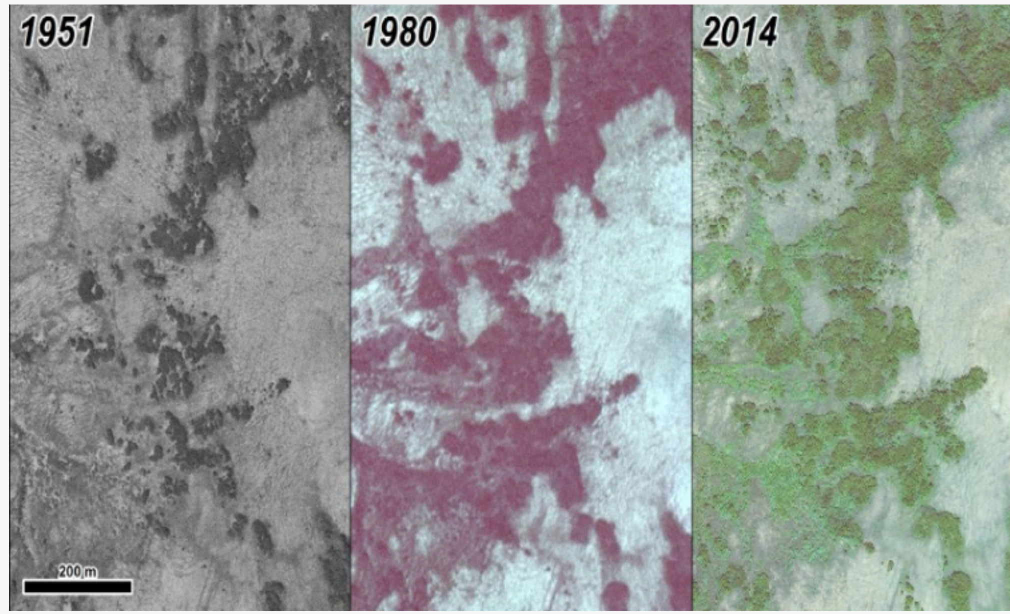
LESSON DESIGN

Audience

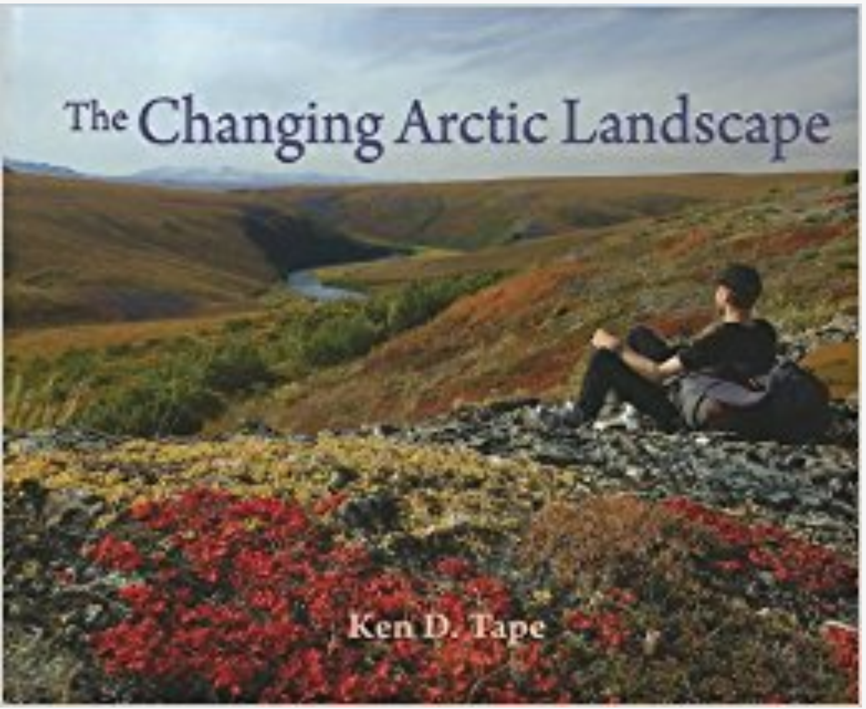
- K-12 Rural Alaskan students
  - Western education material often not aligned with their life experiences
- K-12 Rural Alaskan teachers
  - Many originate in the L48
  - Need resources and knowledge to better connect with their students

