A deep chesty bawl echoes from rimrock to rimrock, rolls down the mountain, and fades into the far blackness of the night. It is an outburst of wild defiant sorrow, and of contempt for all the adversities of the world. Every living thing (and perhaps many a dead one as well) pays heed to that call. To the deer it is a reminder of the way of all flesh, to the pine a forecast of midnight scuffles and of blood upon the snow, to the coyote a promise of gleanings to come, to the cowman a threat of red ink at the bank, to the hunter a challenge of fang against bullet. Yet behind these obvious and immediate hopes and fears there lies a deeper meaning, known only to the mountain itself. Only the mountain has lived long enough to listen objectively to the howl of a wolf.” -Aldo Leopold, Thinking Like a Mountain
Author’s Statement
Ava Goodale graduated from Cornell University with a degree in natural resource management. After working in that field, she used those experiences to transition into progressive education and is now the chair of the Millbrook School Science Department in Millbrook, New York. In addition to teaching, she coordinates the department’s place-based and project-based curriculum, facilitates a student research program, and runs the school’s canopy walkway.

Ava has participated in several research and education programs throughout the Tropics, including learning from the Kayapo People of the Xingu River, Brazil. In partnership with the Morpho Institute, she has visited the Maijuna People of Peru yearly since 2017 and facilitates a professional development workshop for educators, titled Inquiry, Conservation, & Sustainability in the Amazon. It is her great honor to translate their lessons with the hope that many more will back their efforts and be part of a global effort to be better stewards of the places we call home. As Tyson Yunkaporta describes in Sand Talk, indigenous patterns of thinking, doing, and being are a wellspring, as we reexamine our own practices and relationships to people and place. This case study is intended to spark that examination and open a door of discovery for readers to see their own place in the context of other world views—to see what is familiar through a new lens.

This case study is part of a forthcoming series. For more information, please send inquiries to: curriculum@morphoinstitute.org

The Morpho Institute is a 501(c)3 nonprofit created to support the key role of K-12 education in realizing the global goal of environmental conservation and sustainability. To achieve this goal, The Morpho Institute provides professional development programs and curriculum resources which support local to global environmental stewardship in K-12 instruction.

In collaboration with US and international partners, The Morpho Institute provides US educators the opportunity to experience the Amazon rainforest as a compelling context for developing a global perspective on biological and cultural resources, participating in conservation, exploring sustainability, and inspiring environmental stewardship. Our field workshops and resources apply key elements of inquiry, STEM, and placed-based learning to assist educators in making these critical local to global connections in their classrooms, instruction, and curricula. Learn more at www.morphoinstitute.org

OnePlanet is a 501(c)3 nonprofit that partners with indigenous and traditional communities to build a more sustainable, empowered, and just future through community-based projects, outreach, and technical assistance. We respect indigenous and traditional communities by treating them as equal partners in our projects. We view them as collaborators instead of participants and we work with them rather than for them. We have witnessed that engaging communities and individuals in this way helps to build capacity and local ownership ultimately increasing the long-term sustainability and viability of our programs.

Our work is focused in the Peruvian Amazon with the Maijuna indigenous group. OnePlanet was founded in 2015 and builds on the extensive biocultural conservation work that our President and founder, Dr. Michael Gilmore, started with the Maijuna in 1999. Learn more at www.oneplanet-ngo.org/

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Introduction

Thank you for taking part in this case study. In the pages that follow, you will learn about the Maijuna indigenous people’s wildlife management strategies, as an approach to community-based conservation in Peru. You will take the perspective of a student visiting the Maijuna village to learn about their conservation success story so you can be an agent of change in your home community. As the story unfolds, you’ll be asked to answer questions, reflect on conservation in your local community, and finally participate in a citizen science project. The icons used throughout are intended to draw your attention to specific features of the case study. The tapir icon indicates a snapshot from the field in Peru, the checklist icon indicates an action item, and the pencil icon indicates questions for you to answer as you go.

Before you continue, please read the background article, The Maijuna: Fighting for Survival in the Peruvian Amazon and answer these empathy reflection questions (Ritchhart et al., 2011):

1. ℹ️ The Maijuna might see <insert an issue that was mentioned in the article> as <insert a description of what their viewpoint might be> because <insert a justification for your thinking>.

