Chapter 16
Embracing Nature, Meaningful Experiences for Teaching and Learning Endeavors: Lessons from the Northern Gulf of California

Paloma A. Valdivia-Jiménez, Peggy Turk-Boyer, Nélida Barajas-Acosta, Christine Flanagan, Debra Colodner, and Angeles Y. Sánchez-Cruz

16.1 Introduction

The CEDO Intercultural Center for the Study of Deserts and Oceans (CEDO) is an active conservation, research, and education center that has been informing, inspiring, and empowering stewards of the Northern and Upper Gulf of California for more than 43 years. CEDO is a unique collaboration between Mexican and U.S. not-for-profit organizations inspired by a shared vision, mission, and development of strategic programs that pool resources to offer realistic environmental and community-based solutions to tackle local and regional problems. Motivated by recognition and respect, its operations have drawn inspiration from the cultural, socio-economic, and biological interconnections between the U.S. and Mexico.

Since CEDO first opened its doors in 1980, Outdoor Environmental Education (OEE) has been a key element in achieving its evolving mission to foster vibrant communities and resilient ecosystems in the Northern-Upper Gulf of California and the Sonoran Desert by integrating people, knowledge, and solutions.

Located in the extraordinary natural region where the Sonoran Desert meets the Sea of Cortez, CEDO has provided first-hand experiences in nature to different audiences and guided them to appreciate its beauty, understand its importance, increase respect, and use nature in sustainable ways.

P. A. Valdivia-Jiménez (✉) · P. Turk-Boyer · N. Barajas-Acosta · C. Flanagan
A. Y. Sánchez-Cruz
CEDO Intercultural Center for the Study of Deserts and Oceans (CEDO), Puerto Peñasco, Sonora, Mexico
e-mail: paloma@cedo.org

D. Colodner
Arizona-Sonora Desert Museum, Tucson, AZ, USA

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The outstanding biodiversity has been the perfect setting for a long tradition of OEE where fishing, tourism, research, education, and its complex nexus frame the scenario for the long tradition and deep results of CEDO's work presented in this chapter.

We invite you to explore these lessons learned in more than four decades of work and the long-lasting results achieved under the biocultural and binational environments where CEDO works.

16.2 The Northern Gulf of California: The Perfect Setting for Outdoor Education

The Gulf of California in northwestern Mexico, also known as the Sea of Cortez, is considered one of the five most productive and biodiverse marine ecosystems on the planet; it is recognized worldwide for its biological richness, its large number of endemics, the productivity of its waters and its scenic beauty (Aburto-Oropeza & López-Sagástegui, 2006).

The Northern Gulf of California is a distinct biogeographic zone extending from the Colorado River Delta to the midriff islands. It is known for its shallow waters and physically extreme conditions including tidal range, salinity, and water temperatures (Brusca et al., 2005). Year-round upwelling replenishes surface nutrients and stimulates high productivity (Alvarez-Borrego & Lara-Lara, 1991). Over 15% of Mexico's fishery production historically came from the Northern Gulf of California (Cudney-Bueno & Turk-Boyer, 1998).

Nearly half of the species diversity in the entire Gulf of California is found in the Northern region (Brusca et al., 2005), its great variety of coastal and marine habitats providing important breeding, spawning, and nursery places for many commercial and non-commercial species. Its waters are home to endemic and endangered species such as the vaquita marina (*Phocoena sinus*), a small porpoise that today is considered the most imperiled marine cetacean in the world, and the totoaba (*Totoaba macdonaldi*), a fish which has been illegally exploited by unregulated, non-selective fishing methods that are also the main threat to the vaquita porpoise (Rojas-Bracho & Taylor, 1999).

The coastal landscape is characterized by negative estuaries with vast tidal wetlands, intertidal and subtidal beach rock, basalt and granite platform reefs, and sandy beaches (Turk-Boyer et al., 2014a). Offshore, the San Jorge Island archipelago is one of the most important California sea lion rookeries (Szteren et al., 2006) and an important nesting place for marine birds. Populations of cetaceans and other pelagic megafauna such as great white sharks, whale sharks and sea turtles have found favorable conditions to live here. Scientific studies on species distribution, trophic ecology (food webs), and connectivity (larval dispersal) have helped to define a unique corridor ecosystem along the Sonora coast from Puerto Peñasco to Puerto Lobos (Fig. 16.1) (Intercultural Center for the Study of Deserts and Oceans, 2019).