lesson Design

Phenomenon



lesson Design



Global Change Biology (2006) 12, 686–702, doi: 10.1111/j.1365-2486.2006.01128.x

The evidence for shrub expansion in Northern Alaska and the Pan-Arctic

KEN TAPE*, MATTHEW STURM† and CHARLES RACINE‡
*Geophysical Institute, University of Alaska-Fairbanks Fairbanks, AK 99775, USA, †USA-CRREL-Alaska Ft., Wainwright, AK 99703, USA, ‡USA-CRREL, Hanover, NH 03755, USA

Abstract

One expected response to climate warming in the Arctic is an increase in the abundance and extent of shrubs in tundra areas. Repeat photography shows that there has been an increase in shrub cover over the past 50 years in northern Alaska. Using 202 pairs of old and new oblique aerial photographs, we have found that across this region spanning 620 km east to west and 350 km north to south, alder, willow, and dwarf birch have been increasing, with the change most easily detected on hill slopes and valley bottoms. Plot and remote sensing studies from the same region using the normalized difference vegetation index are consistent with the photographic results and indicate that the smaller shrubs between valleys are also increasing. In Canada, Scandinavia, and parts of Russia, there is both plot and remote sensing evidence for shrub expansion. Combined with the Alaskan results, the evidence suggests that a pan-Arctic vegetation transition is underway. If continued, this transition will alter the fundamental architecture and function of this ecosystem with important ramifications for the climate, the biota, and humans.

Keywords: arctic, climate change, greening, shrubs, tundra

Received 29 August 2005; revised version received and accepted 19 October 2005

Introduction

The Arctic has warmed about 2 °C per decade over the last 30 years (Overpeck *et al.*, 1997; Serreze *et al.*, 2000; ACIA, 2004). This warming has been accompanied by a host of environmental changes (Arendt *et al.*, 2002; Hinzman *et al.*, 2005), of which the most widely noted is a reduction in sea ice (Rothrock *et al.*, 2003; Stroeve *et al.*, 2005). The observed 10% reduction in ice extent, paired with a commensurate lessening in ice thickness, has been news-worthy (Overpeck *et al.*, 2005) and has had major implications for the heat budget of the Arctic (Sturm *et al.*, 2003; Kolbert, 2005).

The terrestrial counterpart has been a shift in land surface vegetation (Chapin *et al.*, 1995; Myneni *et al.*, 1997; Sturm *et al.*, 2001; Zhou *et al.*, 2001; Lloyd *et al.*, 2003; Stow *et al.*, 2004), but it is less clear whether this budgets of the Arctic by amounts comparable with those associated with changes in sea ice. Without knowledge of the spatial scale of the change, we cannot (a) establish its link to climate conclusively or (b) quantify its feedbacks and effects on the climate and pan-Arctic ecosystem.

The reason for our uncertainty on this important issue is that it is hard to monitor vegetation change using satellites (Fung, 1997; Stow *et al.*, 2004). In contrast, monitoring the extent of sea ice change remotely has been at the operational level for more than 30 years (cf., http://pafc.arh.noaa.gov/ice.php). Also, with a wide variety of arctic land surface vegetation types, more than one type of vegetation change has been underway. Sea ice change, on the other hand, can be measured with a single metric. Moreover, the response time to a warming climate is longer for vegetation than for ice.

lesson Design

- Audience: Rural Alaskan middle school students
- Learning goals: Understanding how ecosystems change over time
- Relevance: increased shrub abundance in the Arctic affects subsistence activities

brief communications

Nations, Geneva, 2000).
3. Gonzalez, E. *et al. Proc. Natl Acad. Sci. USA* **96,** 12004–12009 (1999).
4. Wilkinson, D., Abdool Karim, S. S., Williams, B. & Gouws, E. *J. Acq. Imm. Def. Syndr.* **23,** 405–409 (2000).
5. Gregson, S., Donnelly, C. A., Parker, C. G. & Anderson, R. M. *AIDS* **10,** 1689–1697 (1996).
6. Stephens, J. C. *et al. Am. J. Hum. Genet.* **62,** 1507–1515 (1998).
7. Charlesworth, B. *Evolution in Age-Structured Populations* (Cambridge Univ. Press, Cambridge, 1980).
8. Census (International Programs Center, Population Division, United States Census Bureau, 2000).

