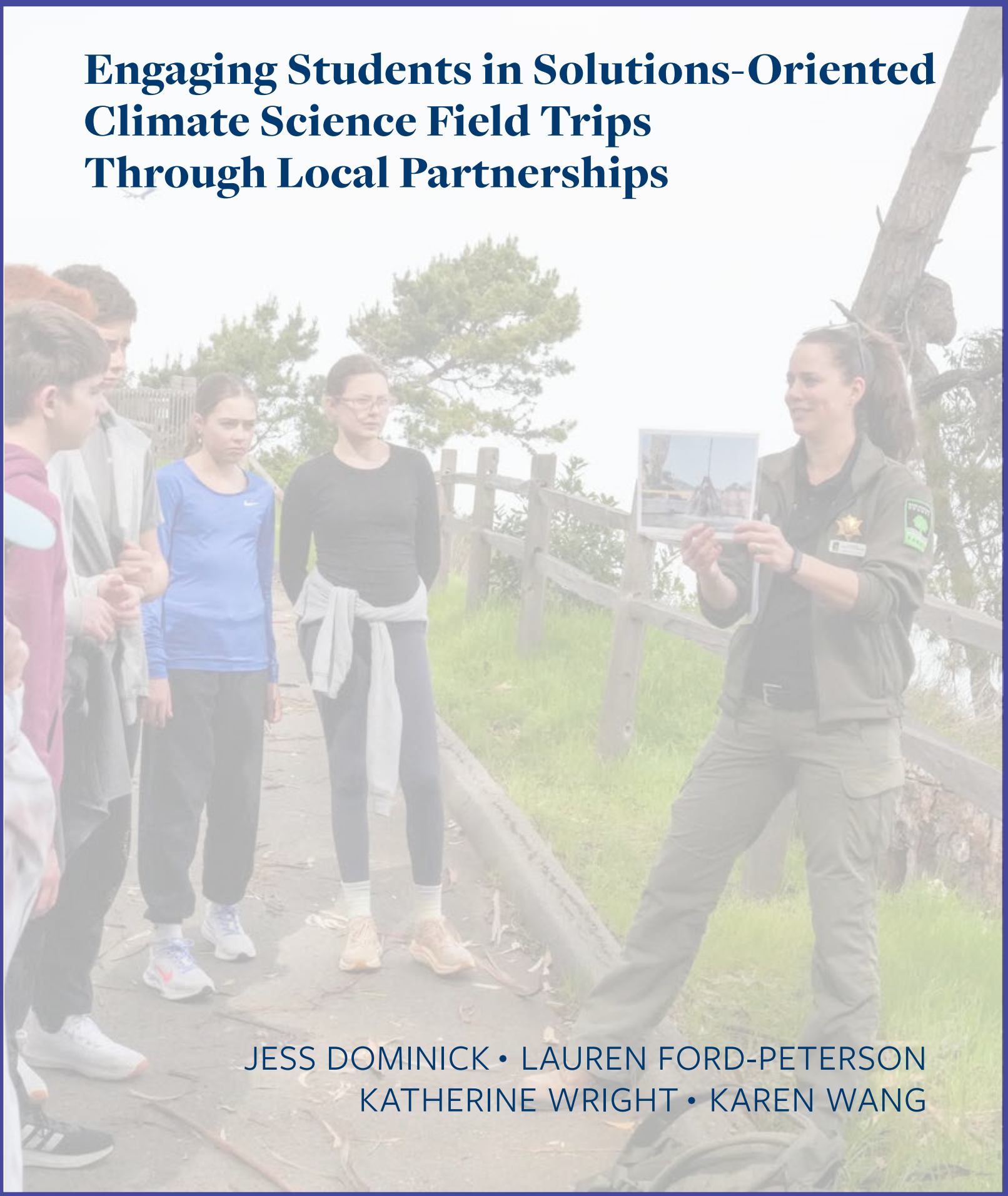
Engaging Students in Solutions-Oriented Climate Science Field Trips Through Local Partnerships



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INTRODUCTION

Youth climate change programming in parks and natural spaces offers a compelling, solutions-focused approach to addressing local impacts and should be championed by park and open space managers, educators, and community partners. By combining climate change education with hands-on experiences in nature, the San Mateo County Youth Exploring Climate Science (YECS) program exemplifies how parks and open spaces can inspire and empower the next generation to confront local climate challenges.