2. What do you think a Maijuna person sees, observes, or notices?

3. What might a Maijuna person know, understand, hold true, or believe?

4. What might a Maijuna person care deeply about?

5. What might a Maijuna person wonder about or question?
Part 1: As you cross the threshold into a Maijuna house, you notice the hinge on a Dutch-style door. It takes you a moment to realize that it’s the rubber sole of an old shoe, repurposed to fold in half as the gate swings open, welcoming you into Jorge’s home.

He warmly finds you a seat and thanks you for coming to his village. Your eyes begin to dart around the room with curiosity. Yet, Jorge smiles with a warmth and calm that settles your attention. You notice how his nervousness in front of your group quickly eases, as everyone connects to his kind demeanor. Your attention sharpens again, as Jorge surprises you by picking up his shotgun and explains that he would like to share his story as an indigenous hunter.

Jorge tells you about his hunting treks—just him, some bullets, and a canoe, living in the forest about eight hours upriver for about a week at a time. His love for the forest makes his smile brighten even more. His love for the animals he depends upon truly makes him beam, as he shares the joy it brings him to watch monkeys play and eat fruit.

6. What question would you ask Jorge to show your interest, curiosity, and appreciation?

Your friend asks if any animals are threatened or endangered here. Jorge shifts his weight, indicating that this is a heavy question. He starts a story that begins about a decade ago, when he and his community were on the brink of starvation. Your heart immediately sinks to imagine your new friend in such despair. He explains their forests were subjected to logging, both legal and illegal. You anticipate that Jorge will describe impacts you are familiar with—habitat loss, forest degradation, and species extirpation. These problems are apparent in Jorge’s description, but you learn that logging was selective and significant forest cover was not lost (Gilmore et al., 2010). The core of the problem had to do with the loggers themselves, who poached the game animals that the Maijuna depend on for daily sustenance. Jorge talks faster now, saying that loggers killed as many animals as they could, not thinking about the future, just coming and going because after all this was not their land. They ate and sold the bushmeat, especially primates, lowland tapir, brocket deer, peccaries, and paca, causing populations to rapidly decline in less than 8 years (Mayor et al., 2015). Your blood starts to boil at this injustice, until you realize these loggers were mostly poor people who could become indebted to the logging companies (Kozloff, 2010), if they did not pay off their living expenses with income generated from the bushmeat market (Mayor et al., 2015). The intense hunting pressure stopped in 2010, when the timber companies were evicted, leaving the Maijuna with a ghost forest to tend.

7. Investigate and describe an environmental justice issue in your area.
Part 2: Jorge takes you down to the muddy banks of the Sucusari River, a tributary of the Napo that eventually leads to the Amazon herself. You are joined by two elders, Sebastián and Victorino, who will take you to important hunting sites to show how their food system reaches far into the forest. With cloudy skies reflected in cloudy water, you load the boat and start your journey. As you travel, Sebastián shares the story of how things began to change after their forests were impacted by logging and poaching.

It started with a huge sheet of paper, some markers, and a lot of excitement. Before the loggers left, the Maijuna used participatory mapping from 2004-2009 to depict the significant and memorable features of their ancestral land, culturally, ecologically, and economically (abbreviated version to the left). Victorino opens a large map (see next page), displaying over 900 points that were catalogued using GPS in partnership with researchers, including special hunting places, hunting camps, and ancient hunting camps (Gilmore and Young, 2012). You are stunned—never before have you seen culture and biology, art and cartography, and western science and traditional knowledge integrated together to form one whole. The land this map represents rolls out in front of you, starting with the dense jungle walls to your sides. The traditional ecological knowledge this map encodes also stands in front of you, in the form of wisdom built up by Victorino and Sebastián during their lives in the forest. They explain that these maps were a crucial step in gaining official land rights to the conservation area they now steward.

Maps are potent sources of information and have the potential to display asymmetries in power and privilege. Participatory mapping is a form of counter mapping, contesting those dynamics and creating space for the marginalized to claim their identity, ownership, recognition, and deep-rooted connection to place. The group, Native Land, has created their own counter map. Find your school on this traditional territories map. Click on your location and learn more by following the links that appear to the left.

8. In order to recognize the indigenous presence in your area, complete the acknowledgement statement below, adding information, such as languages and treaties (Native Land, 2019). I want to acknowledge that we are on the traditional territory of:

Now, it is time for you to make your own map come to life and create meaning from place, as the Maijuna have demonstrated, by creating an Event Map. With your classmates, take a walk in a natural area. Using post-it notes, create at least 5 quick sketches with notes of “events” you observe along the way—anything from a croaking frog to a flying bird. When you return, work as a group to create a base map on poster paper that includes key geographical features from your hike. Everyone should then place their post-it notes on the map roughly were they experienced them (Hinchman, 1999).

