

THE  
**WILDLIFE**  
**PROFESSIONAL**

# ‘Two-eyed Seeing’

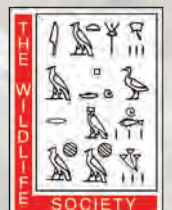
**INTERWEAVING  
INDIGENOUS  
KNOWLEDGE AND  
WESTERN SCIENCE**

---

**Using eDNA to  
find the sharp-  
tailed snake**

**Hidden heroes of  
North American  
conservation**

**A framework  
for sagebrush  
conservation**



This article was originally published in *The Wildlife Professional*, Vol. 14.4. This reprint has been provided to Science Delivered for use in their educational curricula. Additional copying, republishing in part or whole, posting on a different website or using for commercial purposes is protected under copyright laws and requires additional permission from the publisher and original author(s).

Learn more about The Wildlife Society at [www.wildlife.org](http://www.wildlife.org).

©2020 The Wildlife Society, 425 Barlow Place, Suite 200, Bethesda, MD 20814, USA.

# ‘Two-eyed Seeing’

## INTERWEAVING INDIGENOUS KNOWLEDGE AND WESTERN SCIENCE

By Joshua Rapp Learn

**G**rizzly bears represent a powerful force for the Heiltsuk First Nation of British Columbia. When people gather for ceremonies, dancers representing grizzlies make sure nobody breaks the rules. Stand when you’re not supposed to, or eat at the wrong time, and a grizzly dancer will quickly approach. If participants get unruly, grizzly dancers will show them the door.

“The grizzly bear is really iconic in our tradition and in our culture,” said William Housty, conservation manager for the Heiltsuk Integrated Resource Management Department. “They’re very well respected in our ceremonies.”

▶ Grizzly bears in British Columbia hold special significance for the Heiltsuk, whose historical knowledge helped determine grizzly occupancy on their land.



The bear's spiritual significance reflects its position in the surrounding coastal rainforests, where the grizzly (*Ursus arctos horribilis*) is an apex predator known to chase black bears (*Ursus americanus*) from its territory. Its ritual importance is mirrored in its key role in the ecosystem around the Koeye River and its tributaries in Heiltsuk territory. The presence of grizzlies usually means the presence of salmon, which the bears feed on as the fish swim upstream. Outside of spawning season, bears feed on Columbia black-tailed deer (*Odocoileus hemionus columbianus*) and other prey. Grizzly ranges often overlap with those of predators like wolverines (*Gulo gulo*) and gray wolves (*Canis lupus*).

So when forestry companies approached the Heiltsuk seeking a logging concession on their land, one way the First Nation determined where sustainable logging could occur was by avoiding areas occupied by grizzlies. "We're protecting not just grizzly bears but also numerous other mammal species," Housty said.

The provincial government had developed models to predict the best places to find grizzlies, but those projections didn't sit right with community members — people with decades of knowledge about wildlife on their lands. "We had a good chuckle. Everyone knew that it wasn't even close to being accurate," Housty said. "Everybody spends time on the water and the land here — it's just a way of life. Everyone has a sense of where the bears are."

Biologists can often see Western science and Indigenous knowledge as incompatible — and sometimes even at odds. But wildlife professionals are learning that the two can be complementary. Traditional wildlife management practices can integrate Western science. Peer-reviewed research can incorporate Indigenous wisdom — often referred to academically as traditional ecological knowledge, or TEK. In the best of cases, supporters say, both types of narratives can be interwoven from a stance of mutual respect.

### Two-eyed seeing

"We use this 'two-eyed seeing' approach," said TWS member Jesse Popp, the Canada Research Chair in Indigenous Environmental Science at Mount Allison University in New Brunswick and a member of the Wiikwemkoong Unceded Territory. Popp attributes the

Credit: Murray Foubister

phrase — meaning using both Indigenous knowledge and Western science — to Albert Marshall, a Mi'kmaq Elder.

“If we can learn to see through two lenses, or with two eyes, we will better understand the world, ecology or environmental science in general,” she said.

In the central coast of British Columbia, the Heiltsuk put this concept into practice to manage timber practices. Instead of following the provincial models, they set out to create a new habitat model and to do it in a way that minimizes disturbance of the animals and respects them according to *Gvi'ilas* — Heiltsuk customary law. Setting hair snares along

found the area the local grizzly population used was much larger than they had anticipated.

“This just really kicked the door open, because it was heavily based on Heiltsuk knowledge that was intertwined with a lot of this DNA analysis,” Housty said. “Together, it painted a pretty powerful picture of what grizzly bears actually need and opened our eyes to the space we need to give them.”

The use of generations of their own knowledge also gave the Heiltsuk confidence when granting logging concessions. “It’s definitely something to be proud of,” Housty said. “It has really opened the door to not only how we manage grizzly habitat but how we build relationships with other people that operate in our territory.”