Youth across the country are already experiencing the effects of climate change—wildfire smoke, shifting seasonal patterns, extreme weather events, and more. These changes heighten the risk of climate anxiety, grief, and hopelessness, with research linking these emotions to long-term mental health disorders like PTSD (post-traumatic stress disorder) and depression (Gislason et al. 2021; Hickmann et al. 2021). The San Mateo County YECS program can be adapted to local parks and natural areas undergoing varying climate change impacts to actively connect students with their environment, present tangible solutions to local climate issues, and inspire meaningful action.

BACKGROUND

Located in the San Francisco Bay Area in California, San Mateo County lies between the Pacific Ocean to the west and the San Francisco Bay to the east. San Mateo County's 53 miles of bay shoreline are at risk from sea level rise, threatening urban centers, while its 60 miles of coastline face erosion hazards that heavily affect rural communities (County of San Mateo 2018). Studies conducted by the county reveal significant vulnerabilities, with flooding and erosion expected to affect at least 34 schools under mid-level sea level rise scenarios (County of San Mateo 2018). It is estimated that over 85% of wetlands in the San Francisco Bay Area have already been destroyed or developed, and it's projected that even more will be devastated by sea level rise in the future (Association of Bay Area Governments 2023). Additionally, wildfires, extreme heat, flooding, and landslides are also climate change risks that have impacted students through school closures, poor air quality, power outages, and evacuations.

Coyote Point Recreation Area is managed by the San Mateo County Parks Department and is a popular destination that attracts more than 500,000 visitors annually. Located on the San Francisco Bay, Coyote Point features a rocky peninsula of 149 acres that includes picnic areas, three playgrounds, trails, a gravel beach, and fishing spots. The recreation area also includes 538 water acres that offer opportunities for windsurfing, sailing, and kayaking. Historically, Coyote Point Recreation Area was an island surrounded by salt marsh. Shell mound remains found in the area indicate that local Indigenous people, such as members of the Ohlone Tribes, did use the site, although there has been no evidence of a village site. Around 1850, the land was privately purchased, and the marsh was filled to create pastureland. In addition to the filling of marshland, the bay was also dredged to allow for the shipping of goods.

Coyote Point Recreation Area in San Mateo County, California, is situated along the San Francisco Bay shoreline, featuring stunning views and various recreational opportunities. SAN MATEO COUNTY SUSTAINABILITY DEPARTMENT

OVERLEAF **San Mateo County Parks Department staff lead guided hikes for students around Coyote Point, sharing the history of the park and discussing how the park can be more resilient in the face of sea level rise and climate change.** SAN MATEO COUNTY SUSTAINABILITY DEPARTMENT

