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# Transnational research for coastal wetlands conservation in a Cuba–US setting

Victoria C. Ramenzoni[1], Mark R. Besonen[2], David Yoskowitz[2], Vanessa Vázquez Sánchez[3], Armando Rangel Rivero[3], Patricia González-Díaz[4], Armando Falcón Méndez[5], Daily Borroto Escuela[5], Idania Hernández Ramos[5], Norgis Valentín Hernández López[5] and Larry McKinney[2]

[1]Department of Human Ecology, Rutgers University, The State University of New Jersey, 211 Cook Office Building, 55 Dudley Road, New Brunswick, NJ 08901-8520, USA; [2]Harte Research Institute for Gulf of Mexico Studies, Texas A&M University-Corpus Christi, Corpus Christi, TX 78412, USA; [3]Museo Antropológico Montané, Universidad de La Habana, Havana, Cuba; [4]Centro de Investigaciones Marinas, Universidad de La Habana, Havana, Cuba and [5]Parque Nacional Caguanes, Servicio Nacional de Áreas Protegidas, Sancti Spíritus, Cuba

## Long Form Research Paper

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**Author for correspondence:**
Dr Victoria C. Ramenzoni,
E-mail: victoria.ramenzoni@rutgers.edu

### Non-technical summary

Sharing information between different countries is key for developing sustainable solutions to environmental change. Coastal wetlands in the Gulf of Mexico are suffering significant environmental and human-related threats. Working across national boundaries, this research project brings together scientists, specialists and local communities from Cuba and the USA. While important advances have been made in strengthening collaborations, important obstacles remain in terms of international policy constraints, different institutional and academic cultures and technology. Overcoming these limitations is essential to formulating a comprehensive understanding of the challenges that coastal socioecological systems are facing now and into the future.

### Technical summary

This article presents initial results from an ongoing transnational research collaboration between the USA and Cuba for the conservation of coastal wetlands in Caguanes National Park, Sancti Spíritus, Cuba. It focuses on the first two initial workshops among research scientists from Harte Research Institute for Gulf of Mexico Studies (Texas A&M University-Corpus Christi) and Universidad de La Habana, resource managers from Caguanes National Park and local communities. The main goals of these exchanges were to share knowledge and experiences in the protection of wetlands, to identify current and future environmental threats to these habitats and to develop a common programme of research that might potentially enhance wetland conservation in the larger Gulf region. A comparison between Caguanes and the Laguna Madre ecosystem is made to establish similarities in ecological conditions. As outcomes of the exchanges, participants agreed on a common set of research interests, management priorities and extension activities that will include the active engagement of local communities. The contribution also explores issues about local development, co-production of knowledge and societal transformations in place-based research. The article highlights the complexities of developing a research programme that relies on transnational partnerships that are very sensitive to larger geopolitical configurations.

### Social media summary

Transnational research in Cuba for wetlands conservation shows benefits of collaboration in sustainable solutions.



## 1. Introduction

In July 2015, after more than 50 years of strained bilateral relations, the USA resumed diplomatic ties with Cuba. The announcements were followed by modifications in travel sanctions and the opening of embassies in both countries. The optimism inspired by these changes was short lived, as many of the new policies would be reversed during the Trump Administration. However, this brief period of interaction, coupled with more relaxed license requirements related to educational and research exchanges, created an unprecedented opportunity for US-based scientists to engage with Cuban counterparts. While tourism activities in Cuba remain prohibited for American citizens and anyone subjected to US federal jurisdiction, the thawing of relationships between both countries has favoured a rapid increase in visits

to the island (Guttman, 2016; Lieberman, 2017). This surge in the demand for recreational services has produced significant pressures on natural habitats (García *et al.*, 2015; Salazar, 2016). In order to anticipate and mitigate impacts, the government has begun a process of reviewing environmental policies and regulations on protected areas. Much remains to be done for wetlands, coastal lagoons and marine habitats that, excluded in the past, have become hotspots for tourism. In this article, we describe an initiative of transnational scientific collaboration between both countries for the protection of coastal wetlands and explore the main lessons drawn from these efforts.

In 2017, a team of researchers from the Harte Research Institute for Gulf of Mexico Studies at Texas A&M University-Corpus Christi, Montané Anthropological Museum and the Center for Marine Research, both at Universidad de La Habana, joined specialists from Caguanes National Park (CNP) and local community members from La Picadora and Yaguajay, Sancti Spíritus, in two 3-day-long workshops. The park sits south of Florida and the Old Bahama Channel, a few hundred kilometres off the south-eastern border of the Gulf of Mexico Large Marine Ecosystem (Yáñez-Arancibia & Day, 2004). Due to its unique geographical position, it constitutes an important corridor for the migration of biodiversity between the Gulf and the Caribbean seas. It is also a sentinel location for anticipating, comparing and understanding a wide range of impacts associated with environmental and anthropogenic stressors on coastal and marine habitats. Threats such as progressive climatic aridification and exposure to extreme events are already affecting the CNP as well as other wetland ecosystems in the Gulf (Dahl & Stedman, 2013; Day *et al.*, 2013). In fact, important similarities can be established between the hypersaline conditions predominating in the CNP and the Laguna Madre system in southern USA and northern Mexico. These similarities enable the transfer of study findings and management strategies across sites (Figure 1). With that goal in mind, the main purposes of these collaborative exchanges were to share knowledge and experiences, to identify current and future environmental threats to biological and human communities in these locations and to develop a common programme of research that might directly enhance coastal wetland conservation in the region at large.

