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Tribally led planetary health education in southeast Alaska

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Abstract

Limited reporting of Indigenous-led planetary health education programmes has constrained efforts to expand planetary health education, in Indigenous communities and beyond, despite urgent need. Although incorporation of Indigenous knowledge and cultures cannot be standardised, showcasing successful programmes could reveal good practices and aid replicability. In this Personal View, we highlight how shellfish toxin education programmes, designed and organised by the Sitka Tribe of Alaska, reduce local environmental health risks and support youth in pathways towards careers in planetary health. We describe how programmes build awareness and understanding of the local environment, environmental and health risks, and context-appropriate adaptation strategies by centring Tlingit culture and using hands-on activities that integrate Tlingit culture with western science. Lesson plans and resources created by

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HBR and MOG were responsible for research concept and design. HBR and MOG provided project supervision; MOG provided primary funding (principle investigator of R01ES029165) and HBR was responsible for project administration. HBR and JK acquired the data, and HBR, JK, KL, and EGK undertook data analysis and interpretation. HBR, JK, KL, AY, and SH drafted the manuscript, and all authors were involved in editing the manuscript drafts.

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Sitka Tribe of Alaska staff for these programmes are available in the US National Institute for Environmental Health Sciences Partnerships for Environmental Public Health resources web database.

Planetary health education

Planetary health takes an integrated approach to merging human and environmental health that rejects human-centric perspectives and human–environment distinctions and reflects the knowledge of many Indigenous peoples.[1–3] Supporting planetary health requires cross-disciplinary action at the intersections of the environment, health, and social systems, and a centring of Indigenous knowledge from which planetary health orientations stem.[3,4] Local socioeconomic, cultural, and environmental conditions and local learning priorities are included in the Planetary Health Education Framework, developed in 2019–21.[5] Additionally, researchers have called for culturally focused and context-specific planetary health education to facilitate student interest, self-efficacy, and long-term engagement in tackling ecological crises.[5–10] This Personal View contributes a detailed account of one such programme in southeast Alaska.

Centring Indigenous values in planetary health education promotes respectful and reciprocal relationships with the Earth that align with planetary health's interconnected, ecosocial approach. Indigenous knowledge is gathered by observing relationships within the natural world and is rooted in place.[11–13] Fundamental values of Indigenous epistemology include building and nurturing relationships, honouring intergenerational knowledge transfer, acknowledging metaphysical and spiritual orientations, and respecting the interdependence between people, places, plants, animals, and natural phenomena.[12,14,15] Indigenous epistemology fosters wholeness for individuals and communities and a more comprehensive and nuanced understanding of place that centres interconnection.[8,10,12,14,16–21] Planetary health education that draws on collective memory and provides hands-on, place-based learning experiences can help students connect with local ecosystems, learn land-based practices, and develop a sense of place.[10,12,22,23] Furthermore, programmes that celebrate Indigenous cultures, affirm Indigenous sovereignty, and challenge western science perspectives that overlook Indigenous experiences and accumulated knowledge support decolonial planetary health.[4,24–27]

Through centring Indigenous values, planetary health-related education programmes can blend traditional Indigenous knowledge systems with western science. Distinctions between traditional Indigenous knowledge and western science have been extensively studied, with research juxtaposing intuitive, holistic, subjective, qualitative, and contextual traditional knowledge with analytical, reductionist, objective, and quantitative western science.[3,28] Recognising the complementary aspects of these perspectives, some programmes have integrated both. For example, planetary health-related education with Native families and in Alaska Native communities has combined Indigenous knowledge about plants with bioexploratory approaches, and used storytelling in lessons on robotics and computer programming.[29–31] In higher education settings, some programmes have designed environmental science learning around Indigenous language and culture, and used talking

circles and land-based pedagogy to promote interconnectedness to human and natural communities.[32–34]

Integrating Indigenous knowledge and western science in planetary health education can facilitate student interest and empowerment. Cultural lessons strengthen the connection between academic learning and local experiences and make learning more relevant to Indigenous students.[8,35] Programmes that blend Indigenous knowledge and western science can enhance student engagement and retention of both scientific concepts and traditional practices and instil confidence that responses to climate crises can have meaningful effects.[24,36–39] Programmes that focus on Indigenous perspectives also empower wider Indigenous communities by strengthening and preserving traditional languages and cultures and challenging western biases of Indigenous practices.[6,40] These outcomes underscore the need for more such programmes.