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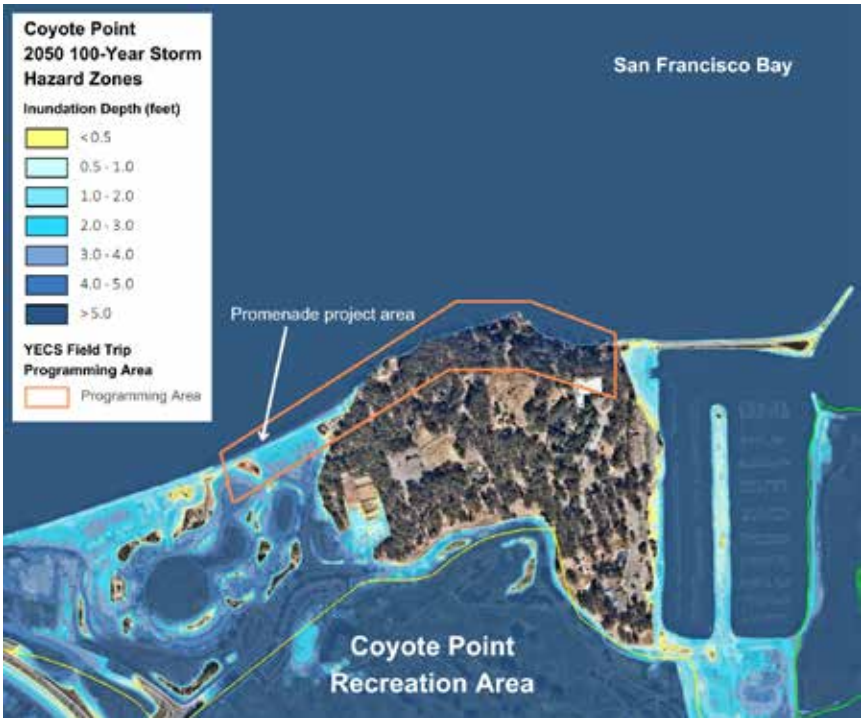
Today, Coyote Point's windy, salty environment supports distinctive stands of eucalyptus and Monterey cypress. Remnant salt marsh, a beach promenade, a marina, and the breakwater provide habitat for numerous native shorebirds and songbirds.

The YECS program aims to connect students with the local environment at Coyote Point to highlight local histories and educate them about climate impacts, both present and future. Coyote Point has already experienced impacts of sea level rise, including bluff erosion, the degradation of the beach area, and infrastructure damage from high storm surges during winter months. Modeling predicts that Coyote Point will be heavily impacted by rising sea levels, which contribute to dangerous storm surges that could inundate the park severely. In 2022, a new beach promenade was constructed to adapt to the future impacts of sea level rise on the park. The promenade acts as a natural barrier to sea level rise, with a new beach area that was raised 12 feet due to the addition of more than 10,000 tons of sand. Other adaptations include the relocation of the parking lot further inland and the addition of new sea walls to protect the park against flooding at high tides or during storm surges. This location provides a unique opportunity for students to witness adaptation examples first-hand, while learning about local climate change impacts. By linking science, history, and hands-on learning, YECS programming empowers students to envision a sustainable and resilient future in their own communities.

PROGRAM DETAILS

YECS field trips provide a multi-faceted learning experience centered on climate change and local adaptation strategies for students in 7th through 12th grade across San Mateo County. The program begins with a 20-minute pre-recorded video lesson that introduces key concepts, including sea level rise, mitigation, and adaptation. Students are shown this video during their class time approximately 1–2 weeks before the scheduled field trip and teachers lead students in a discussion relating to the video. Embedded within the video are three comprehension and reflection questions that ask students about the topic of sea level rise, climate change impacts, and adaptation strategies. Teachers are supplied with worksheets to guide classroom discussions, ensuring students arrive on site with foundational knowledge about climate change impacts and sea level rise projections. Additionally, the video lesson touches on multiple Next Generation Science Standards relating to climate science, human impact on nature, and engineering principles relating to solutions. Across the different age ranges, there are five middle school standards and seven high school standards that are discussed at various points throughout both the video lesson and the trip (Table 1).



By 2050, the hazards posed by 100-year storm surges could be devastating to Coyote Point. The park regularly faces impacts from storms and flooding, but with climate change models indicated multiple feet of sea level rise in the next few decades, Coyote Point is at major risk of intense and highly hazardous flooding. YECS field trips look at the park from this perspective, assessing solutions and adaptation strategies such as a sea wall built in the Promenade area. SAN MATEO COUNTY

The field trips to Coyote Point are scheduled to last two hours, with at least one teacher or chaperone required for every 15 high schoolers and one for every 10 middle schoolers. During the trips, two to four parks department and one to two San Mateo County Sustainability Department staff are on site and engaging with students. Field trips are scheduled between the months of February and November and are canceled when there is inclement weather.