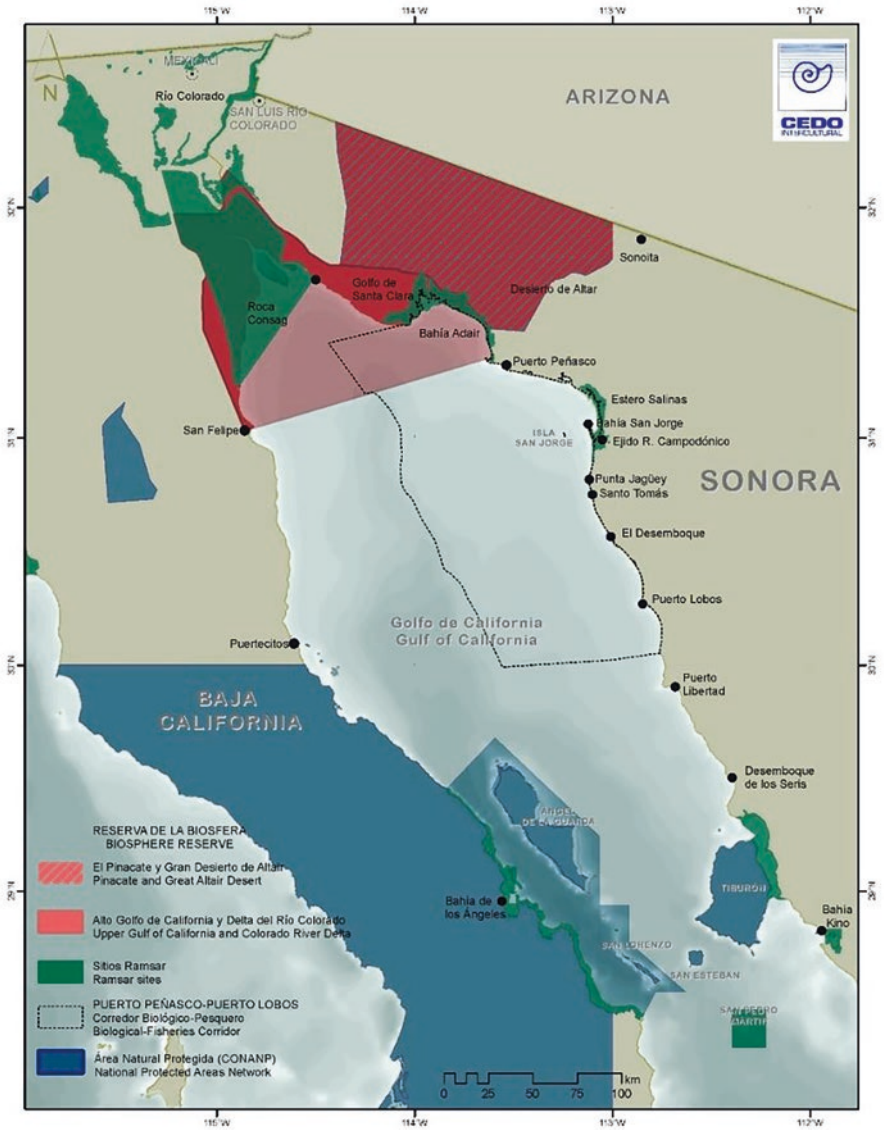


Fig. 16.1 Map of the scope of work of CEDO, which shows the ecoregions of the Northern Gulf of California and the Sonoran Desert, including the Natural Protected Areas, wetlands protected under the Ramsar Convention, and coastal communities. (Credit: CEDO Archives)

The Northern Gulf of California is also the marine gateway to the Sonoran Desert, the most diverse desert in North America (Narro & Gibert, 2014). Species such as the pronghorn antelope (*Antilocapra americana sonorensis*), the flat-tailed horned lizard (*Phrynosoma mcalli*), and the desert pupfish (*Cyprinodon eremus*) are found here, as are the sand dunes of the Gran Desierto de Altar, the extensive fields of columnar cactus and xerophytic scrubs, the volcanic region of El Pinacate and its riparian zones. This desert is tri-national, shared by Mexico, the United States of America (U.S.), and the Tohono O'odham Nation as well as other indigenous communities such as the Cucapá and Comcáac.

The richness of the Northern Gulf of California region has been recognized by the establishment of three Natural Protected Areas under the Mexican legal framework: The Upper Gulf of California and Colorado River Delta Biosphere Reserve and The Pinacate and Gran Desierto de Altar Biosphere Reserve, both decreed in 1993, and The Gulf of California Islands Flora and Fauna Protection Area, established in 1978. These protected areas are also recognized globally under the United Nations Man and the Biosphere Program and are considered World Natural and Cultural Heritage Sites by UNESCO. The area boasts Ramsar sites amongst them including Bahía Adair (site 1866),[1] Bahía San Jorge (site 1983),[2] and Agua Dulce (site 1813).[3]

16.3 The CEDO Intercultural Center for the Study of Deserts and Oceans: An Epicenter for Outdoor Education in the Northern Gulf of California

CEDO owns and operates an environmental resource center in Puerto Peñasco, Sonora and a liaison office in Tucson AZ. The campus includes a biological field station to host visiting classes and researchers, a thermally efficient "Earthship" with a library and a multi-use room, a visitor center with a gift shop, a Sonoran Desert botanical garden, two desert fish ponds for endemic freshwater fish of the Sonoyta river, and other educational exhibits including the first skeleton of a vaquita marina and our iconic fin whale skeleton that landmarks our campus (Fig. 16.2).