Connected by the currents of the Gulf of Mexico, Cuba, Mexico and the USA are reciprocally impacted by their coastal management and conservation practices (McKinney, 2017b). Because of these interdependencies, the development of successful responses to pressing socioecological issues in the Gulf needs to build on the complementarity of research efforts in a way that can overcome knowledge fragmentation and chart a unified course of action (Cundill *et al.*, 2015; Roman, 2018). Many of the challenges that threaten wetlands in Cuba (e.g., diminished freshwater inflow into bays, increasing extreme events such as rapidly intensifying hurricanes, extreme precipitation and drought events) or that the country may face in the future (e.g., fishing pressure, sea-level rise, extreme salinization) are issues that US and Mexican scientists have been working on for a number of years across coastal environments of the Gulf. Conversely, the way in which Cuba has proposed to tackle the long-term impacts of climate change through state-led programmes such as *Tarea Vida*, how it has effectively and promptly responded to extreme events (e.g., preparedness, mitigation and recovery) and how it has developed participatory grass-root solutions to address sustainability in a holistic approach are some among the many lessons that can be transferred to a wider Gulf scenario.

Transnational studies represent the scientific collaboration of different partners towards the attainment of a common goal. Defined as a complementary effort across multiple countries, transnational research rests on the creation of a network that can facilitate the circulation of knowledge, people and practices (Tripodi & Potocky-Tripodi, 2006; Turchetti *et al.*, 2012). This type of collaboration can offer unique insights for the sustainable management and restoration of threatened ecosystems that is essential for the creation of new knowledge (Iaria *et al.*, 2018; Stamm & Figueroa, 2012). Through coordinated yet comparative place-based studies, a cooperative transnational approach can foster a synoptic understanding of the cross-scale dynamics that characterize socioecological systems (Balvanera, Calderón-Contreras *et al.*, 2017; Castro *et al.*, 2018; Massey, 2005). Furthermore, as points of intersection of the global and the local, transnational projects that build on processes of knowledge co-construction may lead to the joint development of long-term regional solutions (Cundill *et al.*, 2015; Mateos & Suáraz, 2016).

Despite its many contributions, transnational research is not devoid of conflict (Balvanera, Daw *et al.*, 2017; Barahona, 2015; Cundill *et al.*, 2015; Pohl, 2008; Walker, 2012). Tensions can originate in the sociopolitical contexts in which practice occurs and when different agendas and interests intersect. These conflicts, if left unresolved, can result in significant impediments to the sharing of financial, institutional and educational resources (Moyi Okwaro & Geissler, 2015; Munung *et al.*, 2017; Walker, 2012; Wang, 2010). Most importantly, issues may also emerge in the translation of findings, in the formulation of a common vision and in the maintenance of dialogue (Caniglia *et al.*, 2017; Martin & Griffiths, 2012; Moyi Okwaro & Geissler, 2015). In order to understand the origins of these obstacles to collaboration, transnational research needs to be placed within broader debates about transdisciplinary knowledge production, stakeholders' participation and sustainability in socioecological transformations (Fazey *et al.*, 2018a, 2018b; Hegger & Dieperink, 2015). Within this context, transdisciplinary practices not only require working at the interfaces of different value systems, institutional cultures and epistemologies of power, but also require the ability to anticipate possible outcomes among a growing number of stressors as societies plan for their future (Iwaniec *et al.*, 2020; Kopp *et al.*, 2019; Sharpe *et al.*, 2016). Their success may rely on being able to balance different rates of change over a long time horizon, a process that necessarily builds, at the international level, on continuous dialogue and collaboration across different governance structures (Fröcklin *et al.*, 2018; Stamm & Figueroa, 2012).

Like many other international initiatives, most Cuba–US scientific collaborations exhibit a long history of persistence, but also of fragmentation (Anthes *et al.*, 2014; Fink *et al.*, 2014; Pastrana, 2015; Pastrana & Clegg, 2008; Roman, 2018). Few of these projects have translated to concrete actions given the many challenges to sustaining cooperation over changing political and economic scenarios. In the next few sections, we explore some of the advantages and obstacles that result from research collaborations between both countries. Comparing this particular case study to other efforts in the region, we contextualize the initial challenges and benefits. The findings are of unusual value given the limited availability of information regarding the recovery of endangered wetland ecosystems in Cuba as well as the coastal restoration methods that are being used. As a testament to its importance, the project has been included in Cuba's Sixth National Report on the Convention of Biological Biodiversity as part of goal number 1 of the Aichi Biodiversity Targets.