At Coyote Point, the program's structure maximizes engagement and active learning. Students are divided into two groups: Group A first participates in a guided hike with Parks Department staff, while Group B engages in an activity with Sustainability Department staff. Dividing students into smaller groups enhances

TABLE 1. Next Generation Science Standards (five middle school, seven high school) that are discussed at various points throughout both the video lesson and the Coyote Point trip. Adapted from: National Academies of Sciences, Engineering, and Medicine. 2012. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Washington, DC: The National Academies Press. https://doi.org/10.17226/13165

Content code (DCI)	Content descriptor	Related question(s) that guide(s) instruction	MS	HS
ETS1.B	Developing Possible Solutions	What is the process for developing potential design solutions?	X	X
ETS1.C	Optimizing the Design Solution	How can the various proposed design solutions be compared and improved?		X
ETS2.B	Influence of Engineering, Technology, and Science on Society and the Natural World	How do science, engineering, and the technologies that result from them affect the ways in which people live? How do they affect the natural world?	X	X
ESS2.D	Weather and Climate	What regulates weather and climate?	X	X
ESS3.B	Natural Hazards	How do natural hazards affect individuals and societies?		X
ESS3.C	Human Impacts on Earth Systems	How do humans change the planet?	X	X
ESS3.D	Global Climate Change	How do people model and predict the effects of human activities on Earth's climate?	X	X

engagement and requires fewer staff members to ensure safe and effective learning conditions. Teachers and chaperones are also split up to accompany the groups and help YECS staff with monitoring on the hike and during lunch.

Guided Hike

The guided hike portion of the field trip first leads Group A students on a one-mile hike around Coyote Point Recreation Area with multiple scenic stops. At the different stops, park staff lead discussions with students that explore the following topics.

San Mateo County Parks Department staff lead guided hikes for students around Coyote Point, sharing the history of the park and discussing how the park can be more resilient in the face of sea level rise and climate change. SAN MATEO COUNTY SUSTAINABILITY DEPARTMENT

Stop 1—Beach promenade

At the first stop, students gather at the new beach promenade with views of the San Francisco Bay. The promenade is the site of the newly constructed sea wall and beach fortification project at Coyote Point.

Discussion Prompt: *Who can tell me what causes sea level rise? What causes warmer ocean temperatures?*

- Review foundational climate change knowledge referenced during the pre-trip video lesson.

Stop 2—Merchant Marine Memorial overlook

At the second stop, students gather at a north-facing overlook where they can see the San Francisco Bay, part of the city of San Francisco, the San Francisco International Airport, and other infrastructure located around the bay. At this stop, park staff lead a discussion about the historical context of Coyote Point and nearby landmarks. This stop sets the stage for understanding the area's transformation over time and how sea level rise can easily affect these low-lying areas.

Discussion Prompt: *What happened in this area in the 1800s that you think may have contributed to large-scale development of marshland around the Bay?*

- The California Gold Rush brought tens of thousands more people to the San Francisco Bay in a matter of years. This magnified the need for more space to support the development of infrastructure for the quickly growing population.
- Swamp Land Acts were bills passed by Congress that encouraged development and settlement on wet and inundated areas. Marshlands around the bay were reclaimed and developed.

Parks Department staff teach students about the history of Coyote Point on a YECS trip. SAN MATEO COUNTY SUSTAINABILITY DEPARTMENT

Question: *How have humans altered the area where Coyote Point is located?*

- The history of Coyote Point shows evidence of land use by Indigenous Ohlone people and the misuse and degradation by private developers over time.
- San Francisco International Airport shows a familiar history of building infrastructure on reclaimed wetlands that are now facing challenges due to sea level rise.

Stop 3—Overlook above the Coyote Point Marina and the shoreline area

At the third stop, students look at the Coyote Point Marina and the neighboring shoreline area. Park staff point out the features of the marina and discuss the process of dredging the area to remove sediment.

Discussion Prompt: *Does anyone know the process of how marshland is naturally made? What might be the role of marshlands in combating sea level rise?*

- Wetlands naturally build up over time to buffer against rising tides.
- The natural buildup of wetlands can't keep up with the rising sea levels.
- Share examples of local agencies working towards restoring and preserving wetlands.