Field research and education for academic groups were among the first activities of the organization. Over time, the field station programs expanded to offer other OEE activities such as regional school programs, nature tourism, and hands-on citizen science projects to a variety of publics. CEDO also helped establish and develop management programs and environmental education components for the natural protected areas in the region.

[1] https://rsis.ramsar.org/es/ris/1866

[2] https://rsis.ramsar.org/es/ris/1983

[3] https://rsis.ramsar.org/es/ris/1813

Fig. 16.2 CEDO Campus at Puerto Peñasco, Sonora, Mexico. (Credit: Donovan Noriega)

Fig. 16.3 Bahía San Jorge Community Center and School of the Sea, at Ejido Rodolfo Campodónico, Caborca, Sonora, Mexico. (Credit: CEDO Archives)

Nowadays, CEDO is in the process of consolidating agreements to expand our work into local communities. As an example, in 2021, with the full participation of Ejido Rodolfo Campodónico and the Penmont Mining Company, we established the Bahía San Jorge Community Center and School of the Sea, providing a classroom with internet services and installing solar cookers and dehydrators, a community garden, and implemented a brand new program to provide clean water to the community of the Ejido (Fig. 16.3).

CEDO recognizes education as a fundamental tool for transforming people and society; its programs for coastal communities of the Northern Gulf are focused on building a culture of stewardship for people whose livelihoods are directly linked

to the sea. For children and youth, the programs are focused on sharing knowledge and appreciation of local ecosystems and analyzing ecosystem threats to search for solutions. CEDO's programming also includes capacity building, resource monitoring, conservation and management activities, as well as labor skills certification.

OEE uses an intersectional approach that supports our primary "Nature-based solutions" strategy that states that all the solutions for societal challenges can be found in nature where knowledgeable, experienced, nature-connected people are the change agents that support and act for nature, and people (https://nature-forall.global/home/).

During its long and diverse career in OEE, CEDO won Mexico's National Award for Environmental Education in 2009 and, in 2010, the Human Diversity Award for Field Science by the Organization for Biological Field Stations. However, our biggest accomplishment is the solid and deep relationships we have with the local coastal communities, authorities, and institutions.

Our goals and audiences have evolved and nowadays OEE activities are included in three areas: *Field Science Education, Conservation Education, and Citizen Science for Sustainable Management*. In this chapter, we present some of CEDO's most relevant OEE results in these areas.

16.4 Field Science Education

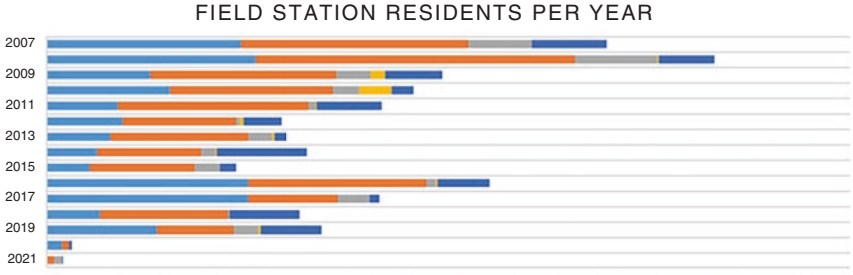
16.4.1 CEDO as a Field Station and Promoter of Field Academic Education

CEDO has continued a long tradition of field-based marine and desert science serving students and researchers from across the U.S. and Mexico in Puerto Peñasco, Sonora. Following a program initiated by the University of Arizona (UA) in the 1960s, CEDO continued as a field station at a new facility with a new direction beginning in 1980. By providing a place to spend the night and facilities to conduct research and education as well as key education and research programs, CEDO advanced in the understanding of the biogeophysical, ecological, and socioeconomic processes impacting the Northern Gulf of California.

CEDO's dramatic setting, supportive facilities, and inspiring OEE programs drew in professors and successive cohorts of students, numbering in the thousands. The many "academic lineages" associated with CEDO, students who became researchers who then brought their own students, speak to the power of seminal experiences in a natural setting (Fig. 16.4).

From the 1980s to date, CEDO's field station and education center received more than 175 institutions and organized groups with an average of 810 people per year, peaking in 1999 with 2378 residents. Between 2001 and 2021, the number of annual residents shifted dramatically due to different factors from the

Fig. 16.4 Researchers from Sonora, Arizona and California at CEDO's field station in the 1980s. Left to right: Susana Bojorquez Yensen, Nick Yensen, Rick Brusca, Lloyd Findley and CEDO Director Peggy Turk (1980–2019). (Credit: CEDO Archives)



	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
K-12	0	23	164	79	301	301	65	76	95	113	106	184	155	312	290
College	11	10	115	191	134	266	156	154	206	170	285	244	277	477	340
Researchers	12	0	36	3	47	14	37	21	35	4	11	39	52	123	94
Long-term	0	0	4	0	0	2	0	2	4	7	1	48	21	3	0
Non Academic	2	5	91	104	15	78	24	136	18	57	98	33	86	82	112

Fig. 16.5 CEDO's field station residents per category from 2007 to 2021. Data are shown as the number of residents per year

events of 9/11 to the global economic crisis of 2008, travel insecurity in Mexico, to the SARS-CoV-2 pandemic, which interrupted travel and economies on a global scale. Figure 16.5 shows field station behavior by resident category from 2007 to 2021.