9. After examining all map contributions in detail, take a step back to view your map as a whole. Identify and describe emerging patterns that document salient experiences along your group’s “path to place” (Hinchman, 1999).
Fig. 25. Map highlighting over 900 culturally and biologically significant sites to the Maijuna of the Sucusari, Yanayacu, and Algodón river basins.
Part 3: Stepping off the boat, you enter the low light of the forest, seeping with moisture. You struggle to keep up, while navigating wet roots, taking in bird calls, and trying to decipher one green area from the next. Seeming to sense your effortful trek, Victorino and Sebastián pause to inform you that you just passed through three of the 70+ habitat types the Maijuna recognize in their language, Máihiki. These include maca (primary forest), imi titi (upland forest), and yiaya coti (floodplain forest). This system, more complex and nuanced than any western scientific record, is based on geomorphology, physiognomy, disturbance, and indicator plants and animals (Gilmore, 2005). Today, you will see a few of the culturally based habitat types that are at the heart of their subsistence livelihoods— caocoa abida (peccary mud wallows), naso baidadi (woolly monkey forest), and tuada (mineral lick) (Gilmore, 2005). The diverse landscape you have just experienced holds the Maijuna’s food security (Vliet et al., 2015) by offering a diverse diet (Gergel et al., 2020), complete with protein, iron, zinc, and vitamin C (Sarti et al., 2015).

Without further deliberation, you are off again, following a trail that seems to be getting thinner in width and thicker in vegetation. Time goes by fast, as the forest noises lull you along. Soon you find yourself at your first stop— caocoa abida, or the mud wallows of the collard peccary (Huangana/Pecari tajacu). You see a 3-meter wide mud pit at the base of a downed tree. Victorino says peccaries often visit during the dry season to bathe, creating a prime hunting location (Gilmore, 2005). It seems to you that this habitat determines the success of the hunt, but Victorino explains that there is a spirit throughout the forest that ultimately makes that determination. As he demonstrates how to make a backpack from ungarahui palm leaves to carry up to 50kg of bushmeat home (photo below), he explains that the conservation area has different rules for different areas based on communal agreements. There is one area in the core of the reserve where no one hunts to allow the forest and its animal populations to recover, serving as a source area. In other areas, the Maijuna hunt for subsistence and income, selling bushmeat in a market 4 hours away, creating a sink area. Biologically sensitive species with great ecological, economic and cultural value, such as peccaries, are protected through community-based management plans. These plans are an important form of collaboration. Every Maijuna family hunts for subsistence and 93% hunt to generate income, which represents over 40% of the community’s income. Today, Victorino is proud to share that the management is succeeding, and they are finding more animals close to their homes, a sign that this forest and its inhabitants are recovering.

See Victorino and Sebastián in action here, as they reflect upon the past and rejoice for the continued recovery of this species.

10. Describe how a species in your area has recovered and why. Relate your findings to the Maijuna. Use the IUCN’s red list advanced search feature and filter for increasing or stable population trends.
Part 4: Your next stop will be a woolly monkey forest or naso baidadi. On your way, Sebastián reintroduces himself, sharing his Maijuna name— Ma Taque, which means red capuchin monkey (Wingfield and Gilmore, 2019). He then decides to share the traditional monkey creation story with Victorino translating in Máihiki (Roncal et al., 2018):