Stop 4—Overlook above the promenade and beach area

At the overlook above the promenade and beach area students discuss measures to adapt to sea level rise. Students see first-hand solutions such as the raised beach promenade, relocated parking areas, and new sea walls—all adaptations designed to mitigate sea level rise impacts. Students then discuss solutions within the county and local communities, such as restoring wetlands, building sea walls, and doing large-scale shoreline protection projects, like relocating vulnerable infrastructure inland.

Discussion Prompt: *What kind of engineered solutions can be built to address sea level rise? Have you seen any of these solutions in your own life?*

- Look for the mix of adaptation measures implemented both at Coyote Point and across San Mateo County to

combat the impacts of sea level rise, including wetland restoration and sea wall construction.

Stop 5—Hike conclusion at beach promenade

At the conclusion of the one-mile hike, students return to the beach promenade for a final discussion about ways they can work towards making a difference in the face of climate change.

Discussion Prompt: *What actions can you take to combat climate change and ensure that our community is resilient to the impacts of climate change?*

- Biking or using public transportation, because transportation is the largest source of greenhouse gas emissions in the area.
- Staying informed about and supporting policy changes that can contribute to climate mitigation and adaptation.
- Getting involved in youth climate groups in the local community.

Facilitated Activities

Meanwhile, Group B participates in facilitated activities with Sustainability Department staff to deepen their understanding of sea level rise and solutions in San Mateo County. Middle school students mainly learn about climate change impacts and engineering strategies, while high school students engage in discussion about environmental justice and community resilience.

Card Sorting Game

Students categorize cards featuring images of hard and soft engineering strategies, discussing the pros and cons of approaches such as sea walls versus habitat restoration in San Mateo County and beyond. Discussing these strategies for protecting and adapting communities to the impacts of climate change helps students see solutions across their community, whether they see a levee in their town or visit any of the existing wetlands that are protected across the county.

Discussion Prompt: *Which strategies can or should be implemented in San Mateo County? What are the pros and cons of the various strategies?*

- Hard-engineered strategies include the construction of physical barriers such as sea walls, levees, and tide gates.
- Soft-engineered strategies such as habitat restoration and wetland rehabilitation are crucial across the county, as well.
- While some strategies are expensive, increasing resilience and adapting the shorelines and surrounding areas will ultimately prepare the community at Coyote Point and in San Mateo County to face the impacts of climate change.

On YECS field trips, middle school students work on a card sorting activity that asks them to identify and categorize sea level rise adaptation strategies relating to soft and hard engineering.
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Environmental Justice Mapping

High school groups examine maps showing overlaps between vulnerable communities and projected sea level rise, fostering discussions about equity and climate resilience. Discussing vulnerable communities in the context of potential sea level rise impacts increases students' understanding of the interconnectedness of social and environmental issues and encourages students to expand their perspectives. Many parts of San Mateo County are socially vulnerable to rising sea levels, and students on YECS trips discuss the overlap in hazards present in these communities. Solutions-oriented discussions approach environmental justice in this context to help students consider the dual impact of sea level rise on their own local community and the rest of San Mateo County.

Discussion Prompt: *What does vulnerability mean to you? What is a "vulnerable community"?*

- In this context communities are identified as being vulnerable where high instances of at least three of the following social vulnerability indicators exist: the presence of young and elderly people, people of color, and non-English speakers; housing and transportation cost burden; low homeownership levels, household income, and educational attainment; and transit dependence.

On YECS field trips, high school students discuss the overlap between vulnerable communities and sea level rise projections in order to assess the risks and resilience of communities across San Mateo County. Blue areas on the map represent projected sea level rise, while orange zones represent vulnerable communities.
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Why should local governments, organizations, and community members consider vulnerability and climate change together?