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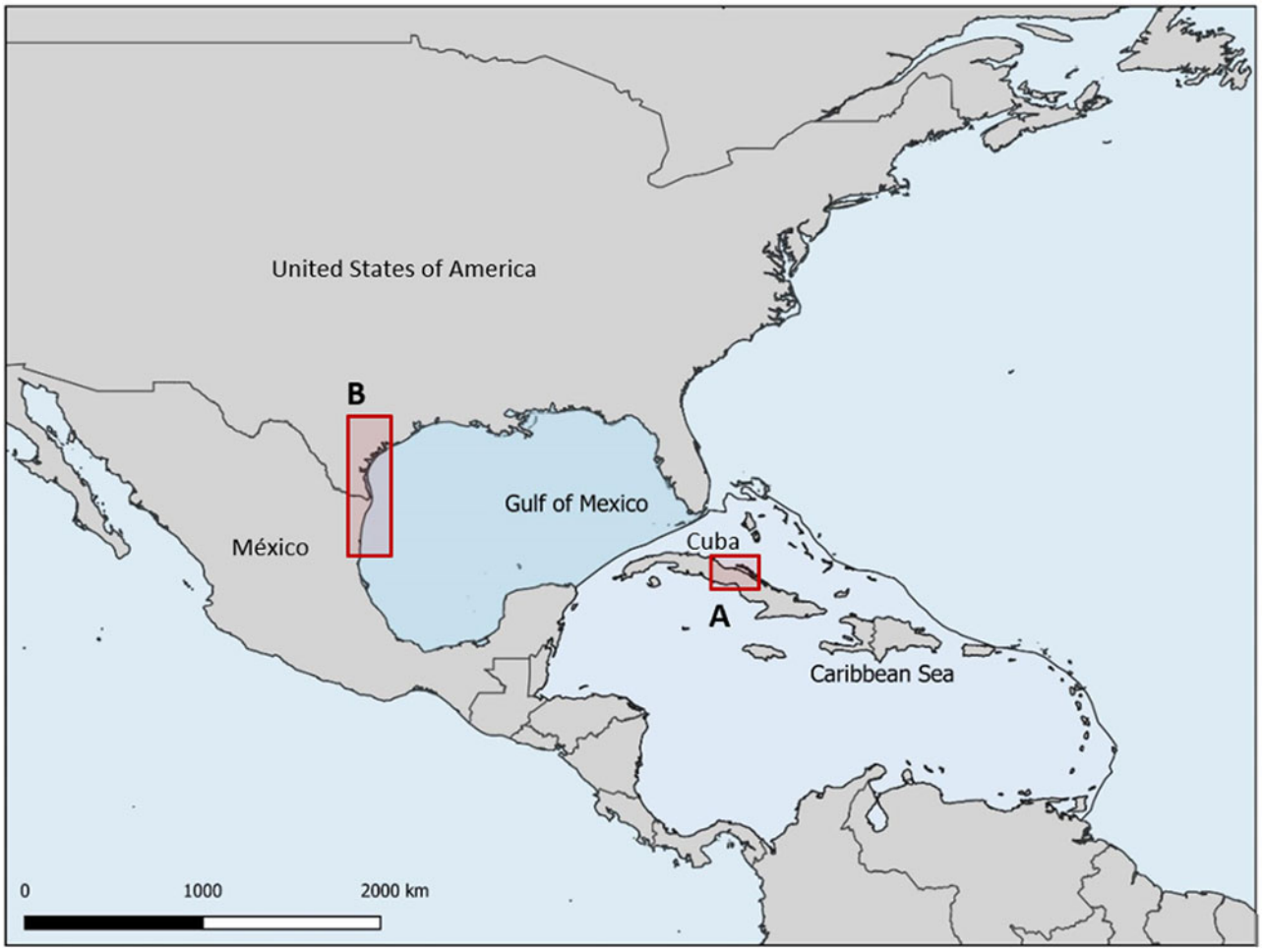


**Fig. 1.** Map of the Gulf of Mexico and the two research sites. Site A is Caguanes National Park. Site B is the Laguna Madre ecosystem.

## 2. Caguanes National Park

The CNP was created in 2001 to protect one of the most uncommon karstic landscapes in the Gulf of Mexico and the Caribbean. Located within the Buenavista Biosphere Reserve in the central provinces of Sancti Spíritus, Villa Clara and Ciego de Ávila, the park extends over the northern floodplains of the Guayaberas swamp, the Llanura Corralillo-Yaguajay and several smaller keys known as Los Cayos de Piedra (Figure 2) (Alcolado *et al.*, 2007; Domínguez González *et al.*, 2012). Approximately 70% of the 20,490 ha of the CNP are within shallow marine areas between 1 and 4 m deep. Vast meadows of marine seagrasses from the *Thalassia*, *Syringodium* and *Halodule* genera cover the muddy bottoms (Martinez-Daranas *et al.*, 2015). The remaining 30% of the park can be described as a marginal marine zone, a transitional area of coastal low plains, littoral marshes, seasonal lagoons, mangrove forests and freshwater swamps (Lahera *et al.*, 2007). Home to several endangered species (i.e., Royal palm, *Roystonea regia*), the park has been designated as a Ramsar site (Alcolado *et al.*, 2007; Martínez-Daranas *et al.*, 2015).

Several rural communities live in close proximity to the boundaries of the CNP. Historically, these communities were centres of production of the sugarcane industry (Domínguez González *et al.*, 2012; Funes Monzote & Martin, 2008). With a population exceeding 55,000 inhabitants, Yaguajay is the head of the district and houses the administrative offices of the CNP (ONEI, 2018). The region experienced low anthropogenic impacts until the second half of the nineteenth century when sugar production intensified and hundreds of hectares of swamps and forests were drained or deforested to facilitate the cultivation of cane (Acosta Rodríguez, 2012; Hernández Ramos & Perdomo González, 2012). In the early 2000s, following the collapse of the Soviet Union in the previous decade, the government deactivated local sugar mills in Yaguajay and introduced large-scale livestock operations (Altieri & Funes-Monzote, 2012; Díaz-Briquets & Pérez-López, 2000). The government also committed the area of the Santa Maria cays for the development of international tourism.

Over the past 15 years, the administration of the park has begun to recover wetland habitats (Carrera Menéndez, 2013; Carrera Menéndez *et al.*, 2006, 2007; Llanes-Regueiro, 2007). Following the adoption of a sustainable development framework at the national level in the early 1990s, the country has spearheaded the decentralization of spatial organization to municipal governments (Boffill Vega, Reyes *et al.*, 2009). This action has had important repercussions for the success of conservation efforts in Yaguajay (Boffill Vega, Calcines Díaz & Sánchez Cid, 2009; Pérez Hernández *et al.*, 2001; Zulueta Acea & Boffill Vega, 2014). Territorial reorganization has led to the implementation of an integrated environmental strategy that focuses on the control of extractive practices, the protection of natural resources and the restoration of degraded habitats by equally