Climate change

Increasing shrub abundance in the Arctic

The warming of the Alaskan Arctic during the past 150 years[1] has accelerated over the last three decades[2] and is expected to increase vegetation productivity in tundra if shrubs become more abundant[3,4]; indeed, this transition may already be under way according to local plot studies[5] and remote sensing[6]. Here we present evidence for a widespread increase in shrub abundance over more than 320 km[2] of Arctic landscape during the past 50 years, based on a comparison of historic and modern aerial photographs. This expansion will alter the partitioning of energy in summer[7] and the trapping and distribution of snow in winter[8], as well as increasing the amount of carbon stored in a region that is believed to be a net source of carbon dioxide[9].

During oil exploration of the United States Naval Petroleum Reserve no. 4 in northern Alaska in 1948–50, low-altitude oblique photographs of exceptional clarity were taken at thousands of locations between the Brooks Range and the Arctic coast[10]. In July of 1999 and 2000, we took photographs at 66 of the same locations spanning an area 400 km (east to west) by 150 km. We analysed pairs of new and old photographs for changes in the three principal deciduous shrubs, dwarf birch (*Betula nana*), willow (*Salix* sp.) and green alder (*Alnus crispa*), and for changes in treeline white spruce (*Picea glauca*) along the southern edge of the study area.

In 36 of the 66 repeat photo-pairs, we found distinctive and, in some cases, dramatic increases in the height and diameter of individual shrubs, in-filling of areas that had only had a scattering of shrubs in 1948–50, and expansion of shrubs into previously shrub-free areas (Figs 1, 2). At treeline sites, there was a marked increase in the extent and density of the spruce forest (Fig. 2). In some cases, shrub-dominated vegetation that covered about 10% of the landscape in 1948–50 had doubled by 2000. In the 30 photo-pairs in which the amount of deciduous shrubs had not increased, there was no detectable reduction in shrub abundance either.

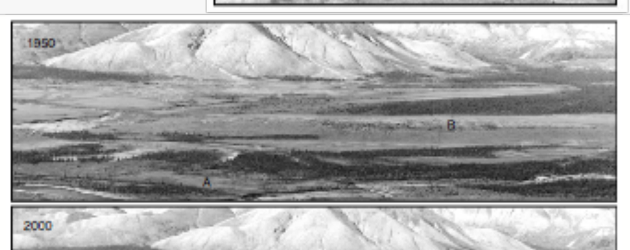
The increase in shrub abundance appears to have been mainly the result of the growth and expansion of alder, perhaps partly because dark-coloured alder are the most conspicuous shrubs (Fig. 1). However, in several photographs ($n = 4$), birch and willow were also seen to have increased in abundance. All three species belong to the same functional group and respond to experimental warming and fertilization in a positive manner[5]. This indicates that the abundance of the smaller dispersed birch and willow found throughout tussock tundra may also be increasing, and so our detection of change could be conservative. These smaller shrubs comprise most of the shrub biomass in the study area.

Our study area is in a location where human and natural disturbances (leading to successional changes) are minimal, so we attribute much of the increase in the abundance of shrubs to the recent change in climate. During the Early Holocene, warming in the Alaskan Arctic was accompanied by one or more large-scale shrub invasions[11], and today shrub abundance increases along latitudinal temperature gradients[12]. These findings, combined with our observations, show that the vegetation of the region is able to respond to changes in climate, perhaps rapidly. The extensive peat deposits[13] are evidence that the region has been an important sink for global carbon in the geological past. The increased primary production inferred from our photographic analysis could be a significant contributor to changes in the high-latitude carbon budget, as well as contributing to important changes in the exchange of surface energy.