“Healthy systems benefit everybody,” he said, “not just Heiltsuk people.”

### What’s in a name?

Interweaving Indigenous and Western knowledge starts with a discussion of language, and the concept of TEK has a number of different understandings.

“There is no universally accepted definition,” wrote TWS member Seafha Ramos, a postdoctoral fellow in biology with the National Science Foundation and a research associate at Humboldt State University, in an opinion in the *Wildlife Society Bulletin* (Ramos 2018) on applying TEK to wildlife conservation.

One commonly cited definition, she wrote, comes from Fikret Berkes, an applied ecologist and professor emeritus at the University of Manitoba. In his book *Sacred Ecology*, Berkes calls it “a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment.”

Ramos also shares a quote from a contributed book chapter she wrote on Yurok TEK after interviewing members of her community. “Yurok TEK can be thought of as a branch of Indigenous Science and conceptualized as *hkelonah ue meygeytohl* (to take care of the Earth), a system where Yurok people and wildlife collaboratively strive to create and maintain balance of the Earth via physical and spiritual management in tandem (Lara-Cooper and Lara Sr. 2019).”



Credit: Jean Polfus

▲ A Dene hunting camp stands along the Begádeé, or Keele River, in the Shúhtagot'ıne Néné, or Mackenzie Mountains, of the Northwest Territories, Canada. Researcher Jean Polfus collected tissue samples from animals harvested during a community hunt here.

the Koeye River, they collected about 2,500 samples between 2006 and 2011 and analyzed the DNA from some of them to better understand the genetic diversity and the population size of bears in the area (Housty et al. 2014).

While it is a long time compared to many wildlife studies, five years still only represented a snapshot of grizzly bear occupancy. To bolster the genetic survey, Housty and his colleagues tapped into generations of Heiltsuk knowledge of grizzly landscape use. They interviewed Heiltsuk Elders about what species they had harvested dating back to 1985 and where they had seen grizzlies. Plotting this data along with the DNA information on a map, they



Credit: Jean Polfus

For TWS member Julie Thorstenson, executive director of the Native American Fish and Wildlife Society, TEK is “ingrained in native people,” since they’ve adapted cooperatively with the landscape and the wildlife within it.

“Indigenous people are experts. They’ve been here the longest,” she said. “Traditional ecological knowledge is tied very tightly with culture and cultural upbringing and the stories passed down from generation to generation.”

Jean Polfus, a senior species-at-risk biologist with the Canadian Wildlife Service — a branch of Environment and Climate Change Canada — prefers the term “Indigenous knowledge” and believes a deeper focus on Indigenous languages themselves can help broaden ecological understanding. The word “traditional” suggests such knowledge is old or static, she said, but culture and knowledge are constantly evolving.

As part of her PhD research, Polfus worked with the Sahtú Dene communities around Great Bear Lake in the Northwest Territories of Canada to understand more about the dynamics of various caribou (*Rangifer tarandus*) populations in the area. “Understanding where the boundaries between the groups are has pretty big ramifications for endangered species policy,” she said.

The Sahtú Renewable Resources Board was working on a mandate to follow Dene law and make use of Dene knowledge. In practice, this meant that researchers couldn’t touch the animals they were working with, making it impossible to use techniques like radio-collaring caribou. Instead, Polfus and her colleagues provided community members \$25 gift certificates for gas for every pile of caribou scat they brought in. The genetic data it contained helped identify over 550 individual caribou and allowed managers to delineate differences between boreal woodland caribou (*R. t. caribou*),

▲ Tǫǫzi, or boreal woodland caribou, make their way through the boreal forest of the Sahtú Region near Délı̄ne, Northwest Territories, Canada. These caribou remain year-round in small groups throughout the boreal forest.



Courtesy Serra Hoagland

▲ TWS member Serra Hoagland, right, has encouraged Indigenous students, including Elisha Flores, left, from the Hoopa Nation, and TWS member Chase Voirin, center, from the Navajo Nation, to pursue wildlife careers.

► Ella Bowles records measurements of a walleye from Mistissini Lake.



Courtesy Ella Bowles

barren-ground caribou (*R. t. groenlandicus*) and the mountain caribou ecotype.

When Polfus brought this information back to the Dene Elders, she found the groups they'd identified using genetics correlated with distinctions made by the Dene language. Boreal woodland caribou are known as *tɔdzi*, barren-ground as *ʔekwé* and mountain caribou as *shúhta ʔepé*. "Linguistic history also mirrors the strong patterns you're seeing in the genetics," she said.