In addition to residential academic programs, CEDO has also conducted a number of outreach programs with field education and participatory components for local communities, including a series of mini-courses in marine mammals, intertidal ecology, meteorology and recently adding other social science programs geared towards sustainable community development.

Despite the external factors affecting CEDO's visits, the field station has served students and researchers from Mexico and the U.S. for more than four decades. We look forward to continuing to introduce students, researchers and local communities to field experiences and to meet the challenges of adapting to climate change, water scarcity, and other challenges at the national and international levels mainly under a sustainable development approach.

16.4.2 NaturArte by CEDO: Ecotourism Experiences

NaturArte by CEDO was created to diversify local economies by connecting the day to day activities of the communities with residents and visitors while raising intercultural and environmental awareness and OEE.

NaturArte is positioned to respond to three market-driven dynamics: the demand by tourist groups seeking outdoor activities with CEDO, the rise of mass tourism in the region in a relatively short time causing increased pressures on the environment, and the need of the people of the community (direct users of natural resources) to diversify their economic activities.

In the beginning, NaturArte focused primarily on strengthening small oyster farming businesses in the estuaries of the Northern Gulf of California, particularly in the Morúa Estuary. The high scenic value has driven urban and tourism developments, marinas, and shrimp farms. Oyster cooperatives were trained to strengthen their businesses by improving infrastructure and customer service in their seaside restaurants, accessing local markets, learning business management practices, developing their English proficiency, and creating new ecotourism products. A successful example of these efforts is the "Cooperativa Única de Mujeres del Mar" where CEDO partnered with other organizations and the College of Fine Arts of the University of Arizona to improve the "El Barco" restaurant facilities by building a kitchen and a "palapa" and incorporating nature elements in their building to become a permanent exhibit for the biodiversity of the estuary for the more than 1000 visitors who come to the restaurant every year (Fig. 16.6). With the "Punta Roja Cooperative", CEDO developed the OEE "Oyster Experience" where interested people work as oyster farmers for a day to learn oyster biology, the hard work needed to bring a plate to their tables, and the stories behind the ladies in charge of the oyster farm and restaurant. A final activity is tasting the fruits of their labor (Fig. 16.7).

CEDO's ecotourism experiences have evolved and nowadays NaturArte offers 11 eco-adventures, including visiting the tidepools and the Pinacate craters–dunes–desert, San Jorge Island, and enjoying a set of experiences in the estuaries. All these experiences are now recognized as OEE programs (Fig. 16.8).

Fig. 16.6 Educational mural at El Barco Restaurant of the Cooperativa Única de Mujeres at Estero Morúa. (Credit: CEDO Archives)

Fig. 16.7 Oyster experience ecotour with Punta Roja Cooperative. (Credit: CEDO Archives)

From 2009 to 2021, CEDO conducted an average of 28 eco-adventure events per year, with an average of 145.2 total participants per year. In general, the tidepool explorations and kayaking in an estuary are the most popular OEE ecotourism experiences.

In 2007, the Universidad del Valle de México (UVM), in collaboration with the International Youth Foundation and the Sylvan/Laureate Foundation, awarded NaturArte the UVM award for "one of the best social impact projects", and in 2021 the Fundación Yves Rocher awarded the oyster farming project with the Tierra de Mujeres Prize.

Fig. 16.8 NaturArte eco-adventures catalog. (Credit: CEDO Archives)

16.5 Conservation Education

As conservation issues moved to the forefront of environmental concerns in the 90s, resulting in the establishment of the Upper Gulf and Pinacate Biosphere Reserves, CEDO began to intensify its community outreach education and involvement in conservation initiatives in Puerto Peñasco and other communities of the region. These initiatives ranged from community-wide participation in clean-up activities to multi-year programs for school children. From 1992 to 1994, the 41 schools of the Upper Gulf Reserve's three communities were taken to the field and participated in learning about vaquita, totoaba, and the Upper Gulf ecosystem. An evaluation of these programs highlighted the need for teacher training, and in 1998–1999 CEDO responded with a comprehensive, field-based training program and classroom curriculum for 75 teachers from the Reserve.

In this millennium, as conservation issues became more complex and heated, CEDO once again began to deliver programs directly to school children. We realized that the passion, experience, and commitment of CEDO's staff had a profound impact on inspiring the region's youth to meet new challenges. The contents and structure of these OEE programs were based on environmental problems identified, conservation needs, and survey input from teachers in these communities. The objectives were to share information on basic ecological concepts, increase appreciation, enjoyment, and respect for nature through direct experiences, and shape behavior by promoting responsible stewardship and shaping environmental spokespersons for the communities. Here we delve into a few of the programs with the most impact.