Matthew Sturm*, Charles Racine†, Kenneth Tape‡

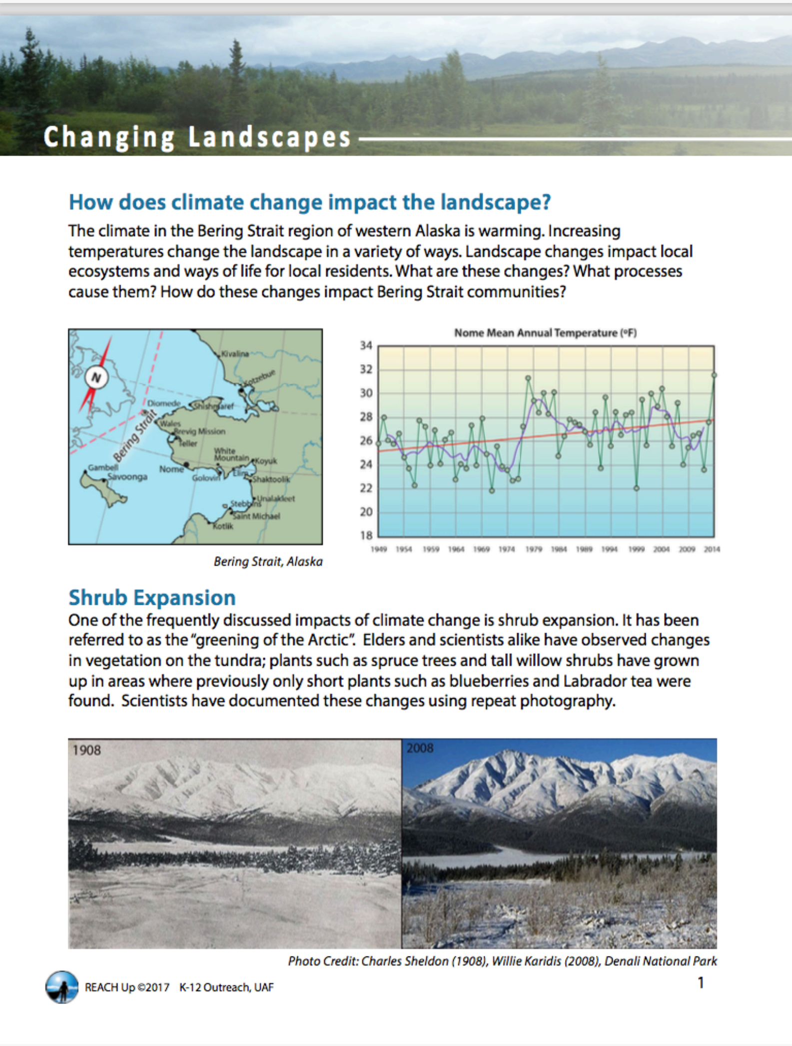
**US Army Cold Regions Research & Engineering Laboratory–Alaska, PO Box 35170, Fort Wainwright, Alaska 99703, USA*

Figure 1 The Ayiyak River (68° 53′, W152° 31′), showing an increase in the density of shrub patches, the growth of individual shrubs and an expansion of shrubs into areas that were previously shrub-free. A and B denote the same locations in the old and new photographs.



lesson Design

Development



Changing Landscapes

How does climate change impact the landscape?

The climate in the Bering Strait region of western Alaska is warming. Increasing temperatures change the landscape in a variety of ways. Landscape changes impact local ecosystems and ways of life for local residents. What are these changes? What processes cause them? How do these changes impact Bering Strait communities?

Bering Strait, Alaska

Shrub Expansion

One of the frequently discussed impacts of climate change is shrub expansion. It has been referred to as the "greening of the Arctic". Elders and scientists alike have observed changes in vegetation on the tundra; plants such as spruce trees and tall willow shrubs have grown up in areas where previously only short plants such as blueberries and Labrador tea were found. Scientists have documented these changes using repeat photography.