- Vulnerability indicators may affect the abilities of residents to prepare for, respond to, and recover from the impacts of climate change.
- Local governments have a duty to care for the entire community and can prioritize those with highest need or at highest risk for programming, resources, and research into potential climate change impacts.
- Local organizations and community members can coordinate community events, emergency-preparedness meetings, and other local initiatives to connect neighborhoods, towns, and regions.

Reflection and Solutions

Students brainstorm adaptation strategies for their own communities, encouraging critical thinking and solution-oriented discussions. These reflections help students synthesize what they've learned throughout the YECS trip with a forward-thinking approach to climate action.

Discussion Prompt: *What are some things you and your community can do to combat climate change?*

- YECS staff share with students the importance of local community engagement, including opportunities to volunteer and reminders to participate civically.

Each activity session includes unstructured time for students to explore the sandy beach or other natural areas, fostering a personal connection to the environment. Observations and student reflections indicate that these unscripted moments are highly impactful, allowing students to relax and absorb their surroundings. For some students, it's the first time they've touched the water of the bay or held seaweed in their hands. In any environmental education program, providing these opportunities for connection are crucial and deeply important to the student experience.

After the 40-minute hike or activity session, Group A and B switch roles, ensuring all students experience both components. This rotation structure maintains engagement while maximizing learning opportunities.

Middle school students on a YECS field trip consider engineered solutions to sea level rise impacts across San Mateo County. SAN MATEO COUNTY SUSTAINABILITY DEPARTMENT

YECS Wildfire and Biodiversity Field Trips

Though the issue of sea level rise is one of the most pressing that San Mateo County will face in the coming decades, the structure of YECS field trips is also used to explore other climate impacts, such as on wildfires and biodiversity. In a different type of YECS field trip, students are brought to a forested San Mateo County Park, Huddart Park, and introduced to fire fuel reduction work to limit risk from future wildfires.

Different forestry techniques are introduced, and through facilitated discussions, students are asked to weigh in on what they think needs to happen moving forward with forest management to respond to increasing risk of drought and wildfire. This hike was created in response to the August 2020 CZU Lightning Complex Fire that swept through the Santa Cruz Mountains destroying structures and burning thousands of acres of forest, including parts of Butano State Park and San Mateo County's Pescadero Creek Park, and much of California's oldest state park, Big Basin Redwoods. The wildfire burned fast and hot, fueled by over 100 years of understory vegetation build-up, and hot, dry temperatures. This natural disaster changed local perspectives about climate risk and resilience and led San Mateo County Parks to shift how it stewards its open spaces.

In 2021, San Mateo County Parks' first Forest Health Work project took place at Huddart Park to reduce wildfire danger to the neighboring community. Work was concentrated along park boundaries, fire roads, and residential roads. San Mateo County's Parks Interpretive Division and San Mateo County's Sustainability Department saw a teaching opportunity and started a partnership that offered guided wildfire hikes focused on the effects of climate change and the benefits provided by fuel reduction work.

YECS field trips are also offered for students to learn about the effects of climate change on biodiversity. Student groups are guided on hikes throughout local parks to learn about native versus invasive species, natural adaptations, and ecosystem services. Engaging students in their local parks connects them deeply to their surroundings and encourages them to form connections to the organisms that are often overlooked around them. These trips increase students' understanding of the impact of human interactions on local ecosystems and consider ecosystem resilience from the perspective of community members, local government agencies, and conservation organizations.

REPLICABILITY

The YECS program model can be adapted for other regions and climate challenges, focusing on three key elements.

1. Experiential, place-based learning

Experiential, place-based learning is essential because it allows students to directly connect with their environment, fostering a deeper understanding of climate challenges and solutions. Field trips offer a hands-on and memorable way to engage students by immersing them in local sites that are directly experiencing the impacts of climate change. For San Mateo County, the impact is primarily sea level rise. However, for other educators looking to replicate this program, look for the local impacts that can be visually seen or experienced. Possible impacts could be from stronger tornados or hurricanes, increased fire severity, flooding, loss of biodiversity, or drought.