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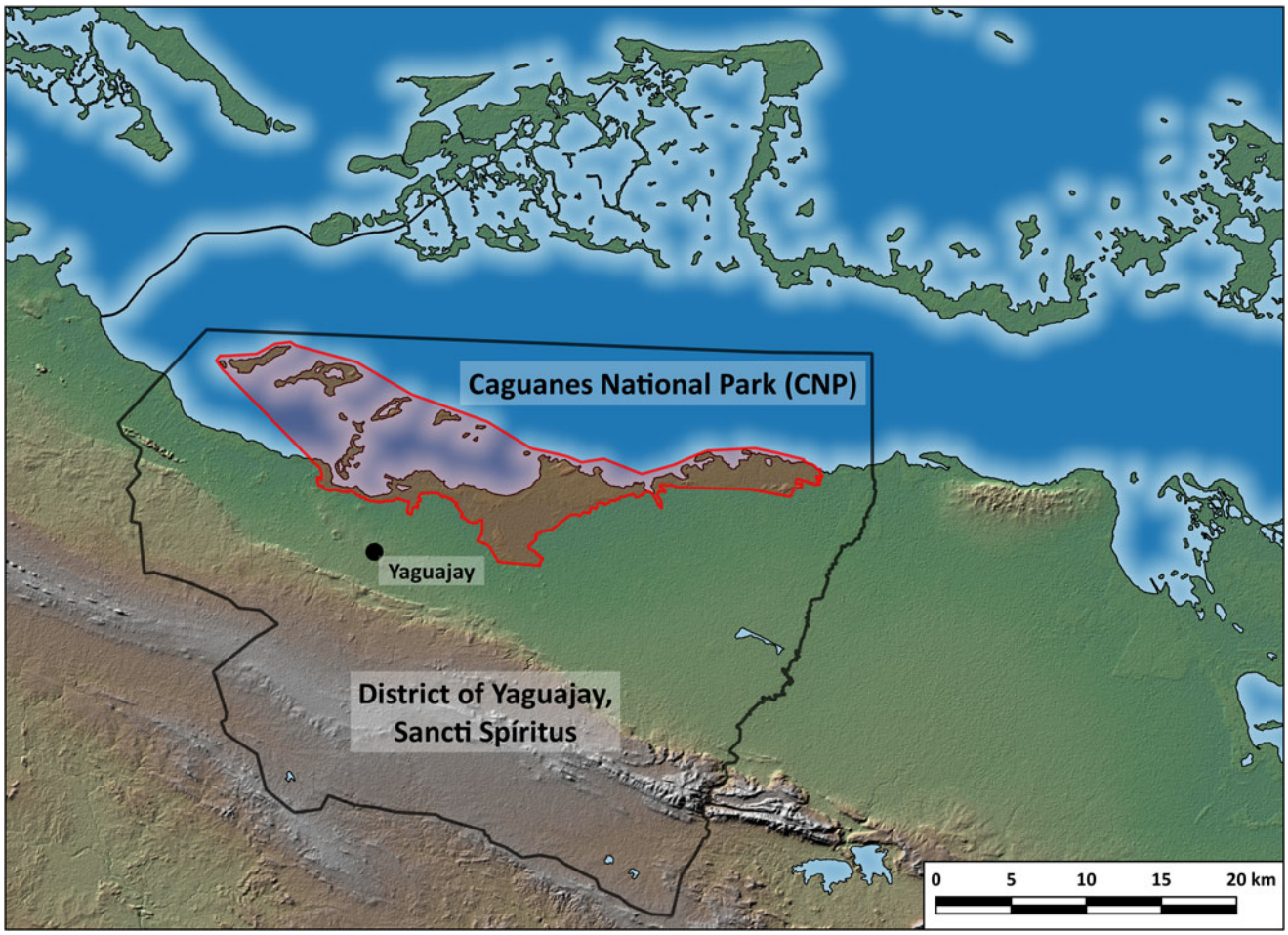


**Fig. 2.** Caguanes National Park, central Cuba.

weighing social, ecological and economic concerns (Caraballo Yera, 2012; Méndez Herrera & Sánchez Cid, 2011). Significant emphasis is placed on fostering local networks through regional economies and technological innovation while continuing environmental reforestation efforts (Driggs-Fuentes, 2015, McCune *et al.*, 2011; Patel & Brogan, 2017).

While reforestation and careful management have helped reconstitute ecosystems to successful levels (Borrego Díaz, 2014; Escambray, 2017), these habitats also face pressures from urban development and climate change. Alterations in precipitation and temperature regimes, sea level and coastal morphology and in the intensity and frequency of extreme events have already been observed (Planos Gutiérrez *et al.*, 2012). In late 2017 and early 2018, the park suffered critical damage from Hurricane Irma and Tropical Storm Alberto that resulted in the loss of 4000 ha of mangroves. In addition to more frequent flooding and drought episodes, the CNP is preparing for substantial losses in hydrological resources that may approximate 38% for central Cuba by 2100 (Batista Ponvert-Delisles, 2016; Planos Gutiérrez, 2014). The combination of future climatic scenarios with anthropogenic pressures tied to the developing tourism industry, agriculture and the expansion of cattle ranching could further aggravate conditions. This synergy of vulnerabilities represents a cautionary yet recurring tale for other wetland systems in the Gulf of Mexico (Dahl & Stedman, 2013).

## 3. Methodology

Initial exchanges took place in La Picadora and in the offices of the CNP in Yaguajay in February and May of 2017. The main goals of the two workshops were to share knowledge and experiences in the protection of wetlands, to identify current and future environmental threats to biological and human communities in these locations and to develop a common programme of research that might potentially enhance wetland conservation in the larger Gulf region. At the beginning of each workshop, participants ranging from local community leaders to scientific experts conducted a series of presentations on the conditions of the park. Then, researchers facilitated conversations through guided discussions and work sessions regarding specific threats to the CNP habitats. During the first meeting, with the help of a map of the area, participants constructed a timeline of changes and singled out key zones that were affected. In the second workshop, discussions were guided towards establishing research and management priorities and to further exploring changes in wetlands. This approach to data sharing and collection stimulated conversations and resulted in an increased awareness of current climate risks (Bretos *et al.*, 2017; Karr *et al.* 2017). Interactions were captured by two note takers. The programme, while focused on Caguanes' coastal habitats, can help identify management actions and develop best practices that are transferable to other scenarios. February and May workshops consisted of 34 and 37 participants,

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respectively, including local farmers, park authorities and research specialists, community leaders, conservationists, scientists and resource managers from the area.