16.5.1 Youth Towards a Sustainable Northern Gulf of California

From 2005 to 2010, this environmental education program implemented by CEDO involved about 1000 fifth graders per year in 9 coastal communities in the state of Sonora (Turk-Boyer et al. 2014b). The program comprised a one-day session at CEDO's field station and one-day interpretive field excursion in a local wetland. Activities highlighted the concept of fishery management and action that could promote sustainable yield. Other activities focused on conserving wetlands as a means of promoting broad benefits to the human and other living inhabitants of the region (Fig. 16.9).

Fig. 16.9 Youth learning about the biodiversity, ecology, and environmental services of wetlands in the Northern Gulf of California. (Credit: Pia Mijares-Mastretta)

The short-term and long-term changes in perceptions, attitudes, and knowledge of the student participants were evaluated using surveys and The Environment Questionnaire (TEQ)[4] designed by Johnson and Manoli (2008). In addition to measuring knowledge, this questionnaire evaluates two dimensions of perceptions towards the environment: the "Preservation" (biocentric) and "Utilization" (anthropocentric) of values toward nature, which are subdivided into different factors (Table 16.1).

The study results show that this OEE program had an immediate and positive impact on the 5th graders with medium-term durability. Immediately after their participation in the OEE program, they had a significant increase ($p \leq 0.05$) in two of the TEQ Preservation environment perception factors: the intent to support and care for resources. Long-term changes in participants of the OEE program showed that they were less in favor of nature alteration (TEQ Utilization environment perception factor) ($p \leq 0.05$) than non-participants. In terms of knowledge acquired, children increased their correct answers in a survey by 48.7% after participating in the program, and two months later there was only a slight decrease of 2.3% (Fig. 16.10).

The first-hand experiences in nature have been one of the most important factors that sensitized students and increased their sense of place; 26.6% of the OEE participants considered the Morúa estuary (one of the local wetlands they explored) one of the most important places in the region to preserve (Fig. 16.11). Students also consider wetlands as places that make their communities unique and special and one

[4]The Environment Questionnaire was used with permission from the Earth Education Research and Evaluation Team from the College of Education at the University of Arizona.

Table 16.1 Perceptions towards the environment as measured by The Environment Questionnaire (TEQ)

Component	Factor	Sample item
Preservation	Intent of support	If I ever have extra money, I will give some to help protect nature.
	Care of resources	I always turn off the light when I do not need it anymore.
Utilization	Enjoyment of nature	I would love to visit an oasis in the desert to see birds flying
	Altering nature	Weeds should be killed because they take up space from plants we need.
	Human domination	People are supposed to rule over the rest of nature

Modified from Johnson and Manoli (2008)

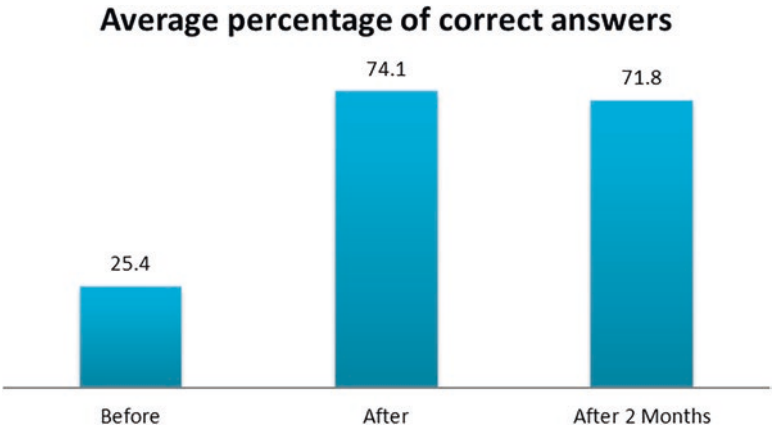


Fig. 16.10 Average percentage of correct answers for 5th graders in a knowledge test that was applied to them before (n = 373), immediately after (n = 331) and two months after (n = 291) their participation in the Youth Towards a Sustainable Northern Gulf OEE program

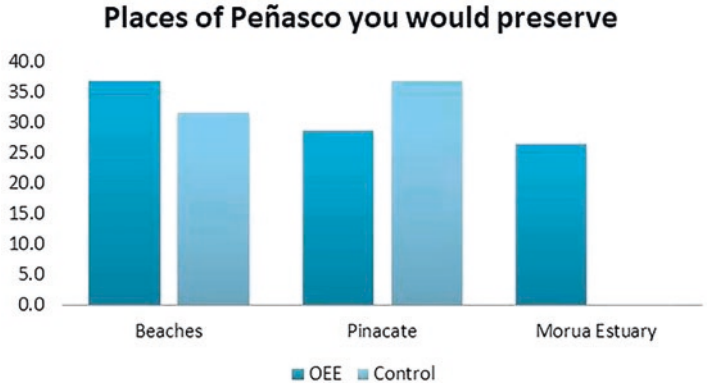


Fig. 16.11 Main places in Puerto Peñasco that youth from 11 to 16 years old would preserve. The data is shown in percentage. OEE = students participating in Youth Towards a Sustainable Northern Gulf OEE program (n = 49), Control = students who did not participate in the program (n = 19)

of their favorite places to visit in their free time. The wetlands are places known and visited by the community; however, the youth who explored them together with CEDO appreciate them on a different dimension and they cite the destruction of the estuaries and overfishing as some of the main problems facing their communities. Both issues were addressed in the "Youth Towards a Sustainable Northern Gulf" OEE program.