“We want to eat fruits,” said the group of people. Acue acueyo oiyi yiquia. “You want to eat fruits?” asked the Creator. Misa acue oyie. “Yes, we wish we could go up and eat them,” replied the group of people. Quima mini acueyo oiyi. “If you want fruits then unite the rope from your hammock and place it down toward your butt (to make a tail),” said the Creator. Acue oij ani misa jaijoma jaseoma misajuna bari oje t'tecaci. [In the meantime] the Creator was grating Genipa americana fruits. Be irigui. After grating the fruit he rubbed it on their faces and mouths. Be irire yia quirigui yobi tea. “Who wants to be a naso (Sound file: Common woolly monkey)?” he asked. Nebi naso bayo iij. “I do,” a woman replied. Yi bachi ijo. “What does a naso sound like while eating fruits?” the Creator asked. Quima jicaqui naso acue acuequi ani. She listened to him, climbed a tree, and said: “chichi, chichi, chichi.” Asare mico chi, chi, chi chi ijo. “You are a chichi (Sound file: Black-mantled tamarin). You are not a real naso,” he said. Chichina ja. “This is what I will be then,” the women said. Cao ní bachi ijo. At this moment she became a chichi monkey. “Who is going to be a naso?” the Creator asked again. Nebi bayo. “Me,” replied a man. Yia iji. “What does a real naso sound like?” asked the Creator. Quima jicaqui naso debi ani. The man climbed a tree and happily gathered fruits. Mini acue titequi chibaji. He then called out, “Choyoro, choyoro, choyoro.” “Yes, you are a naso,” said the Creator. Ase caita nasona chibaji. “Now, who will be a jaijui (Sound file: Red howler monkey)?” asked the Creator. Jana igueca ne baya jaijui. “Me. I want to be a jaijui,” a woman replied. Yia ijo. Yi jaiqui bachi. “Let me hear you. Sing so I can hear how a jaijui sings,” requested the Creator. Ja jica asayi. Ja yima asayi jaijui quima yiqui. “Oju, oju, oju, oju,” she sang. “You are a bao (Sound file: Titi monkey),” said the Creator. “This is what I will be then,” replied the woman. Caqu bachi ijo. “Now, who will be a jaijui?” asked the Creator. Jana igueca ne baya jaijui. “Me,” a man replied. Yia iji. The creator then placed a small bichibi (gourd) into the man’s throat. Bichibi t'tecacui. Then, the creator rubbed annatto over his entire body (to paint it red). Be ɨrɨre yia jaijui. “Now, who will be a jaijui?” asked the Creator. Jana igueca ne baya jaijui. “Me,” a man replied. Yia iji. The creator then placed a small bichibi (gourd) into the man’s throat. Bichibi t'tecacui. Then, the creator rubbed annatto over his entire body (to paint it red). Be ɨrɨre yia jaijui. “Now, who will be a jaijui?” asked the Creator. Jana igueca ne baya jaijui. “Me,” a man replied. Yia iji. The creator then placed a small bichibi (gourd) into the man’s throat. Bichibi t'tecacui. Then, the creator rubbed annatto over his entire body (to paint it red). Be ɨrɨre yia jaijui. “Now, who will be a jaijui?” asked the Creator. Jana igueca ne baya jaijui. “Me,” a man replied. Yia iji. The creator then placed a small bichibi (gourd) into the man’s throat. Bichibi t'tecacui. Then, the creator rubbed annatto over his entire body (to paint it red). Be ɨrɨre yia jaijui. “Now, who will be a jaijui?” asked the Creator. Jana igueca ne baya jaijui. “Me,” a man replied. Yia iji. The creator then placed a small bichibi (gourd) into the man’s throat. Bichibi t'tecacui. Then, the creator rubbed annatto over his entire body (to paint it red). Be ɨrɨre yia jaijui. “Now, who will be a jaijui?” asked the Creator. Jana igueca ne baya jaijui. “Me,” a man replied. Yia iji. The creator then placed a small bichibi (gourd) into the man’s throat. Bichibi t'tecacui. Then, the creator rubbed annatto over his entire body (to paint it red). Be ɨrɨre yia jaijui. “Now, who will be a jaijui?” asked the Creator. Jana igueca ne baya jaijui. “Me,” a man replied. Yia iji. The creator then placed a small bichibi (gourd) into the man’s throat. Bichibi t'tecacui. Then, the creator rubbed annatto over his entire body (to paint it red). Be ɨrɨre yia jaijui. “Now, who will be a jaijui?” asked the Creator. Jana igueca ne baya jaijui. “Me,” a man replied. Yia iji. The creator then placed a small bichibi (gourd) into the man’s throat. Bichibi t'tecacui. Then, the creator rubbed annatto over his entire body (to paint it red). Be ɨrɨre yia jaijui. “Now, who will be a jaijui?” asked the Creator. Jana igueca ne baya jaijui. “Me,” a man replied. Yia iji. The creator then placed a small bichibi (gourd) into the man’s throat. Bichibi t'tecacui. Then, the creator rubbed annatto over his entire body (to paint it red). Be ɨrɨre yia jaijui.