The language also suggested a fourth type of caribou that Western taxonomies hadn't identified: *Tɛnat'əa*. Details about this type have been lost over the generations, and the definition is uncertain other than that these animals are fast runners that come from far away, but Polfus said future research may try to use DNA analysis to identify it.

"The really cool part there is that their language is identifying diversity in caribou below the species level, below even maybe the subspecies level, because [the Dene] have such a long history and understanding of caribou," she said.

### Macro vs. micro

Western scientific methods and Indigenous knowledge don't always see eye-to-eye on matters of ecology, but supporters of integrating them believe the two can be complementary.

"You have this yin-yang between two different types of knowledge," said Serra Hoagland, CWB®, a liaison officer for the U.S. Forest Service and past chair of the TWS Native Peoples Working Group.

Where Western science is often compartmentalized, dealing with a specific question about a specific part of the ecosystem, TEK tends to be more holistic, she said. Scientific studies are often focused on a short time frame, sometimes due to funding or politics. Traditional knowledge can span generations — something that can be a benefit to researchers and managers. "Our society, our profession — all of this is yearning for that deeper, hundred-year perspective of forest," Hoagland said. "We're just itching for that deeper, longer-term knowledge."

Ella Bowles, a postdoctoral fellow with the University of British Columbia-Okanagan and Mount



Credit: Ella Bowles

Allison University, worked with the Cree Nation of Mistissini in northern Quebec to find out if walleye (*Sander vitreus*) were getting smaller in the southern part of Mistassini Lake. Talking with Elders and fishermen, her team gained a better understanding of fishing practices on the lake over a long period of time and regional changes in the walleye. When they took body size measurements and genetic samples, they found a signal in the southern part of the lake — where most fishing occurs — not present in populations in the north indicating the southern fish were distinct and were indeed changing. If the researchers had not been guided by the Elders and fishermen, Bowles said, they probably wouldn't have noticed the change.

“Oftentimes, Indigenous knowledge works as an early warning system,” she said, and it can recognize regional differences in ecology that biologists might overlook.

### Two eyes on the future

Combining traditional and Western approaches can be difficult, though. Traditional knowledge is often discounted by scientists as mythology. Elders

are often reluctant to share their knowledge. Past friction between Indigenous communities and scientists has strained relations, and the fraught colonial history of European settlement has left a gulf of distrust.

“There is some difficulty with building these relationships, because there has been a very unfortunate and poor history with research related to Indigenous communities and Indigenous knowledge,” Popp said.

TWS member Michel Kohl, AWB®, a wildlife extension specialist and assistant professor of wildlife management at the University of Georgia, was born on the Fort Peck Sioux and Assiniboine reservation in Montana. He believes better incorporating traditional knowledge into university wildlife courses — rather than relegating them to anthropology or Native American studies classes — could help bridge the divide. “It is a detriment to these students that are going to be exposed to these policy and management issues to not have any background from that context,” Kohl said.

▲ The Cree Nation of Mistissini in northern Quebec was concerned walleye were getting smaller. Body size analysis supported the observation, and DNA analysis suggested that populations were changing.



Courtesy Michel Kohl

▲ TWS member Michel Kohl scans the landscape for elk and wolves. Born on the Peck Sioux and Assiniboine reservation, he believes in better incorporating traditional knowledge into university wildlife courses.

Polfus, who isn't Indigenous, had to carve her own path in pursuing her line of study. It started when she had the opportunity to work with the Taku River Tlingit First Nation on caribou management in northwestern British Columbia (Polfus et al. 2013).

"I had a strong realization that conservation successes are going to come when Indigenous people are empowered and have their stewardship and governance practices respected and realized," she said. During her master's program at the University of Montana, she took social science courses to bolster her knowledge of Indigenous culture. Now, she is helping to implement an agreement for caribou protection with the Sauteau and West Moberly First Nations, the British Columbia provincial government and the Canadian federal government.

"That education experience and background allows her to understand and incorporate the perspectives of First Nations groups while merging it with western science into this cohesive management strategy of caribou nationwide," said Kohl, who worked in a lab with Polfus when he was at the University of Montana. "That's the epitome of why this education component is so important."

The university has now brought on three Indigenous graduate students to work on tribal wildlife projects, including bison (*Bison bison*) reintroduction on the Blackfeet Indian Reservation, bordering Glacier National Park. More actions like this will likely improve the integration of Western science with Indigenous knowledge, Kohl said. "In a lot of ways, it benefits society and it benefits the resources."

### TEK technology

With new generations of wildlife professionals come new ways to use technology to integrate knowledge. In the Biigtigong Nishnaabeg community of northwestern Ontario, people were concerned about moose decline. Popp and others created a moose tracking app in which hunters and land users record moose observations on cellphones, including the animals' sex and age,

similar to citizen science apps like iNaturalist or eBird (Popp et al. 2018).