## 4. Outcomes and results

As direct outcomes of the workshops, participants agreed on a common set of research interests, management priorities and extension activities. In this article, we concentrate on presenting the three major lessons that resulted from these meetings: the identification of threats to wetlands and coastal lagoons; insights from sharing of knowledge and experiences of conservation; and the exploration of the challenges to continued collaboration.

### 4.1. Getting to know current and future threats

During workshops, participants identified some of the current and future threats that the CNP wetland habitats are experiencing in relation to environmental and anthropogenic change. Comparisons were drawn between conditions in the park and other lagoon environments in the Northern Gulf of Mexico such as the Laguna Madre ecosystem. Extending 445 km along the coasts of Tamaulipas, Mexico, and Texas in the USA, the Laguna Madre is the only hypersaline lagoon system in North America (Figure 3) (Day *et al.*, 2013; Yáñez-Arancibia & Day, 2004). Similarities between the CNP and the Laguna Madre systems are numerous, including the prevalence of shallow coastal lagoons with high levels of salinity (more than 35 parts per thousand), limited freshwater inflow due to reduced water sources, dominance of semiarid conditions (low precipitation, high evaporation and high temperatures) and high exposure to extreme events (droughts and tropical storms). Also characterized by highly productive seagrass meadows and fisheries and constituting essential habitats for bird colonies, both systems have been impacted by intense anthropic modifications, non-point source runoff and agricultural pollution (Smith *et al.*, 2013). Through presentations and discussions, the exchange of knowledge about these environments resulted in a more integral picture of stressors, pressures and impacts. Critical threats to wetlands and coastal lagoons include water quality, coastal development and more frequent and intense extreme events.

#### 4.1.1. Water quality issues, pollution and eutrophication processes

Participants indicated that activities related to farming, waste management and industrial practices are affecting water quality in both systems with important consequences for biodiversity. For example, low concentrations of dissolved oxygen are found in all monitoring sites within the CNP as reported by park personnel. Some of these results are attributed to the use of chemical fertilizers and to the discharge of other contaminants suggesting eutrophication processes. The pollution of coastal areas has led to the degradation of near-shore habitats, including soft-bottom environments where large beds of seagrasses grow. This has been also reported in the Laguna Madre system where low ratios of seagrass to unvegetated bottoms and changes in vegetation composition are now seen in several locations (Smith *et al.*, 2013). Impacts to seagrass integrity has affected aquatic biodiversity, with fishermen reporting a decrease in abundance and size of captured fish in the CNP, as well as modifications in the diversity of extant species. The channelling of rivers and freshwater streams for irrigation and changes in precipitation patterns have also altered water quality levels by modifying freshwater discharge regimes. This is observed along the estuaries and lagoons of the CNP, which have now become hypersaline for larger portions of the year. A similar process is seen in several locations of the Laguna Madre ecosystem, where poor agricultural practices have limited natural water flow through the systems. Reduced inflows combined with high evaporation rates have increased the residential time of water in lagoons (Smith *et al.*, 2013). Finally, water quality issues have also been linked to brown tides in the Laguna Madre and potentially to red tides in the CNP. While the causes of these events are not completely understood, research suggest that climatic conditions play a role in triggering these occurrences. Although control of algae blooms is challenging, preserving the ecological integrity of shallow habitats is essential to maintaining biodiversity. With this purpose, participants agreed that mapping, protection and restoration of seagrass habitats should be priorities in future research and conservation efforts.

#### 4.1.2. Coastal development alterations

In past decades, engineering work, such as the construction of a causeway close to the CNP and in multiple sites of the Laguna Madre, has altered the natural hydrology of these ecosystems. The closing of lagoons to the influx of fresh tidal water has not only resulted in higher salinity in estuaries, but may also have produced changes in currents, in sediment transport and deposition and in shorelines. Other modifications discussed were related to the reconversion and filling of tidal lands such as marshes. For example, in the 1980s, a hotel was built on the waterfront of Playa Vitoria in Yaguajay along with a beach and a pier. The site is now abandoned due to subsidence. Likewise, along the coasts of the Northern Gulf, saltmarshes have been impacted considerably by rising sea levels and by their conversion to upland uses (Dahl & Stedman, 2013). Urban and rural development have also produced the encroachment of freshwater marshes, mangroves and swamp forests. Large tracts of land now remain deforested, providing scarce protection from insolation and increasing temperatures. The loss of transitional and riparian areas has exposed upland freshwater marshes to tidal inundations. Elevated levels of salt in soils have caused plant desiccation and exacerbated water stress.

#### 4.1.3. Extended droughts and hurricanes

The prevalence of drought conditions and their effects on local agricultural practices were also mentioned by participants as sources of concern (see Figure 4 for a chronology of most recent changes in Caguanes). For instance, in 2016–2017, prolonged drought prevented farmers from Yaguajay from planting rice and damaged other crops such as maize and beans. In addition to agricultural impacts, reduced freshwater availability provoked the loss of livestock due to heat stress. The period of extensive drought concluded with the arrival of Hurricane Irma in September 2017. The CNP experienced massive damage to vegetation, with up to 80% tree blowdown. The associated increase in precipitation brought by unusually strong cyclonic seasons led to massive flooding in 2017 and 2018. Similar conditions were experienced in the Northern Gulf with the passage of Hurricane Harvey in late August 2017. Reports showed values exceeding 1530 mm of rainfall in areas of south-central Texas (Samenow, 2017).