This traditional Maijuna story carries natural history information and traditional ecological knowledge, revealing cultural ties in a way you’ve never been taught. But it is so easy to learn in the forest—so easy to follow this blend of symbolism, story, salience, subsistence, and sustainability. It doesn’t surprise you to learn that primates, one of the most hunted taxa regionally (Parry and Pares, 2015), are not sold commercially in Sucusari, creating a locally relevant practice that is embedded both in conservation plans and cosmology. Sebastián elaborates, as you arrive at your destination—the home of the common woolly monkey, which is targeted by hunters most often during a specific time of year when these primates are fattened from eating seasonal fruits. In the past, it was ritually eaten to celebrate the yearly harvest and as an offering in courtship. Victorino adds to the conversation, describing red howlers as sorcerers and night monkeys (iti, Aotus vociferans) as demons who eat hunters (Roncal et al., 2018). He also shares his Maijuna name—Name Bao, meaning red titi monkey (Wingfield and Gilmore, 2019). These primate species are eaten with gratitude, care, and in silence out of respect for their power. You look to the treetops in reverence, thinking about these creatures, thinking about this forest in all her prowess and agency. Here, a hunter must use an intense awareness to conform to this forest in humility and

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1 A black dye is made from the fruit, Genipa Americana. This is why woolly monkeys have black faces, according to Maijuna tradition (Roncal et al., 2018).

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<table>
<thead>
<tr>
<th>Kingdom: Animalia</th>
<th>Culturally Significant Primate Species in Sucusari Village</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum: Chordata</td>
<td>Scientific Name</td>
</tr>
<tr>
<td>Class: Mammalia</td>
<td>Máihiki Name</td>
</tr>
<tr>
<td>Order: Primates</td>
<td>Bao</td>
</tr>
</tbody>
</table>

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Photo credit: Mark Bowler
deference. He must learn to be still, to go undetected, to be mindful of how these creatures perceive him, if he is to be granted permission to harvest them. He must be absorbed into the patterns of the forest—to not be in nature, but of nature (Pilgrim and Pretty, 2010).

View sample footage here from 2016 when the Maijuna partnered with researchers Mark Bowler (San Diego Zoo Global) and Michael Gilmore (George Mason University) to track recovering mammal populations, using arboreal camera traps, a revolutionary method to monitor global biodiversity (Bowler et al., 2016). A related *ethnoprimate* study interviewed community members to understand how cultural values might inform conservation initiatives (Roncal et al., 2018).

11. Using the figure to the right, describe how the investigation described above was designed.

12. Using the table below, interpret the abbreviated results and discuss their implications (For the cultural salience ranking, 1 is the highest).

<table>
<thead>
<tr>
<th>Primate Common Name</th>
<th># Camera Detections</th>
<th>Cultural Salience Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Bowler et al. 2016</td>
<td>Roncal et al. 2018</td>
</tr>
<tr>
<td>Red howler</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Woolly</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Titi spp.</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Common squirrel monkey</td>
<td>63</td>
<td>1</td>
</tr>
<tr>
<td>White-fronted capuchin</td>
<td>32</td>
<td>7</td>
</tr>
<tr>
<td>Pygmy marmoset</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Black-mantled tamarin</td>
<td>28</td>
<td>5</td>
</tr>
<tr>
<td>Night monkey</td>
<td>26</td>
<td>8</td>
</tr>
<tr>
<td>Saki monkey</td>
<td>73</td>
<td>2</td>
</tr>
</tbody>
</table>

13. A statistical analysis revealed that *arboreal* mammal populations in the Sucusari are considered low, potentially showing the legacy of poaching during the time period of logging in the river basin. Animal occupancy was lowest for large-bodied primates that were frequently hunted and at sites closest to the village (Bowler et al., 2016). How might these patterns affect the Maijuna’s cultural traditions, including the rituals described earlier?

Part 5: Bloated clouds release the afternoon rains, as your pathway quickly becomes a stream. The whole forest swells, “speaking a language unique to this forest...in big syllables, phonemes unlike the clipped rain of most other landmasses” (Haskell, 2020). Just as the chatter subsides, interrupted only by droplets rolling down drip-tipped leaves, you reach your last stop. Without the sun glistening on slicked ground, you might have missed any discernable distinction in this habitat. Sebastián defines the area for you, pointing to the rolling slope jutting into a depressed bowl now filled with soupy mud, heating
up as the sun penetrates the canopy. This is an ono bɨtuada or mineral lick (see photo below. Credit Brian Griffiths), called Yao Uti Tuada that is well-known for tapir visits and named after an ancestor who hunted here (Wingfield and Gilmore, 2019).