2. On-site impacts and solutions

What does six feet of sea level rise look like? During the YECS field trip, students are shown projected models of future sea-level rise in the exact location they're standing, along with models of the larger San Francisco Bay Area. Students are asked to identify important features on the landscape that would be impacted by increasing sea levels, including major highways, shipping ports, airports, homes, businesses, wetland habitats, and more. The students are introduced to local solutions at Coyote Point Recreation Area, including soft and hard engineering, and to other local projects. Students are asked to think about what solutions they might come up with for other important areas that will need protection in the future.

The ever-increasing threat of climate change on our ecosystems, infrastructure, and communities can be a distressing theme for many students, but by teaching them about adaptation and mitigation strategies, environmental educators can empower and inspire hope. The key is to find a location that has a clear, visual representation of the impacts and begin a discussion with the students about the potential solutions. During this discussion, it is important to weigh the pros and cons and help students understand that there might not be a one-size-fits-all solution for the various impacts locally or globally.

3. Collaborative Partnerships

Effective partnerships are critical to success. In San Mateo County, the Parks Department provides site-specific expertise, while the Sustainability Department contextualizes broader regional strategies. Replicating programs elsewhere will require similarly aligned partnerships between local government, environmental organizations, and schools to provide a comprehensive and place-based curriculum. Teachers are also crucial partners in sharing YECS information, as they must integrate the video lesson and discussion curriculum into their own course schedule. Aligning the trips with their lesson plans allows for the curriculum to be seamlessly integrated into topics already discussed in the classroom.

By leveraging these three key elements, regions facing diverse climate impacts can develop localized and meaningful educational experiences to inspire future generations.

CHALLENGES AND CONSIDERATIONS

While YECS has proven successful, several challenges persist:

1. **Access and Equity**
   Transportation costs and time spent on coordination can limit the ability of schools to participate in outdoor field trips. San Mateo County currently provides no-cost transportation options for schools and handles transportation logistics for teachers, greatly increasing access to outdoor education field trips for schools with fewer resources. Seeking funding for similar outdoor education programs is key to reducing disparities in the ability of schools to be able to access meaningful environmental education trips. YECS trips are also offered at no cost to teachers, as the staff time is covered by Parks and Sustainability Department staff members.
2. **Capacity Limitations**
   Demand for field trips often exceeds program availability due to capacity limits on Parks and Sustainability Department staff. Increasing educator capacity is essential to meet the growing demand, particularly as states like California move to require climate change science in schools (California Department of Education 2024). Park staff provide interpretive and educational programming across San Mateo County, and the Sustainability Department has one staff member and one full-time fellowship position working on climate change education and outreach initiatives across the county. Neither department has a staff member working full-time on the YECS program, so there are varying capacity limits for staff based on seasons and other programming needs.
3. **Language Barriers**
   Currently, YECS trips are only offered in English. In San Mateo County, Spanish and Mandarin/Cantonese are the next most spoken languages, and 20.7% of students in the county are English language learners (Ed-Data, n.d.). To increase accessibility, programs should con-

sider multilingual materials and staffing to expand the educational experiences offered to all students.

Despite these hurdles, YECS and other programs offering similar field trips can inspire hope and agency in the face of climate change if educators and organizations can prioritize the importance of place-based and solutions-oriented conversations.

CONCLUSION

The Youth Exploring Climate Science program exemplifies how place-based environmental education can address the pressing challenges of climate change while inspiring and empowering students. By combining experiential learning, on-site exploration of climate impacts, and discussions of actionable solutions, YECS fosters a deeper understanding of both local and global issues. Through partnerships between local agencies, organizations, and schools, this model creates a pathway for students to see themselves as active participants in addressing the climate crisis.

As climate impacts intensify globally, adapting programs like YECS to different regions can empower future generations to build resilience and drive meaningful change. Programs like YECS demonstrate how connecting youth with nature, addressing local challenges, and exploring actionable solutions can empower them to build a sustainable and resilient future.

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Students on a YECS trip, February 2025. SAN MATEO COUNTY SUSTAINABILITY DEPARTMENT

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