Whereas evidence indicates that coastal and marine environments in the Caribbean and in the Gulf of Mexico have regularly suffered from the action of cyclonic activity in the past few centuries (Wallace *et al.*, 2019; Pulwarty *et al.*, 2010), projections

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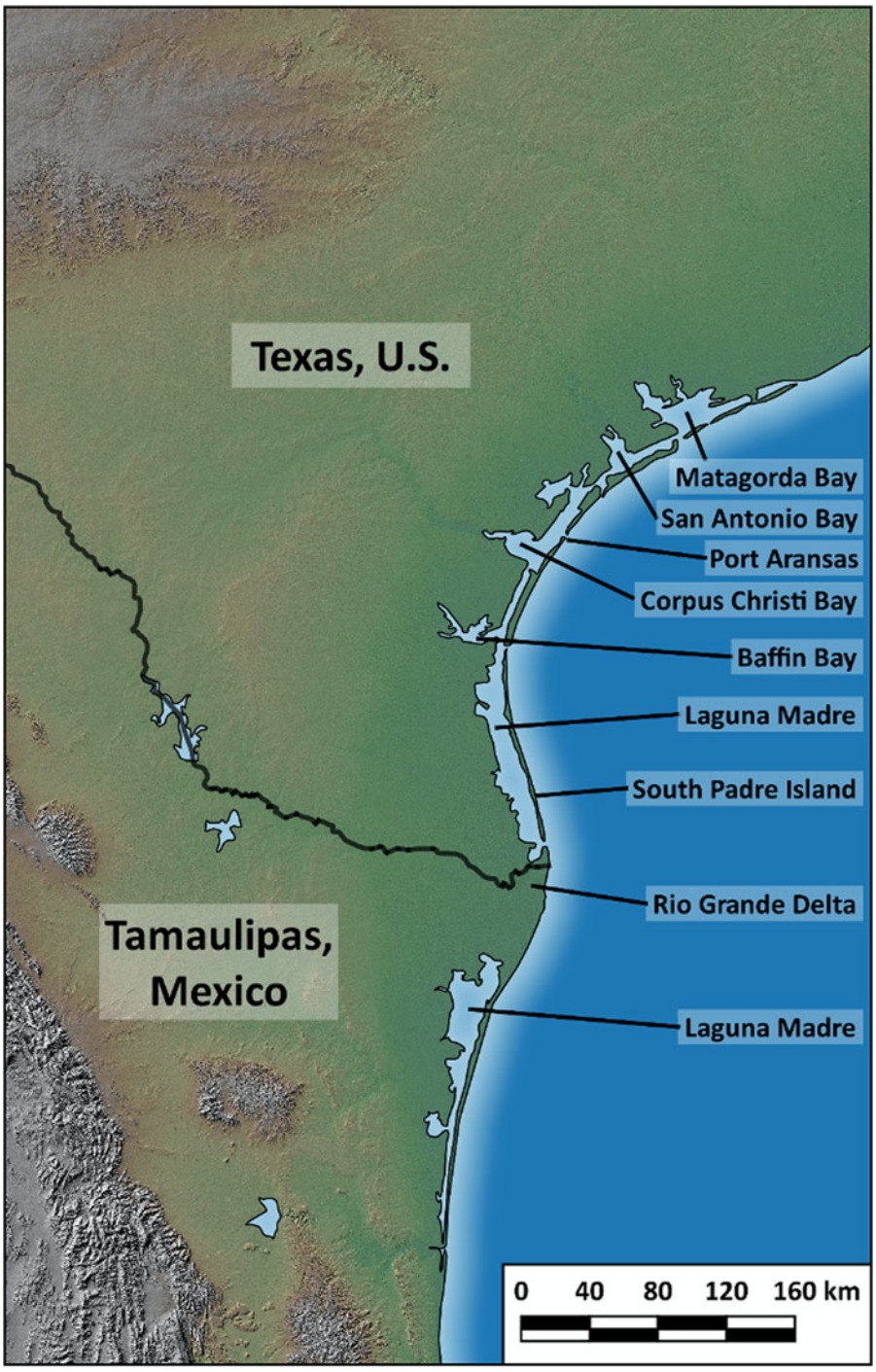


**Fig. 3.** Laguna Madre ecosystems, Tamaulipas, Mexico, and Texas, USA.

indicate a likely increase in their occurrence and strength through the end of the current century (FAO, 2019; Taylor *et al.*, 2018). In the Laguna Madre, drought conditions have been shown to alternate with hurricanes and tropical storms, resulting in large systemic effects that may ultimately stimulate biological productivity (Smith *et al.*, 2013; Yáñez-Arancibia *et al.*, 2013). Dry–wet alternations are represented as decadal cycles of boom and bust where additional precipitation from hurricanes produces a flushing of the system. Yet, climate alterations such as rapidly intensifying storms or the progressive aridification of climatic regimes may create imbalances in the functioning of these dynamics. In order to develop adequate preparedness measures, participants agreed that it was essential to formulate an understanding of each ecosystem's responses to the new pressures and the different trajectories of recovery. Including precautionary and adaptive management approaches into current restoration and conservation efforts at the CNP was also seen as an immediate priority to be addressed in future activities.