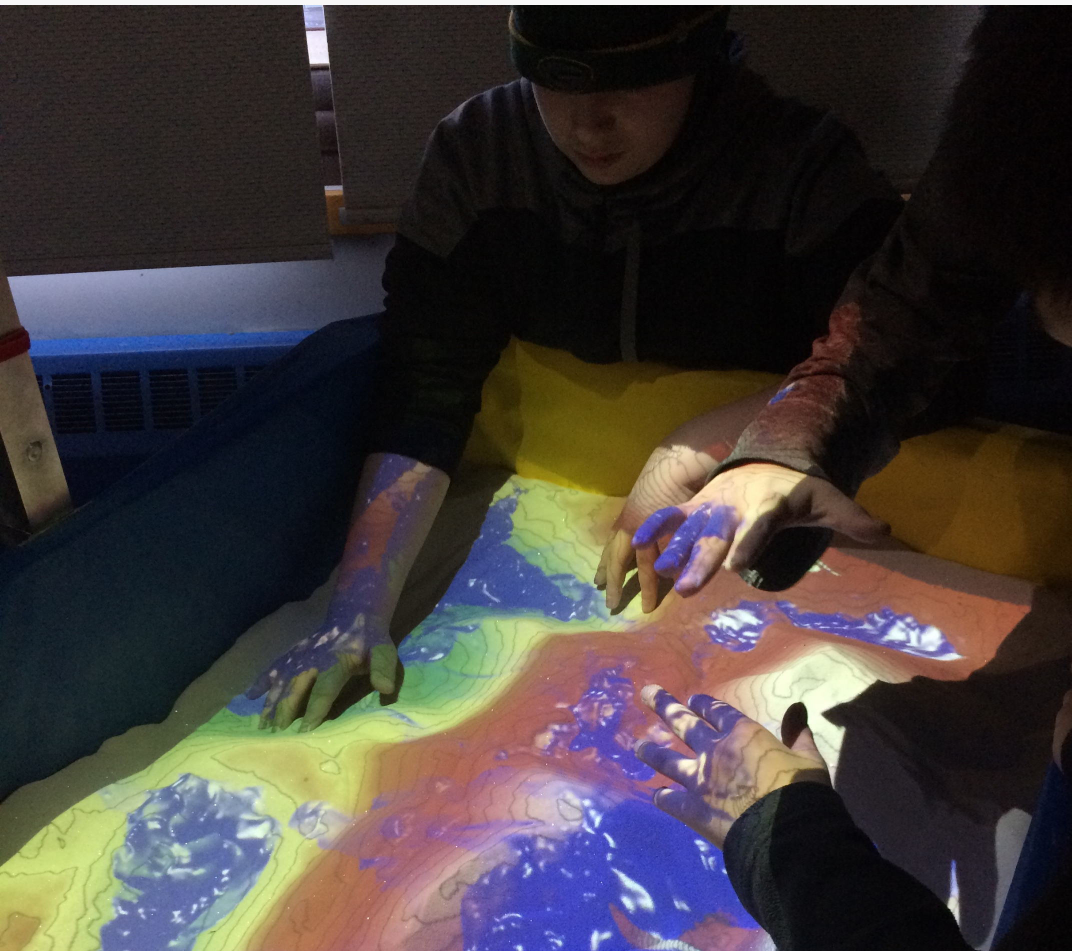
Photo Credit: Charles Sheldon (1908), Willie Karidis (2008), Denali National Park