In this Personal View, we describe education programmes organised by the Sitka Tribe of Alaska (STA) that address local environmental health risks related to shellfish toxins and encourage lasting interest in planetary health. Planetary health education at a young age is necessary to introduce future generations to the environmental and related health issues they will increasingly face.[32] However, limited reporting of Indigenous-led planetary health education programmes means that little information regarding good practice and relevant resources is available, constraining efforts to expand planetary health education, in Indigenous communities and beyond, despite urgent need. Although incorporation of Indigenous knowledge and cultures cannot be standardised, as communities have unique cultural ties to place,[33] showcasing successful programmes created for specific communities could reveal common practices and aid replicability. We present a detailed description of the STA's shellfish-related planetary health education programmes as a model for similar culturally focused, context-specific programming in other communities. Throughout this Personal View, we use Indigenous when we reference people and cultures that were present before European contact in what is now known as the USA. Whenever possible, we reference individual tribes, cultures, or other groupings of people by their preferred name.

Climate and health risks in southeast Alaska

Present-day southeast Alaska is located on the traditional territories of the Tlingit, Haida, and Tsimshian people. The region faces pressing environmental and sociocultural issues. Global warming threatens Tlingit, Haida, and Tsimshian cultural resources such as yellow cedar (*Chamaecyparis nootkatensis*),[41] sockeye salmon (*Onchorhynchus nerka*),[42,43] and shellfish.[44] In addition to the ecological disruption of anthropogenic climate change, tribes in southeast Alaska contend with the legacies of colonial conquest and state-sanctioned violence, cultural erasure, and land theft.[45–47]

Shellfish toxins are a locus for the intersection of envir onmental and sociocultural risks exacerbated by climate change in southeast Alaska. Paralytic shellfish toxins are among a suite of toxins produced by harmful algal blooms (HABs) that concentrate in bivalves such as blue mussels, butter clams, and cockles.[44] As waters warm, HABs are becoming more common and widespread, which increases the period during which toxin levels in shellfish

that are near blooms exceed the threshold for human consumption set by the US Food and Drug Administration.[48–54] Paralytic shellfish poisoning (PSP) from consuming shellfish contaminated by paralytic shellfish toxins can be fatal, and there have been over 200 recorded cases in Alaska since 1973, with many more cases probably unacknowledged.[55] This is a major concern among Tlingit, Haida, and Tsimshian people living in the region, as shellfish are a culturally important food. Shellfish harvesting is widely practised in the region,[56] shellfish appear as a motif in traditional artwork,[57] and shellfish harvesting is part of traditional food education.[58] Because shellfish consumption is culturally important to them, Tlingit, Haida, Tsimshian, and other coastal Alaska Native people are at elevated risk of toxin exposure; Alaska Natives have a 50% greater risk of shellfish toxin exposure compared with non-Natives.[55] Disparities in exposure risk translate to disparities in health. In two coastal Alaska communities, Alaska Natives were 11·6 times more likely to report a history of PSP than non-Natives, with 20% of Alaska Natives reporting a history of symptoms.[59] Other shellfish toxins (eg, domoic acid and okadaic acid) contribute additional risks, such as heightened risk of colorectal cancer.[60] During 2014–18, the colorectal cancer rate for American Indian or Alaska Native people in Alaska was over twice as high as for White people in Alaska.[61]

Despite the cultural importance of subsistence shellfish harvesting and related disparities in exposure risk and health, non-commercial shellfish are not included in the State of Alaska's toxin monitoring activities. To fill this gap in public health risk prevention, the STA founded a consortium of 16 Alaska Tribal Governments in the Gulf of Alaska called the Southeast Alaska Tribal Ocean Research network (SEATOR) in 2014 to serve as a regional environmental research and monitoring partnership. Among other environmental research, the SEATOR consortium organises shellfish toxin testing of subsistence harvesting sites in communities across southeast Alaska to provide near real-time information about local shellfish toxin levels.[62] Throughout the year, each tribal partner collects shellfish samples at key subsistence harvest sites and ships samples to the STA Environmental Research Lab (STAERL) for toxin testing. Testing results are publicly shared on the SEATOR website and used by tribal partners and subsistence harvesters to reduce exposure risks.