Victorino has known this mineral lick for over 50 years. When he hunts here, he sets up his hammock at night and waits. “I came and listened here,” he says. Sebastián shares that there are over 80 such mineral licks dotted throughout the Sucusari River basin, many of which are named by the Maijuna after people, plants, and animals (Gilmore, 2005). Hunters spend about a third of their effort at these sites, where nearly 20 different species visit, making them diversity hotspots (Blake et al., 2011). Many herbivores and frugivores come to the licks to consume soil (termed geophagy).

Geophagy has garnered many different hypotheses including alleviating digestive issues to detoxifying plant compounds. Montenegro (2004) tested an additional hypothesis by comparing mineral lick soil to non-lick soil, which stated: “Hypothesis 1: Soils at natural licks have higher mineral concentration (for one or more minerals) than non-lick soils.” After soil sample analysis, she found that soil pH was higher at mineral licks, in addition to macrominerals, including calcium, magnesium, sodium, and phosphorous.

14. Using the table below, circle the microminerals that were statistically more concentrated at mineral licks (remember a p-value lower than 0.05 is statistically significant).

15. Do these results support or refute the hypothesis above? Justify your response using data.

16. If you were a partner in this research, how would you design a community-based field investigation to monitor game populations at mineral licks, incorporating western science and traditional ecological knowledge perspectives?
As mammal populations have slowly recovered over the last decade, the Maijuna have carefully and collectively managed their hunting practices. The Maijuna hold a monthly community meeting, where everybody speaks, makes decisions together, and thinks about the future. Here, there is a direct link from resource to socially enforced decisions (Vliet et al., 2015). They have agreed to limit how much hunting can be done and how much meat can be sold commercially. If someone goes against these decisions, it is discussed at the monthly meetings and people are held accountable. Sebastián says the last meeting was particularly intense. But he explains that good leadership is about relationships. A good leader is friendly, talks to many different people in his or her community, and shows up at meetings. You immediately see that that style of leadership is equipped to handle intensity. It can respond to change, even rapid change coupled with a complex ecosystem. You wish you could see these meetings in action—to see the Maijuna share their direct knowledge and day-to-day experience; to see them use that feedback to reflect and understand their impacts on the environment; to turn that collective, social learning into adaptive action that loops back again to feed the next meeting (Evans et al., 2020). You imagine how knowledge-practice-belief form a complex that has allowed the Maijuna to recover from disturbance, absorb its stresses and maybe even some day transcend them, creating new opportunities for renewal (Berkes et al., 2000). Sebastián and Victorino interrupt your fly-on-the-wall daydream to mention that their meetings are combined with data collection projects to track the results of their efforts. In partnership with researchers from OnePlanet, George Mason University, and San Diego Zoo Global, they setup camera traps on a grid throughout the river basin and at mineral licks, keep hunting logs, and mount GPS units to their guns.

See camera traps in a Sucusari mineral lick [here](#) and find photos closer to home [here](#).

As you wrap your head around the feedbacks between ecosystem change and locally-crafted management plans (Berkes et al., 2000), another feedback pops into your head—predator and prey. With all this talk about primates and ungulates, you’re curious if large cats visit the licks as well. Sebastián explains that he has never seen any jaguars or ocelots eating soil directly, but he has indeed seen them at these sites!

Carefully examine the camera trap frames taken in the Sucusari (next page), featuring a Brazilian porcupine (*Toto, Coendou prehensilis*) and ocelot (*Leopardus pardalis*). Follow the timeline in the time stamp to imagine this rarely documented scene unfolding (Griffiths, 2020).

17. Write a figure description that explains your observations and uses the photographic evidence provided to evaluate this claim: mineral licks are “hotspots of risk” (Laundré and Hernández, 2010) for prey.

18. Given what you know so far, in what ways are mineral licks a *keystone resource*? Complete the table below to answer each question with yes, no, or unsure. Add notes to justify your responses.