16.5.2 The Environmental Contest

CEDO's Environmental Contest was one of our most successful tools for involving youth in learning about their surroundings and helping maintain a healthy environment by solving local problems (Turk-Boyer et al., 2014b). These contests began in 1994 in Puerto Peñasco and in 2011 expanded to other communities in Sonora and Baja California.

The Environmental Contest was run for 22 years focusing on locally relevant environmental themes and the participation of students and teachers from different school levels. Participants, organized in teams, were trained to follow specific rules to guide them to do their own field research about the environment and the issues at hand, design solutions based on their findings, and then take action to raise awareness in their communities. In the early years, contests were focused on urban issues, and teams got involved in cleaning up trash, recycling, and similar activities. In later years, the contests became more sophisticated and focused on raising awareness about and offering protection for the region's natural resources: wetlands, rocky reefs, migratory birds, and sustainable fisheries, and tackling climate change (Table 16.2).

As an example, in the 2008 contest, "Exploring Between Tides and Rocks", students researched the diversity and abundance of organisms that inhabit the intertidal rocky reefs, described their condition, and evaluated potential threats such as solid waste disposal and specimen collection for aquariums and for making shell handcrafts (Fig. 16.12). In the 2009 contest "Flying to the End", student teams conducted a bird census in wetlands and beaches to learn about migratory birds that come to the region and evaluate threats such as loud music during holidays and off-road vehicles that crush nests in the coastal dunes. In the 2016 to 2019 contests "Fishing for the Future", students took field data of important fisheries in their communities and interviewed fishermen to identify the main fisheries problems such as unregulated fishing, overfishing, and incidental capture of other species that are impacting the ecosystem.

Some very interesting solutions emerged. One year, the students petitioned the municipal government to take care of least tern nesting sites. One group of students held a meeting with fishermen in their community (many who were their own parents!) to get them to stop overfishing and to follow the law. Other students conducted a massive ghost fishing gear clean up (underwater remains of abandoned traps, nets, and other gear) to stop species bycatch (Fig. 16.13) and others attempted

Table 16.2 Themes of the environmental contests organized by CEDO (1995–2019)

Year	Theme
1994–2000	Clean up and recycling campaigns
2001	Native plant gardens
2002–2003	Organic waste
2004	Cardboard recycling
2006	Sustainable water use
2007	Wetlands conservation
2008	Rocky reefs conservation
2009	Migratory birds conservation
2010	Wetlands and climate change
2011–2012	Sustainable fishing: fisheries improvement
2013	Climate change
2016	Sustainable fishing: ecosystem management
2017	Sustainable fishing: fisheries certification
2019	Sustainable fishing: fishing refuges

Fig. 16.12 Students conducting a research project about intertidal rocky reef invertebrates. (Credit: CEDO Archives)

to design a new flotation device for oyster culture in estuaries to reduce the solid waste problems created by the disintegration of their styrofoam floats.

Students' creativity was unleashed in the awareness campaigns they carried out in their community: they held parades, performed sketches, launched radio campaigns, talks, concerts and even wrote songs! These campaigns were important for raising awareness within the entire community.

Fig. 16.13 Environmental contest participants conducting a ghost trap clean up. (Credit: CEDO Archives)

Awards for contest winners were given in an Environment Festival in which students had a space to present their projects and exchange experiences with public. In an atmosphere of joy and celebration, with cultural events such as concerts, dances and plays (some presented by the participants themselves), the winners received their prizes from a jury and celebrated together their achievements. Student winners were invited to a multi-day field camp where they stayed overnight at CEDO's field station and visited some of the Natural Protected Areas in the region (Fig. 16.14).

What began as a simple contest has evolved into key actions that solve some of the region's environmental problems. Best of all, these solutions have been developed and implemented by local youth who are becoming leaders in their community and stewards of their natural resources. The most important result of this program was the opportunity it created for making community-level social change. The contest facilitated the development of bonding relationships among students, teachers, fishermen, and others in the community, engaging them at large in a collective project towards the responsible use of natural resources.