Supporting careers in planetary health

To educate youth about Tlingit culture, the southeast Alaska environment, and environmental health risks, including risks of shellfish toxin poisoning and safe shellfish harvesting practices, the STA organises shellfish-related planetary health education programmes for elementary (ages 5–10 years), middle (ages 11–13 years), and high school students (ages 14–18 years), and an internship programme for high school and university students. The high school and internship programmes were launched in 2016, and the elementary and middle school programmes in 2022. Programmes have been funded by the US Environmental Protection Agency's Indian Environmental General Assistance Program, the AmeriCorps Vista Program, the Biomedical Learning and Student Training Program at the University of Alaska Fairbanks, the Rural Alaska Students in One-Health Research Program at the University of Alaska Southeast supported by the US National Institutes of Health, and the US National Institute of Environmental Health Sciences. Some of this support is grant-based, which can have implications for programme sustainability and

direction, but programmes have so far been consistently funded, and decision making and governance lies with the STA. The STA's programmes centre Tlingit culture and traditions and use hands-on activities that integrate Tlingit culture and western science to enhance student engagement and learning. Programmes are directly tied to Tlingit people because the STA operates exclusively on traditional Tlingit territory, but similar themes are present for Haida and Tsimshian peoples.[63]

The STA's planetary health education programmes support pathways to careers necessary to prepare for and respond to emerging environmental and health risks. Alaska Natives are under-represented in the staff who track, assess, and facilitate responses to shellfish toxin risks in southeast Alaska. Less exposure to science and engineering fields, and lower graduation rates among Alaska Natives compared with other ethnic groups, combine with education requirements to restrict opportunities for tribal citizens to be recruited to local environmental science positions.[64] Financial barriers and family obligations, limited mentorship, curricula that seems impractical and irrelevant to Native communities' needs, coursework that is geographically inaccessible, and cultures within the earth and health sciences that favour western science perspectives and exclude others discourage Indigenous students from pursuing planetary health-related careers.[65] Cultural discontinuity and an emphasis on multicultural differences and assimilation in formal education might also undermine Indigenous student empowerment and contribute to social isolation.[66] By providing students with mentors and tying lessons to culturally important issues, the STA's planetary health programmes support students' self-efficacy, interest, and persistence in fields relevant to planetary health.[67,68] Although a higher degree is not necessary to be an environmental or cultural steward, the STA's programmes show students that there are multiple ways to see and to be such a steward and support pathways to careers in science as one option.

Methods

In presenting the STA's shellfish-related education programmes as an example of culturally focused and context-specific planetary health education programmes, we draw on methods used in similar environmental education research, including document analysis and co-writing with staff responsible for planning and implementing the education programmes.[69] Our writing team comprised STA staff responsible for designing and managing shellfish toxin education programmes, and academic partners supporting these programmes and research related to these programmes. STA staff on the writing team compiled educational materials and resources, analysed these documents for themes and related patterns, and added new information from their own experiences with the programmes. From this review and analysis, STA staff drafted detailed descriptions of programme objectives and implementation and, together with academic partners, identified how programmes address immediate community health risks and promote interest in and access to careers in planetary health. Similar co-analysis and co-writing methods have been used in community research in other Indigenous communities to assess health-supporting programmes.[40] The funding sources played no role in study design, analysis, writing, or decisions to submit for publication.

The Sitka Tribe of Alaska's shellfish-related planetary health education programmes

In the sections that follow, we discuss how the STA's shellfish-related planetary health education programmes support student learning and long-term engagement in planetary health topics through inclusive teaching practices that centre Tlingit language and culture. The STA has a Cultural Resources Department that houses a ten-person cultural and education staff, in positions such as Traditional Arts Instructor, and implements most of the STA's education programmes. The shellfish-focused education that we share in this Personal View is a collab oration between the STA's Cultural Resources Department and Resource Protection Department that brings together cultural, education, and shellfish biotoxin experts employed by the STA.

Elementary school Culture Camp

The STA's elementary school programme, called Culture Camp, introduces elementary students to culturally important environmental and health issues, including HABs and shellfish toxins. To highlight the environment's central role in Tlingit culture and interest students in their local environment, the week-long summer programme focuses on Tlingit vocabulary, art, and history. Field trips include a shellfish harvest and nature walks to introduce students to local plant species and intertidal organisms and how they relate to Tlingit culture and traditional foods. In Tlingit art projects led by local artists, students make bracelets that represent the water cycle, a weave that depicts the marine food web, and a bentwood box inspired by a beach walk. In other activities, students learn the Tlingit and English names of tidal organisms through a picture matching game, and about pollution, drivers of HABs, and the valuable ecosystem services shellfish provide (eg, removing excess nitrogen), by tracing a clam's nutrient filtration journey through multiple environmental exposures. The programme integrates traditional knowledge and western science as University of Alaska Southeast and STA staff lead interactive scientific demonstrations and lessons on shellfish and plant identification and the cultural significance of each species. Students learn where plants and other culturally important foods are located, and harvest plants for teas, jams, and other foods to share with their families.

By introducing young students to the environment's central role in Tlingit culture, the elementary school programme has supported community awareness of local environmental issues and encouraged lasting interest in planetary health topics. Family member engagement in activities is high, and many Culture Camp students participate in the STA's middle and high school programmes.