<table>
<thead>
<tr>
<th>Keystone Resource Elements (Peres, 2000)</th>
<th>Y/N</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Use: Do a high number of wildlife and people visit the mineral licks?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Redundancy: Do the mineral licks provide something that is in short supply elsewhere?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Reliability: Are the mineral licks a reliable resource that is available when needed?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Abundance: Is the area occupied by mineral licks small relative to its effect on users?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Now that you have seen these investigations in the Amazon, you’re ready to analyze data closer to home. Visit eMammal’s “browse data” tool [here](#), select a tab at the top (animal activity, diversity, and occupancy are recommended), and follow the steps described.

19. For the information you gathered above, record the following: your research question, results summary, and data implications.

Part 6: On your hike back home, you cross a log over a small ravine and begin to wonder how many of the animals you learned about today passed this very spot. Safely on the other side, Sebastián and Victorino share signs of hope. They’ve seen more tapir tracks, heard more titi monkeys, and have even seen the rare short-eared dogs on camera trap footage. Their hope is held by their culture and by their land that extends deep into the rainforest, far beyond the village to the vast tracks of land that house the headwaters of seven rivers. This
interfluvial area, rarely hunted, creates a refugia for the animals they depend upon (Olh-Schacherer et al., 2007; Peres and Nascimento, 2006). The Maijuna see their ancestral landscape as a mosaic of protection and use, source and sink, replenishment and harvest (Robinson and Bennett, 2000). Taken as a whole, stewardship emerges.

20. Which of the following stewardship strategies have you seen evidence for in this case study? Select the top three approaches and explain how each was used by the Maijuna (Chapin et al., 2009).
   a) Foster biological, economic, and cultural diversity
   b) Foster social learning from multiple cultural and disciplinary perspectives
   c) Experimentation and innovation through adaptive co-management
   d) Facilitate dialogue and knowledge co-production by multiple groups
   e) Adapt governance to changing conditions
   f) Provide an environment for leadership to emerge and for trust to develop
   g) Specify rights through formal and informal institutions that recognize needs for communities to pursue livelihoods and well-being
   h) Foster social networking that bridges communication and builds accountability among existing organizations

The boat ride back to the village gives you reprieve from the thick forest air and a moment to reflect on your short journey. Prior to today you thought bushmeat hunting around the world had the reputation for being unsustainable, leading to the empty forests that the Maijuna have sadly experienced firsthand. You had always thought of this as a binary problem of maximum sustainable yield with a straight line between hunter and hunted. That is not what you saw today. The Maijuna showed you that such a model is not equipped to capture the complex socio-ecological system of subsistence livelihoods. Sustainability hinges not only on biological components related to species density, reproductive rates, and lifespans. These elements are interwoven with social components that go well beyond “the take.” Today, no one mentioned fences, fines, or fortresses. Today, no one mentioned resiliency but that is in fact what you saw. This resiliency is not about a single choice but about the process of decision making surrounding that choice, a process that champions participation toward collective action. In the system you saw in action today, diversity greases the wheels. Diversity goes far beyond the biological to include diverse stakeholders, representing diverse perspectives on diverse issues from human well-being to multiple knowledge systems. Altogether, this resilient system captures the Maijuna’s socio-ecological capacity to respond and adapt to change, rather than control it (Vliet et al., 2015). Sustaining this system requires stewards to live in the forest and understand the landscape in all its dimensions (Robinson and Bennett, 2000), as Jorge, Sebastián, and Victorino showed you in many intricate ways today.

21. Consider the visual representation of the socio-ecological hunting system below (Vliet et al., 2015). Review this case study to label each spoke of the three components. Add more spokes as needed.
Part 7: Why wait to get involved and contribute to helping monitor flora and fauna around the world? All you have to do is observe! iNaturalist crowdsources the job and shares findings with the Global Biodiversity Information Facility. The map below is a representation of all species occurrence data, half of which is from citizen scientists like you (CODATA, 2020). From a rare bird to a roadside weed, every entry counts.

- Create an account here or ask your teacher for group log-in information.
- Watch this how-to video.
- Post 10 plants, animals, or fungi to your account and watch your activity feed as other naturalists confirm your identifications.
- Click on the species name on the top header to find out more about each species. You’ll find graphs, maps, and background information, including conservation status.

22. Making references to your iNaturalist field experience and website research, answer these questions:
   a. What are the three most salient points you can take away?

   b. What are two things you would do “tomorrow” with the information you learned?

   c. What is one question you have remaining (Whitman and Kelleher, 2016)?
Conclusion: You finish the day outside Jorge’s home again with his daughter peering out the window. Sebastián pulls out a small black notebook where he has prepared his closing remarks. “Things are better now that we are in control. This is important to us. We are the owners and caretakers. We make these plans so our children’s children will have food. I hope that in 20 years our community will have better lives and better health.” Victorino shakes everyone’s hands and Sebastián even gives you a hug.