Fig. 16.14 Environmental Contest winners in a boat trip to the Biosphere Reserve Bahía de los Angeles, Canales de Ballenas y de Salsipuedes. (Credit: CEDO Archives)

16.6 Citizen Science for Sustainable Management

16.6.1 Beach Clean Ups: Promoting Collective Action

To motivate a change in attitude and behavior regarding the generation and disposal of solid waste on the beaches of the Northern Gulf of California, for 20 years, CEDO has joined the International Coastal Cleanup (ICC) initiative promoted by The Ocean Conservancy (https://oceanconservancy.org/) (Fig. 16.15). During these important events, volunteers from around the world organize themselves to remove waste found on the beaches, seabed, estuaries, rivers, and basins to contribute to the beaches' sanitation. Moreover, using the Clean Swell App students are able to classify and quantify the waste collected and share the information on the free access platform TIDES (https://www.coastalcleanupdata.org/), where they can identify the origin of the debris and propose management actions. The collected waste is sorted and the recyclable material is transported to collection centers.

In Puerto Peñasco, CEDO has helped engage local partners and different sectors to collaborate and take ownership of this initiative. Fishermen and divers have joined to carry out underwater cleaning. Some municipal government agencies and the Local Clean Beaches Committee adopted this event and have leveraged it to help certify beaches under the Mexican standard (NOM-AA-120-SCFI-2016) and to

Fig. 16.15 Scout group participating in The International Coastal Clean Up. (Credit: CEDO Archives)

obtain the prestigious Blue Flag distinction. Other communities have also engaged in this initiative and in 2018, the ICC was organized in a coordinated manner throughout the entire Northern Gulf of California region.

Over the years, 6000+ volunteers have participated in these efforts and more than 39,000 kg of waste have been removed from the sea, including pieces of glass, plastic and styrofoam, cigarette butts, bottle caps, plastic bags, plastic bottles, glass bottles, food wrappers, and disposable cups/plates/cutlery, among others.

CEDO plans to continue this collective beach cleanup effort as a means of encouraging citizen and civic participation in actions that help heal the environment and generate information to support specific waste management actions.

16.6.2 Citizen Monitoring: Generating Knowledge and Stewardship

As part of an integrated effort to protect the ecosystems and fishing resources in the region, citizen monitoring programs were established at CEDO early on. With the dual purpose of helping CEDO to generate scientific information as well as to

engage direct users of natural resources in promoting their conservation and responsible use, fishermen, fisherwomen, visiting and local students, and housewives were trained to monitor target species in the main habitats of the region. Efforts to date include long-term monitoring of the rocky intertidal ecosystem, populations of sea lions, least terns, and other migratory birds as well as underwater biodiversity and fisheries catch.

From 2000 to 2005, CEDO conducted two pilot projects to learn how to use this information to implement effective conservation of key habitats and species in the region. One project was conducted with commercial divers who harvest benthic mollusks in offshore rocky reefs. These fishermen participated with CEDO in a comprehensive program, conducting underwater monitoring, learning and sharing information about the natural history of their resources, establishing and monitoring voluntary no-fishing zones, and strengthening their cooperative and financial sustainability as an alternative to the gillnet fishing that ensnares the vaquita porpoise. In 2003, these efforts were recognized with the CONANP (National Commission of Natural Protected Areas) National Conservation Award.

The second project was focused on wetlands conservation and our work with oyster farmers, who engaged in monitoring and capacity building. With these groups, we sought to strengthen their commitment to low impact activities in Estero Morúa while enhancing their income from tourism. This led to the creation of the NaturArte program described above.

We highlight here the Lobos (sea lions) Group, a group of volunteer monitors established in 2013 who are driven by a love of community and the need to conserve their natural environment. This group consists of 12 trained monitors and 52 additional volunteers from Ejido Rodolfo Campodónico. They conduct activities related to the conservation of the California sea lion (*Zalophus californianus*), a sentinel species of San Jorge Island and other conservation actions in adjacent wetlands. In addition to sea lion monitoring, the Lobos Group has been trained by CEDO and specialists from CONANP and organizations such as The Marine Mammal Center (TMMC) (Sausalito, CA), to conduct sea lion disentanglement, eradication of exotic species, monitoring of the human use of the island, and more (Fig. 16.16).

Such has been the impact of this community group that the fisherman Manuel Muñoz Espinoza, the group's leader, won the 2019 Conservation Award granted by the Mexican federal government. Today, the Lobos Group has found a complementary income for their families, as they are hired by different research institutions to monitor various species in the region, including great white sharks, whales, ospreys, and desert fauna.

Following in the footsteps of their parents, 10 youngsters between 12 and 18 years old joined the conservation efforts of the Lobos Group and established the "Manos en Acción" (Hands in Action) youth group. These young people have gained enough experience and mastery of techniques to be incorporated into the community monitoring team (Fig. 16.17). Currently, the Manos en Acción group is being trained as environmental promoters and stewards to foster a positive environmental culture.

Fig. 16.16 California sea lion disentanglement by Lobos Group. (Credit: Abelardo Castillo CEDO)

Fig. 16.17 Least tern monitoring by Manos en Acción Group. (Credit: CEDO Archives)

CEDO looks forward to continuing this collaboration and support groups such as these and expanding their influence to other communities. These groups are key in helping to promote social cohesion, which is essential for conserving their natural resources, fostering responsible use, and adapting to challenges such as climate change.