Middle school programme

The STA's shellfish-related planetary health education programmes include a semester-long programme at a middle school in Sitka, and the programme was recently expanded to middle schools in Hoonah and Juneau, where it is run by the Hoonah Indian Association and the Central Council of the Tlingit and Haida Indian Tribes of Alaska respectively. This programme was developed to complement and bridge elementary and high school programmes, and is the first education programme available to most students that focuses

on HABs, shellfish, and PSP. Students volunteer into the programme, and lessons are delivered by the STA, Hoonah Indian Association, and the Central Council of the Tlingit and Haida Indian Tribes of Alaska staff, with input and assistance from local teachers. Middle school education activities continue the emphasis on Tlingit culture from the Culture Camp. Lessons similarly engage students through interactive activities that combine traditional knowledge and western science. During the first half of the semester, students learn about phytoplankton, HABs, and PSP through activities such as the identification of phytoplankton using microscopes and the collection of phytoplankton samples with a plankton net tow. During the second half of the semester, the curriculum focuses on shellfish and shellfish toxins. Activities include shellfish identification, field trips to collect shellfish samples and conduct a shellfish biomass survey, and in-class shellfish dissections and presentations on shellfish toxin testing procedures, including how to interpret and communicate shellfish toxin reports. Lessons also cover other topics important to the local environment and Tlingit culture, such as salmon, herring, and local flora. The cultural significance of the environment contextualises each of these activities. Tribal elders feature as regular guest speakers to explain the origins, meaning, and importance of the environment and traditional foods.

The middle school programme has included the option for students to participate in a research study assessing pre–post programme changes in shellfish toxin risk perceptions and behavioural intentions related to shellfish harvesting and consumption and toxin exposure risk reduction. Research activities include surveys and interviews. Preliminary data indicate that lessons have increased awareness in students of HABs and paralytic shellfish toxins, interest in shellfish harvesting, and intent to check toxin levels on the SEATOR website before harvesting.

High school Clam Camp

The STA's high school Clam Camp builds on the broader planetary health education offered in elementary school, and focuses exclusively on subsistence shellfish harvesting topics, including HABs, shellfish toxins, and environmental conditions that increase toxin exposure risks. Clam Camp involves three days of lessons that students opt into during the school year at three Sitka high schools. As with the elementary and middle school programmes, Clam Camp blends Tlingit culture and western science through activities aimed to reduce toxin exposure risks and build interest in planetary health-related fields. Primary activities include data collection and laboratory research that highlight the techniques behind HAB monitoring and toxin testing while emphasising the cultural importance of subsistence shellfish harvesting. Field trips mimic field research, and include microscopy to identify algae that cause shellfish toxins, and shellfish identification, sampling, and dissections. Local experts lead discussions on topics such as environmental conditions behind HAB formation, local organisations' roles in PSP risk reduction, toxin-level data comparisons between years and across harvesting sites, and human health implications of different toxin levels. Activities focus on understanding, analysing, and acting upon real data. For example, students participate in a simulation where they are given information about HABs and species-specific toxin levels in a southeast Alaska community and, using this information, must make decisions about exposure risk and risk communication. As part of Clam Camp,

the STA has also organised tours to introduce students to the research conducted at STAERL and highlight careers available with the STA and partner organisations, including the Alaska Department of Environmental Conservation, the National Oceanic and Atmospheric Administration's National Centers for Coastal Ocean Science, and the University of Alaska.

In the past two years, over one hundred students participated in Clam Camp, which is a large number considering that Sitka's population in 2021 was 8407.[70] Teachers view Clam Camp as a success, both in terms of reducing risks of toxin exposure and supporting pathways to careers in planetary health. Teachers report that the knowledge students retain informs recreational shellfish harvesting behaviours and how students talk about harvesting with their families (personal communication). For example, students might share information about toxin testing resources that are available in the community. Teachers also report that Clam Camp lessons complement classroom activities and increase students' exposure to environmental science topics (personal communication).

High school and university student internship programme

The STA offers a full time, paid summer internship programme for high school and university students that encourages leadership and advocacy around culturally important planetary health topics. As with other STA planetary health education programmes, the internship programme promotes inclusive learning through activities and projects that integrate Tlingit culture and western science. Interns can assist in lesson design for the elementary school Culture Camp, and monitoring of the Klag sockeye salmon weir, which is a major source of salmon for traditional harvest. Interns also work with STA staff to design a research project related to one of the STA's core environmental research areas: shellfish toxins, ocean acidification, fisheries, brownfields and pollution, and cultural resources. Interns are paired with a mentor to support them in this research, and are encouraged to present their research at regional conferences, including the Alaska Marine Science Symposium, the SEATOR workshop, and the Southeast Environmental Conference hosted by the Central Council of the Tlingit and Haida Indian Tribes of Alaska and the STA.[71] Interns also participate in general staff activities, which offers further opportunities to learn professional skills and gain exposure to environmental science careers.