23. To conclude this case study, please finish with these final reflection prompts by completing the sentences:
   a. I used to think…
   b. Now I think…
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Thank you to the Maijuna community for allowing me to share their story with you in this way. Thank you also to OnePlanet and the Morpho Institute, led by Christa Dillabaugh, for facilitating the workshops mentioned in the case study through the Inquiry, Conservation, & Sustainability in the Amazon teacher and student program. And especially to Dr. Michael Gilmore and Elizabeth Benson from OnePlanet for their leadership and dedication to community-based biocultural conservation.

References


CODATA: The Committee on Data of the International Science Council (2020). Pfeiffenberger, H & Uhlier, P. Twenty-Year Review of GBIF.


Photo credits: Mark Bowler, Phil Kahler, Michelle Watkins, Jessica Bennett, and Kelly Keena.

Answer key: Most questions allow for open-ended student responses. Notes on specific questions are provided here:
11: Bowler et al., 2016: “42 camera traps, spaced 2 km apart, in the canopy of the Maijuna-Kichwa Regional Conservation Area, Peru and walked 2014 km of diurnal line transects on 22 trails at the same site.”

12: Students may notice that the 1st and 2nd most salient species had the highest camera detections, whereas the least salient species had the fewest. The pattern breaks down beyond that. There are multiple explanations for this, including animal size. Although neither study looked at the relationship between salience and occupancy, this section is designed to prompt a discussion about how cultural significance relates to populations trends. Roncal et al. 2018 writes: “Salience of biological organisms is shaped by the degree of interactions between people and those organisms and could be reflected by its cultural importance and/or its abundance in the environment. In this study, large body size, sociocultural importance, and higher abundance of certain primate species could be critical factors determining cultural salience.”

13: Roncal et al. 2018: “The Maijuna in the Sucusari community are currently undergoing rapid loss of their traditional beliefs; thus, taboos against red howler monkey hunting are weakening and have almost disappeared (only two elder Maijuna men mentioned it during this study). Cultural taboos associated with red howler monkeys are an important tool to counteract the effects of subsistence hunting, which could lead to unsustainable harvest yields on howler populations.” Declines in biodiversity can coincide with declines in traditional ecological knowledge, as species can lose their cultural relevance with fewer interactions.

14: Montenegro 2004: “Among microminerals, Cu, S and B were more concentrated in the licks.”

15: Montenegro 2004: The hypothesis is supported. “Overall, our results indicate that natural licks represent a source of minerals for wildlife in the Yavari-Miri River valley. Whether animals use licks for one or more minerals would depend on the mineral concentration of their food and their potential needs for specific elements, which probably varies across species.”

17: Griffiths et al., 2020: “Adult porcupine (Coendou prehensilis) can be seen drinking water at the lick while a male ocelot (Leopardus pardalis) looks on; c-d) Ocelot walks along a lot to approach the porcupine from the left; e-f) Ocelot pounces on the back of the porcupine, biting behind the head; g-i) Ocelot drags porcupine onto log and twists its neck. The ocelot stalked the porcupine for over 1 min while the porcupine was drinking water in the mineral lick and readjusted its position before pouncing on the porcupine and dragging it out of the water. Over 7 min pass between when the ocelot pounced and when it dragged the porcupine from the water; presumably, it was killing the porcupine in the mineral lick during this time. It is likely that the camera did not sense movement for 7 min because the camera was located behind and slightly above a fallen log and the mud in the lick was quite deep. While the ocelot is stalking the porcupine, it does not have any mud on its fur. When the ocelot pounced, dragging the porcupine into the mud behind the log, both animals were likely hidden from view of the camera. When the ocelot pulls the porcupine onto the log, both animals are covered in mud.”

18: Students should be able to find evidence for all items on the list.

20: Vliet et al., 2015: “In the context of hunting, the ecological system includes prey species, the ecosystems that support them, and the ecological processes and interactions between prey, their territories and resources, and the different components of the ecosystems in which they live (Fig. 1). The social component of the hunting system corresponds to the hunters, their behavior and choices in relation to their families, the rest of the trade chain and the formal or traditional institutions that regulate their activities, and different interactions and feedback loops between those stakeholders.”