Fig. 16.18 High school students using the *iNaturalist* App. (Credit: CEDO Archives)

16.6.3 Citizen Science

Starting in 2020, in collaboration with the National Commission on Biodiversity of the Federal Government of Mexico (CONABIO), CEDO has been promoting the use of *iNaturalist* App as a tool for all our OEE activities. *iNaturalist* gathers information from more than 11,971 observers and 7787 scientists with more than 286,290 observations of 6416 species. (https://www.naturalista.mx/projects/desierto-y-oceano-sonora).

This application in combination with other tools developed by CONABIO, for instance, enciclovida, (https://enciclovida.mx/) allow us to generate field guides by taxonomic groups, protected areas, municipalities, and other search criteria, which are then used in all our OEE activities (Fig. 16.18).

16.7 Lessons Learned in 43 Years

CEDO's Outdoor Environmental Education activities have built capacity for environmental stewardship in its broadest sense. From local to global, from the Northern Gulf of California to the oceans of the world, our future depends on nature for solutions to all our societal challenges, from poverty eradication to life below water (Agenda 2030 and Sustainable Development Goals) and other multilateral agreements that interlink nature, society, and the economy worldwide.

CEDO is working to build a core constituency to tackle the overarching challenges faced by coastal and desert communities of the Mexico–U.S. shared borderlands face, including overfishing, pollution, and the disruptions caused by a warming planet that threatens community livelihoods that depend on nature.

Achievements have not been easy or without stumbles, but these have offered important lessons that have enabled us to fine tune CEDO's work to be even more effective over time. Against a backdrop of sweeping political change on both sides of the border, social disruption from illegal activity, limited funding, a general reduction in field science activity in response to the cell and molecular science revolution, and an international pandemic, to name just a few of a host of challenges, CEDO has endured and thrived for more than 43 years.

Throughout CEDO's history, one of the things that mattered most was simply showing up, day after day, year after year, being present, on site, ready to engage, and prepared to work. Such continuity builds trust and positive expectations within the staff, community, and other audiences. While demonstrating that working in remote coastal communities with limited resources is possible and that giving up in the face of adversity is not an option.

Among the lessons learned, we would like to share:

- Persistence and endurance are essential to success; they are fueled by belief in the mission, faith in your ability to achieve it, and the power of the vision to draw you forward.
- Identifying and motivating champions who share your vision and are willing to represent you in places of power and assure continuity of resources for an organization.
- A strong work ethic and dedication at the top to inspire the same throughout the organization.
- Respect for the dignity and rights of all individuals, across ages, genders, nationalities, ethnicities, social classes, and other measures of diversity, human and nonhuman, can carry an organization through difficult times of disagreement, economic hardship, and loss.
- Practice flexibility and adaptation to prepare for the inevitability of change. Learn from mistakes and setbacks.
- Nurture creativity. It can take you around corners and over roadblocks.
- Listen with a closed mouth and an open mind.
- Respect the boundaries of your mission as you seize opportunities and nurture the organization.
- Leading involves pushing and pulling, but mostly getting out of the way.
- Connecting the dots by understanding community needs, educating all the stakeholders of a community from leaders to youth to direct resource users to build momentum and guide action at a deep community level.

With these in mind, seize successful models, apply them to local conditions, and creatively modify them as needed to achieve your goals. CEDO has found this to be a formula for success.

16.8 Conclusions

At CEDO, we believe that successful holistic solutions for complex systems can only spring from a core of community engagement and development. The OEE programs integrated into CEDO conservation strategies have been a powerful tool to achieve this. Through field-based curricula development, environmental contests, beach clean-ups, ecology clubs, summer camps, and more, students, instructors, and local stakeholders such as fisherfolk, oyster farmers, landowners, and others have had the opportunity to have first-hand experiences in key habitats and have gained a deep appreciation and understanding of them.

Focused on increasing participants' scientific understanding of the environment, CEDO's OEE programs instill a sense of place-based identity and empower action. Through the development of educational curricula and summer camps, in addition to the knowledge and appreciation of ecosystems and species, we have introduced tens of thousands of the region's school kids and teachers to relevant topics such as wetlands conservation, sustainable fisheries, and climate change. With CEDO's traditional environmental contests, monitoring programs, and ecosystem management initiatives, they have participated in the study of the region's environmental problems and the design of projects to advance their solution. The OEE programs have been an enriching experience for students, tourists, and stakeholders, giving all an understanding of their environment and the importance of everyone's participation in caring for it.

Empowered by knowledge and an atmosphere of respect, CEDO has built a public environmental literacy framework and promoted examples of collective action for ecosystem management and conservation. The organization looks forward to continuing to train community members and creating an environmentally friendly culture for future generations. CEDO's Northern Gulf of California OEE programs are laying the foundation for a new generation of stewards, making them custodians of their natural resources and spokespeople in their communities.

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