Discussion

This Personal View highlights how shellfish toxin education programmes designed and organised by the STA address local environmental health risks and support students' self-efficacy and engagement in planetary health topics, including pathways to careers in planetary health. Limited reporting of planetary health education programmes that are outside of health-care professions and institutions and, particularly, limited reporting of programming that centres Indigenous cultures, represent a knowledge gap in planetary health education programming.[5,72] This gap offers an opportunity to design new, culturally focused and context-specific programmes. The STA's shellfish-related planetary health education builds on science education that incorporates Indigenous cultures in personalised and localised learning.[6,24] Through centring Tlingit culture and practice, the STA programmes blend traditional knowledge and western science in activities that include art

(eg, the bentwood box project), storytelling (eg, lessons from elders), experiential learning (eg, field trips and nature walks), and hands-on data collection (eg, net tows and shellfish surveys). By leveraging varied learning strategies and activities that integrate Indigenous knowledge and western science, programmes support student agency in considering multiple perspectives and career pathways related to planetary health.[39] Through integrating multiple ways of knowing, the STA programmes problematise privileged forms of science and offer a more pluralistic and responsive vision of science—an approach to equity-oriented science learning that some science education scholars argue requires greater attention.[73,74] Moreover, by centring pressing societal challenges that disproportionally affect minoritised communities, this case illustrates what Lee and Grapin propose as "future approaches" to science and science, technology, engineering, and mathematics (STEM) education that promote "justice in STEM education and society broadly".[75]

The STA has shared educational materials with partners across southeast Alaska and supported the expansion of programmes to additional communities to facilitate region-wide replication of planetary health education programmes. STA staff have gained experience in the design, planning, and implementation of planetary health education activities and have created a large inventory of educational materials and curricula. Lesson plans and resources for these activities are available on the National Institute for Environmental Health Sciences' Partnerships for Environmental Public Health resources database.[76] Research components of the middle school programme also offer opportunities to identify generalisable insights and inform programme expansion. In recent interviews with environmental managers responsible for shellfish toxin testing across southeast Alaska, conducted as part of related research, environmental managers perceived education programmes as crucial to reduce risks of toxin exposure and support safe harvesting practices.[77] Environmental managers also stressed the need for education programmes in smaller and more remote communities where subsistence shellfish harvesting is most widely practised. By sharing materials and best practices, the STA aims to support similar education opportunities across southeast Alaska, particularly in smaller and more remote communities underserved in investment and programming.

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Declaration of interests

AY reports involvement with a related project supported by the Washington Sea Grant. EGK and CW report consulting work for Ocean and Earth Environmental Services. MOG reports service with the US National Harmful Algal Blooms Committee and the Florida Harmful Algal Bloom Health Working Group. All other authors declare no competing interests.

References

1. Prescott SL, Logan AC, Albrecht G, et al. The Canmore declaration: statement of principles for planetary health. Challenges 2018; 9: 31.
2. Prescott SL, Logan AC. Planetary health: from the wellspring of holistic medicine to personal and public health imperative. Explore 2019; 15: 98–106. [PubMed: 30316687]