### 4.2. Sharing knowledge and experiences of conservation

Discussions and interactions provided the opportunity for participants to observe the similarities in the threats experienced by the CNP and the Laguna Madre ecosystems. Many were surprised to

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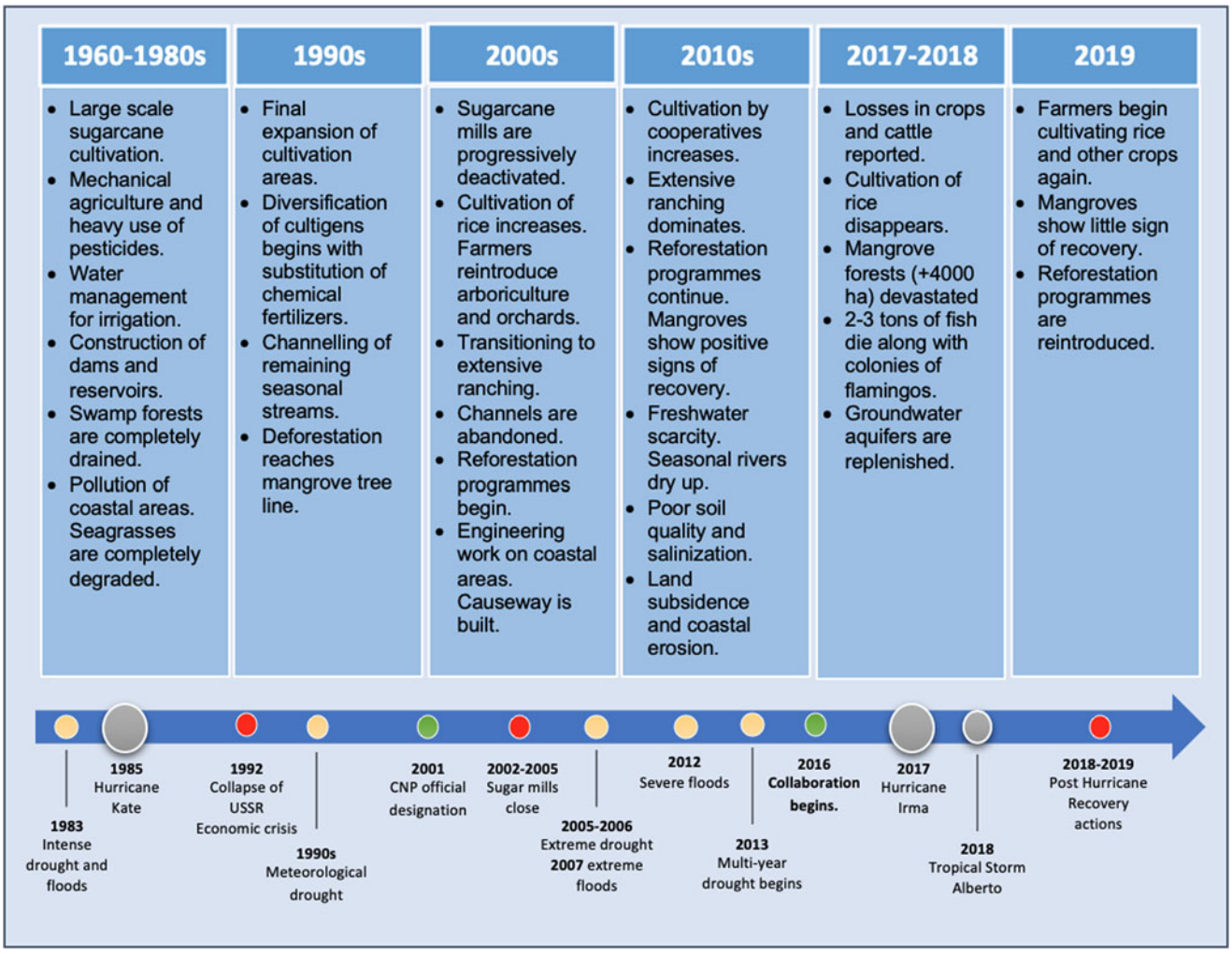


**Fig. 4.** Chronological timeline of major events. CNP = Caguanes National Park.

discover that, despite showing different levels of impact, neither system remained a stranger to the intense landscape modification processes that accelerated the effects of climate change. Already familiar with some of the actions and policy instruments implemented by the USA, much remained to be known about Cuba's marine-environmental policy framework. In this way, US-based researchers learned about the many efforts and mechanisms put in place by Cuban institutions to foster the restoration and sustainable use of resources through educational outreach and hands-on community participation. For example, reforestation programmes involve representatives from local youth organizations who work in coordination with the CNP and other government agencies. Similarly, researchers at the Montané Anthropological Museum and the Center for Marine Research are part of Universidad de La Habana's Local Development Network. The network, which has included the community of La Picadora since 2013, offers a framework to study, analyse and promote academic participation in local development processes connecting society with higher education, knowledge, technology and innovation. Both instances demonstrate the advanced degree of institutionalization that collaborative mechanisms have within Cuba. In all, they make visible differences in each country's model of sustainability.

For instance, Cuba acknowledges the need to subordinate economic development to a more humanistic, equitable and inclusive approach that places people at the centre of all initiatives (Cabello *et al.*, 2012). This belief has led the country to include new legislation in its 2019 constitution that explicitly addresses climate change threats. Yet, even before this explicit commitment, the island has implemented aggressive long-term adaptation programmes, as well as large-scale changes in production systems. These efforts are based on the recognition that, along with different experiences of change, each community of knowledge espouses different views of sustainability along with capacities to anticipate future outcomes (Iwaniec *et al.*, 2020). For example, while scientists equate the restoration of degraded wetlands through reforestation with autochthonous species, resource managers and local farmers anticipate the difficulties that such a programme entails (e.g., slower rates of maturation and success than other more resilient but foreign species). Whereas scientists, resource managers and local entrepreneurs see the value of carefully constraining access to CNP habitats by fostering selective practices of ecotourism, some residents wish for the return to more prosperous times when sugarcane cultivation was still prevalent. Noticing this diversity in opinions, after some discussion, participants agreed that, in order to develop strategies that

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might work over the long term, it is key to attain the active involvement of a wider set of actors not only in the solution, but also in the diagnosis and study of environmental issues (Caniglia *et al.*, 2017). As a way to achieve this goal, participants proposed an inclusive framework for sustainability that recognizes the differences in development models between both countries and can learn from them. Strengthening and supporting local networks, fostering the co-production of diverse kinds of knowledge and prioritizing the extension of findings to the larger community are some of the main strategies adopted. In addition, a critical part of this effort lies in the scoping of future scenarios and in the identification of transformative pathways that can lead to sustainable yet equitable outcomes (Fazey *et al.*, 2018b). Along with capacity development, this task has become the priority of subsequent meetings and workshops.