But the app provided more than raw numbers and statistics. It allowed people to record Indigenous knowledge through text or recorded audio, allowing users to describe a preferred hunting spot used by a family for generations or note areas where once common moose sightings have declined. This "Indigenous guardianship" puts eyes and ears on the ground, Popp said, and Indigenous users can continue to use the app to track populations after the study ends.

In other cases, researchers have reversed the scenario, using traditional technology to help modern research. Andrea Reid, a PhD candidate at Carleton University in Ottawa from the Nisga'a Nation in British Columbia, used a Nisga'a fish wheel to improve salmon tracking and monitoring on spawning runs.

Powered by the river's current, the fish wheels, owned and operated by the Nisga'a Fisheries and Wildlife Department, scoop up water and salmon and deposit them into a side compartment where technicians or researchers can easily examine them and measure body conditions without harming them.



Since the mid-1990s, the Nisga'a have coupled traditional fish wheels with modern statistical methods to get highly accurate estimates of how many salmon successfully make it upriver each year.

Reid has used the fish wheels to recapture salmon at multiple stages along their spawning migration to tell whether fish that were injured or in poorer condition were able to make it all the way to their spawning grounds. By improving their estimates and understanding of migration survivors, Reid said, managers can set better fishing quotas.

“If injured fish aren’t making it upstream, and we’re getting a lot of what we call en route mortality, then they aren’t going to contribute to that really important pulse of nutrients that needs to happen upstream,” Reid said. “They aren’t going to be there to feed the bears and the wolves or deposit their eggs for the next generation.”

### Integrating two paths

For many Indigenous land managers, the use of traditional ecological knowledge doesn’t boil down to explicit steps or techniques they integrate. Instead, they say, it’s present in everything they do while working with wildlife.



Credit: Michael Swarbrick

“TEK is just part of our life. It’s just a natural thing that we rely on,” said Norman Jojola, a natural resource manager with the Northern Pueblos Agency of the Bureau of Indian Affairs.

When he’s out in the field, Jojola said, he will pause for a moment before tackling the management task

▲ TWS member Jesse Popp worked with the Biigtigong Nishnaabeg community in northwestern Ontario to develop an app that could record moose sightings and integrate Indigenous knowledge.



Credit: Cole Morven

◀ A modern version of a traditional fish wheel owned and operated by the Nisga'a Fisheries and Wildlife Department scoops up salmon and water, depositing them into a side area where researchers can take measurements.

---

## Traditional farming benefits endangered Hawaiian birds

To recover a pair of imperiled Hawaiian birds, interpretations of endangered species protections called for a halt to a traditional taro farming project at the He'eia National Estuarine Research Reserve on Oahu. But when evidence showed that the traditional practices actually aided the birds, the taro project resumed.

Like other wetland birds, the endangered 'alaie 'ula, or Hawaiian gallinule (*Gallinula galeata*



Credit: Sean Marrs

▲ The endangered ae'ō, or Hawaiian stilt, stands in a taro patch on Oahu.

*sandvicensis*) and the ae'ō, or Hawaiian stilt (*Himantopus mexicanus knudseni*), evolved in step with natural flood disturbances, said Kawika Winter, reserve manager at the He'eia National Estuarine Research Reserve. Traditional taro agriculture mimics natural flood events.

“When you start expanding wetlands agroecology, wetlands bird populations start increasing,” he said.

When the taro project stopped in 2011, the stilts disappeared, Winter said. After government officials allowed the project to resume in 2012, the reserve has produced a dozen new stilts. Gallinule numbers have been increasing as well.

“There's generally a false dichotomy between Indigenous culture and science,” Winter said. Indigenous people have been gathering knowledge about the natural world through observation for millennia, he said, and they've used those observations to develop best management practices. “That is applied science. I'm trying to use science as a way to translate the difference between world views.”

---

at hand. “You listen to hear what the forest is saying to you,” he said.

While growing up, Jojola said, he was taught that animals will cooperate if you respect and treat them well. It was a lesson he saw firsthand capturing and radio-collaring mule deer (*Odocoileus hemionus*) and elk (*Cervus canadensis*) in the 1970s to determine winter and summer ranges on tribal reservations. He found if he approached a trapped animal without it seeing him and quickly hooded it, it calmed down. Talking to it while he fitted the collar and took measurements helped keep it calm.

“I could talk to the animal, say we're here to help them, not to hurt them,” Jojola said. “I had to connect to them.”

For Housty, the best possible outcomes in conservation and management come from interweaving a variety of approaches.

“Science is powerful on its own,” he said. “Traditional knowledge is powerful on its own. When you bring them together, it's something that is hard to refute by anybody.” ■



Joshua Rapp Learn is a science writer for The Wildlife Society.