3. Redvers N, Celidwen Y, Schultz C, et al. The determinants of planetary health: an Indigenous consensus perspective. Lancet Planet Health 2022; 6: e156–63. [PubMed: 35150624]
4. Parkes MW, Poland B, Allison S, et al. Preparing for the future of public health: ecological determinants of health and the call for an eco-social approach to public health education. Can J Public Health 2020; 111: 60–64. [PubMed: 31792844]
5. Planetary Health Alliance. The planetary health education framework. 2021. 10.5822/phef2021 (accessed Oct 12, 2024).
6. Brand G, Wise S, Bedi G, Kickett R. Embedding Indigenous knowledges and voices in planetary health education. Lancet Planet Health 2023; 7: e97–102. [PubMed: 36608956]
7. Redvers N, Faerron Guzmán CA, Parkes MW. Towards an educational praxis for planetary health: a call for transformative, inclusive, and integrative approaches for learning and relearning in the Anthropocene. Lancet Planet Health 2023; 7: e77–85. [PubMed: 36608953]
8. Kawagley AO, Barnhardt R. Indigenous knowledge systems and Alaska Native ways of knowing. Anthropol Educ Q 2005; 36: 8–23.
9. Barnhardt R, Kawagley AO. Indigenous knowledge systems and education. Teach Coll Rec 2008; 110: 223–41.
10. Cajete GA. Indigenous community: rekindling the teachings of the seventh fire. St Paul, MN: Living Justice Press, 2015.
11. Cloud QY, Redvers N. Honoring Indigenous sacred places and spirit in environmental health. Environ Health Insights 2023; 17: 11786302231157507.
12. Cajete G Native science: natural laws of interdependence. Santa Fe, NM: Clear Light Publishers, 2000.
13. Elk LB. Native science: understanding and respecting other ways of thinking. Rangelands 2016; 38: 3–4.
14. Battiste M, Henderson JY. Protecting Indigenous knowledge and heritage: a global challenge. Saskatoon, SK: Purich Publishing, 2000. 10.59962/9781895830439 (accessed Oct 13, 2024).
15. Williams L, Snively G. Coming to know: a framework for indigenous science education. In: Snively G, Williams WL, eds. Knowing home: braiding Indigenous science with western science. Victoria, BC: University of Victoria, 2016.
16. Battiste M Reclaiming Indigenous voice and vision. Vancouver, BC: University of British Columbia Press, 2000.
17. Battiste M Indigenous knowledge and pedagogy in First Nations education: a literature review with recommendations. Ottawa, ON: National Working Group on Education, 2002.
18. Kawagley AO, Barnhardt R. Education indigenous to place: western science meets native reality. 1998. https://eric.ed.gov/?id=ED426823 (accessed Oct 13, 2024).
19. Okakok L Serving the purpose of education. Harv Educ Rev 1989; 59: 405–23.
20. Ongtooguk P. Education and cultural self-determination. In: Barnhart R, Kawagley AO, eds. Alaska Native education: views from within. Fairbanks, AK: University of Alaska Press, 2010: 313–16.
21. Basso KH. Wisdom sits in places: landscape and language among the Western Apache. Albuquerque, NM: University of New Mexico Press, 1996.
22. Irwin RL, Rogers T, Wan Y-Y. Making connections through cultural memory, cultural performance, and cultural translation. Stud Art Educ 1999; 40: 198–212.
23. Smith GA. Place-based education: learning to be where we are. Phi Delta Kappan 2002; 83: 584–94.
24. Jin Q Supporting indigenous students in science and STEM education: a systematic review. Educ Sci 2021; 11: 555.
25. Battiste M, Henderson JS. Naturalizing indigenous knowledge in eurocentric education. Can J Native Educ 2009; 39: 32.
26. Kirkness VJ, Barnhardt R. First Nations and higher education: the four R's—respect, relevance, reciprocity, responsibility. J Am Indian Educ 1991; 30: 1–15.