lesson Design

Multimedia and Video

lesson Design

Implement and revise

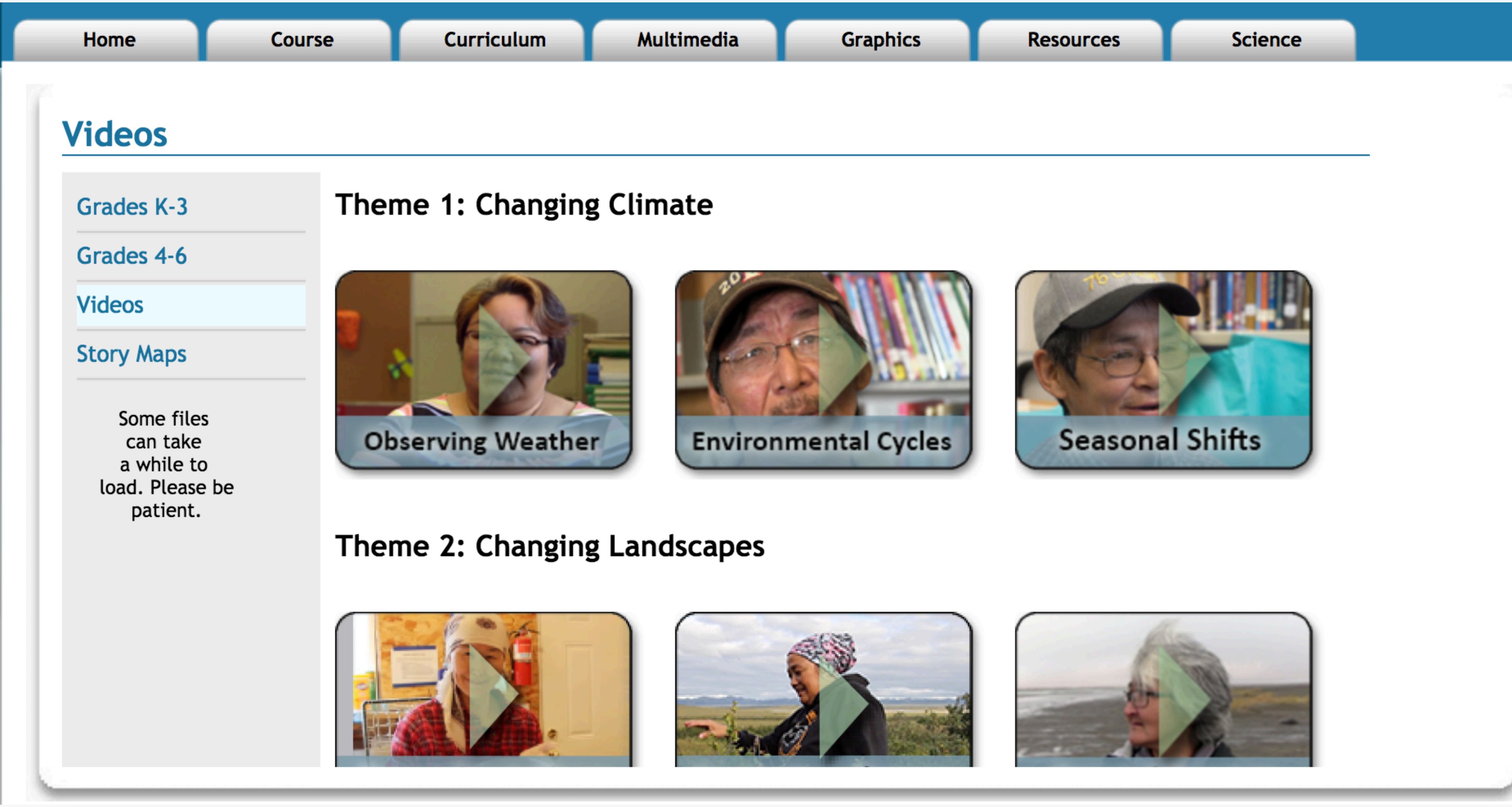


Professional Development Workshops

- Curriculum review
- Learning from Cultural Knowledge Bearers, Elders, and scientists
- Hands on skills and techniques to bring back to classrooms

Science and Culture Camps

- Intensive multi-day camp with Elders, Cultural Knowledge Bearers and scientists
- Thematically tied to education goals



Resources available at K12 Outreach

www.uaf.edu/soe/k12_outreach

This model can be replicated

- K-12 Office has experience with many schools and School Districts throughout Alaska
- Potential for new partnerships to help facilitate place based learning

Thank you

Sam Norlin
REACH Up Program Manager
stnorlin@alaska.edu
(907) 450-8360