27. Hoogeveen D, Atleo CG, Patrick L, et al. On the possibility of decolonising planetary health: exploring new geographies for collaboration. Lancet Planet Health 2023; 7: e179–83. [PubMed: 36754474]
28. Mazzocchi F Western science and traditional knowledge. Despite their variations, different forms of knowledge can learn from each other. EMBO Rep 2006; 7: 463–66. [PubMed: 16670675]
29. Kellogg J, Plundrich NJ, Lila MA, et al. Engaging American Indian/Alaska Native (AI/AN) students with participatory bioexploration assays. NACTA J 2016; 60: 42–50.
30. Tzou C, Suárez E, Bell P, et al. Storywork in STEM-art: making, materiality and robotics within everyday acts of Indigenous presence and resurgence. Cogn Instr 2019; 37: 306–26.
31. Flint CG, Robinson ES, Kellogg J, et al. Promoting wellness in Alaskan villages: integrating traditional knowledge and science of wild berries. EcoHealth 2011; 8: 199–209. [PubMed: 21915737]
32. Poland B, Mashford-Pringle A, Bowra A. Many lenses for planetary health: seeding citizen engagement for sustainable futures visioning with new ways of seeing. Can J Public Health 2020; 111: 901–11. [PubMed: 33140230]
33. Bartmes N, Shukla S. Re-envisioning land-based pedagogies as a transformative third space: perspectives from university academics, students, and Indigenous knowledge holders from Manitoba, Canada. Diaspora, Indigenous, Minor Educ 2020; 14: 146–61.
34. Wilder BT, O'Meara C, Monti L, Nabhan GP. The importance of indigenous knowledge in curbing the loss of language and biodiversity. Bioscience 2016; 66: 499–509.
35. Cook A Indigenizing philosophy on stolen lands: a worry about settler philosophical guardianship. The Pluralist 2022; 17: 34–44.
36. Verlie B, Clark E, Jarrett T, Supriyono E. Educators' experiences and strategies for responding to ecological distress. Aust J Environ Educ 2021; 37: 132–46.
37. McLean M, Gibbs T, McKimm J. Educating for planetary health and environmentally sustainable health care: responding with urgency. Med Teach 2020; 42: 1082–84. [PubMed: 32721202]
38. Muroi SK, Bertone E. From thoughts to actions: the importance of climate change education in enhancing students' self-efficacy. Australian Journal of Environmental Education 2019; 35: 123–44.
39. Eglash R, Lachney M, Babbitt W, Bennett A, Reinhardt M, Davis J. Decolonizing education with Anishinaabe arcs: generative STEM as a path to indigenous futurity. Educ Technol Res Dev 2020; 68: 1569–93.
40. Hilgendorf A, Guy Reiter A, Gauthier J, et al. Language, culture, and collectivism: uniting coalition partners and promoting holistic health in the Menominee Nation. Health Educ Behav 2019; 46: 81S–87. [PubMed: 31549556]
41. Beier CM, Sink SE, Hennon PE, D'Amore DV, Juday GP. Twentieth-century warming and the dendroclimatology of declining yellow-cedar forests in southeastern Alaska. Can J For Res 2008; 38: 1319–34.
42. Bryant MD. Global climate change and potential effects on Pacific salmonids in freshwater ecosystems of southeast Alaska. Clim Change 2009; 95: 169–93.
43. Kovach RP, Ellison SC, Pyare S, Tallmon DA. Temporal patterns in adult salmon migration timing across southeast Alaska. Glob Change Biol 2015; 21: 1821–33.
44. Gobler CJ, Doherty OM, Hattenrath-Lehmann TK, Griffith AW, Kang Y, Litaker RW. Ocean warming since 1982 has expanded the niche of toxic algal blooms in the North Atlantic and North Pacific oceans. Proc Natl Acad Sci USA 2017; 114: 4975–80. [PubMed: 28439007]
45. Thornton TF. Being and place among the Tlingit. Seattle, WA: University of Washington Press, 2011.
46. Coddington KS. Spectral geographies: haunting and everyday state practices in colonial and present-day Alaska. Soc Cult Geogr 2011; 12: 743–56.
47. Lightfoot KG. Russian colonization: the implications of mercantile colonial practices in the North Pacific. Hist Archaeol 2003; 37: 14–28.
48. Laabir M, Collos Y, Masseret E, et al. Influence of environmental factors on the paralytic shellfish toxin content and profile of *Alexandrium catenella* (Dinophyceae) isolated from the Mediterranean Sea. Mar Drugs 2013; 11: 1583–601. [PubMed: 23676417]

49. Hoshiai G, Suzuki T, Kamiyama T, Yamasaki M, Ichimi K. Water temperature and salinity during the occurrence of *Dinophysis fortii* and *D. acuminata* in Kesennuma Bay, northern Japan. Fish Sci 2003; 69: 1303–05.
50. Bill BD, Moore SK, Hay LR, Anderson DM, Trainer VL. Effects of temperature and salinity on the growth of *Alexandrium* (Dinophyceae) isolates from the Salish Sea. J Phycol 2016; 52: 230–38. [PubMed: 27037588]
51. Delmont TO, Hammar KM, Ducklow HW, Yager PL, Post AF. Phaeocystis antarctica blooms strongly influence bacterial community structures in the Amundsen Sea polynya. Front Microbiol 2014; 5: 646. [PubMed: 25566197]
52. Ho K-C, Kang S-H, Lam IHY, Hodgkiss IJ. Distribution of *Alexandrium tamarense* in Drake Passage and the threat of harmful algal blooms in the Antarctic Ocean. Ocean Polar Res 2003; 25: 625–31.
53. Richlen ML, Zielinski O, Holinde L, et al. Distribution of *Alexandrium fundyense* (Dinophyceae) cysts in Greenland and Iceland, with an emphasis on viability and growth in the Arctic. Mar Ecol Prog Ser 2016; 547: 33–46. [PubMed: 27721528]
54. US Food and Drug Administration. Fish and fishery products hazards and controls guidance - fourth edition. Chapter 6: natural toxins. 2011. https://www.fda.gov/media/80235/download (accessed Oct 13, 2024).
55. Harley JR, Lanphier K, Kennedy EG, et al. The Southeast Alaska Tribal Ocean Research (SEATOR) partnership: addressing data gaps in harmful algal bloom monitoring and shellfish safety in southeast Alaska. Toxins (Basel) 2020; 12: 407. [PubMed: 32575620]
56. Ibarra SN. Addressing a complex resource conflict: humans, sea otters, and shellfish in southeast Alaska. Fairbanks, AK: University of Alaska Fairbanks, 2021.
57. Thorsen S, Knapp MR. Carved history: the totem poles and house posts of Sitka National Historic Park. Anchorage, AK: Alaska Geographic Association, 2008.
58. Neumann E AK: culture camp. KCAW Sitka, 2013. https://alaskapublic.org/2013/07/26/ak-culture-camp/ (accessed Oct 13, 2024).
59. Gessner BD, Schloss M. A population-based study of paralytic shell fish poisoning in Alaska. Alaska Med 1996; 38: 54–58. [PubMed: 8712300]
60. Cordier S, Monfort C, Miossec L, Richardson S, Belin C. Ecological analysis of digestive cancer mortality related to contamination by diarrhetic shellfish poisoning toxins along the coasts of France. Environ Res 2000; 84: 145–50. [PubMed: 11068928]
61. Haverkamp D, Redwood, D, Roik E, Vindigni S, Thomas T. Elevated colorectal cancer incidence among American Indian/Alaska Native persons in Alaska compared to other populations worldwide. Int J Circumpolar Health 2023; 82: 2184749. [PubMed: 36867106]
62. Roland HB, Whitehead C, Fleming LE, Berdalet E, Enevoldsen HO, Gribble MO. Knowledge sharing to reduce toxin exposure risks from harmful algal blooms: global networks and political barriers. Ethn Dis 2022; 32: 285–92. [PubMed: 36388868]
63. Moss ML. Shellfish, gender, and status on the Northwest Coast: reconciling archeological, ethnographic, and ethnohistorical records of the Tlingit. Am Anthropol 1993; 95: 631–52.
64. Van Cooten S Where are the Indigenous scientific leaders? Examining the participation of Native American/Alaska Natives in weather and water academic programs and the federal workforce. Bull Am Meteorol Soc 2014; 95: 1725–40.
65. Bueno Watts NF. Broadening the participation of Native Americans in earth science. Tucson, AZ: Arizona State University, 2011.
66. Harper AO, Thompson S. Structural oppressions facing Indigenous students in Canadian education. Fourth World Journal 2017; 15: 41–66.
67. Chemers MM, Zurbriggen EL, Syed M, Goza BK, Bearman S. The role of efficacy and identity in science career commitment among underrepresented minority students. J Soc Issues 2011; 67: 469–91.
68. Keith JF, Stastny SN, Brunt A. Barriers and strategies for success for American Indian college students: a review. J Coll Student Dev 2016; 57: 698–714.

69. Martínez-Rodríguez FM, Fernández-Herrería A. Huerto Alegre: an ecocentric socio-educational experience as a critical practice of education for sustainable development. Austr J Environ Educ 2022; 38: 138–51.

70. United States Census Bureau. QuickFacts: Sitka city and borough, Alaska. Population Estimate, July 1, 2021. 2021. https://www.census.gov/quickfacts/fact/table/sitkacityandboroughalaska/IPE120221 (accessed March 22, 2023).

71. Central Council of the Tlingit and Haida Indian Tribes of Alaska. Environmental. https://www.ccthita.org/services/community/environmental/ (accessed Oct 14, 2024).

72. Barna S, Maric F, Simons J, Kumar S, Blankestijn PJ. Education for the Anthropocene: planetary health, sustainable health care, and the health workforce. Med Teach 2020; 42: 1091–96. [PubMed: 32805141]

73. Philip TM, Azevedo FS. Everyday science learning and equity: mapping the contested terrain. Sci Educ 2017; 101: 526–32.

74. Tzou C, Bang M, Bricker L. Commentary: designing science instructional materials that contribute to more just, equitable, and culturally thriving learning and teaching in science education. J Sci Teach Educ 2021; 32: 858–64.

75. Lee O, Grapin SE. The role of phenomena and problems in science and STEM education: traditional, contemporary, and future approaches. J Res Sci Teach 2022; 59: 1301–09.

76. The National Institute of Environmental Health Sciences. The Partnerships for Environmental Public Health (PEPH) Resource Center. https://connect.niehs.nih.gov/peph/ (accessed Oct 13, 2024).

77. Roland HB, Kohlhoff J, Lanphier K, et al. Perceived challenges to tribally led shellfish toxin testing in southeast Alaska: findings from key informant interviews. Geohealth 2024; 8: e2023GH000988.