### 4.3. Challenges and obstacles

We observed three sets of challenges in advancing transnational cooperation. Similar to other transnational efforts, obstacles were related to international policy constraints, different institutional and academic cultures and technological obstacles that make communication difficult (Anthes *et al.*, 2014; Fink *et al.*, 2014; Pastrana, 2015; Roman, 2018). In terms of the first challenge, the rapid change in the status of relations between Cuba and the USA due to actions of the Trump Administration poses real impediments to transnational cooperation. Despite regulatory provisions that exclude scientific efforts from most US-enforced restrictions, practical issues on how these policies are implemented limit the kinds of collaboration that can be pursued with Cuban scientists. The removal of non-essential personnel from the US embassy in Havana and the closing of consular divisions that are responsible for the processing of visas to visit the USA impede Cuban colleagues from obtaining required travel documents at home. Because they are now required to apply and wait for the issuance of these permits from a third country (e.g., Colombia or México), travel costs increase. Without certainty that visas will be approved and given important financial and legal restrictions that limit US support for Cubans travelling abroad, there are strong disincentives for scholarly visits to the USA. This creates an asymmetry in how relationships are established between research parties, eliminating specific areas of collaboration that include reciprocal academic and educational exchanges.

Other less practical but equally significant issues further restrict transnational scientific cooperation. The tenor of political rhetoric has once again assumed a negative tone that undermines the many efforts directed at building trust among both nations (McKinney, 2017a). US university bureaucrats become suspicious and afraid of engaging with a partner who is listed as being in a sanctioned country (Roman, 2018). Likewise, Cuban counterparts see their paperwork increase at the prospect of receiving American visitors. In this context, navigating the many cultural differences and regulation challenges that exist between academic policies and legal frameworks becomes increasingly difficult. Collaboration only works through the commitment of involved people, the strength of personal relationships and dedication to sustaining a mutual understanding that can prevent missteps (Pastrana, 2015). For example, an important difference exists in university regulations concerning the timing and manner of funding applications. In the USA, given the delay that mediates the submission of a research proposal and the awarding of financial support, it has become increasingly common to prioritize the solicitation of funding over the request of research permits. This is the opposite of what occurs in Cuba, where funding can only be pursued once all authorizations from relevant government offices (e.g., the Ministry of Higher Education) have been secured. Whereas this institutional regulation ensures that much-needed provisions are in place before starting research, it can affect the capacity to collaborate over distance, as monetary and human resources for exploratory activities are subject to a limited budget.

The final challenges that this case study shows are related to technological barriers to cooperation. Differences in technical infrastructure and availability of broadband connectivity affect communications between partners and limit the types of research that can be conducted (Anthes *et al.*, 2014; Marrero *et al.*, 2014). The US embargo against Cuba, which began in 1960, only permits the export of agricultural and medical goods to the island nation. While Cuba has established trade relations with other countries such as China and Russia, US scientists are forbidden from engaging in the transfer of technological assets such as computers and of proprietary software and datasets. Prohibitions not only complicate the exchange, sharing and storage of study-related data, but also the pursuit of project activities that support local capacity development such as mapping and geospatial analysis and the sampling, processing and documentation of biodiversity.

## 5. General discussion and conclusion: building a sustainable approach for coastal wetlands protection

This article presents initial results from an ongoing transnational research project between the USA and Cuba for the conservation of coastal wetlands in the CNP, Sancti Spíritus, Cuba. Focusing on the first two exchanges among scientists, resource managers and local communities, it discusses key outcomes from this collaboration. Efforts have resulted in the socialization of knowledge and the identification of gaps in information and capacity. Initial workshops were followed by several training and educational exchanges, numerous participations in conferences and regional meetings, the signing of official agreements of cooperation and several peer-reviewed articles. The collaboration continues and has expanded to incorporate Mexican-based institutions. Beyond language and participation barriers, a common understanding has begun to emerge in terms of shared challenges to the conservation of coastal wetlands.

In all, lessons from these two initial exchanges converge with findings from different studies of transdisciplinary collaboration. They show that working together towards future sustainability can help broaden participants' knowledge bases, foster dialogue and increase reflexivity among researchers, practitioners and stakeholders (Boon *et al.*, 2014; Hegger & Dieperink, 2015; Iwaniec *et al.*, 2020). For example, the comparison between the Caguanes and Laguna Madre ecosystems has allowed participants to identify a synergy of anthropogenic and climate-related vulnerabilities impacting coastal habitats. The interconnected nature of many of the transformations suffered by wetlands has led to the realization that an integrated transboundary vision that can advance regional strategies for adaptation is urgently needed (Yáñez-Arancibia *et al.*, 2013). However, despite a long history of collaborations between Cuba, Mexico and the USA, proposing an integrative conservation approach that would link place-based research in these countries has proved challenging. Significant differences exist in the policy and legal frameworks, which continue to hinder joint efforts. Institutional and technological restrictions

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prevent establishing an equal partnership by affecting academic and scientific exchanges and knowledge co-production.

Comparative studies of transnational efforts have underscored that, along with important benefits, any kind of collaboration involves trade-offs, obstacles and risks. Where political systems and legal and institutional frameworks differ, the success of cooperation is affected by the distinct modes of governance exhibited by each country (Berkman, 2011; National Research Council, 2012; Stamm & Figueroa, 2012). Trade-offs must be made between including and excluding partners, and complexity increases as the number of participant institutions grows. In this context, any scientific undertaking must reconcile not only divergences in how natural resources are managed and protected within each nation, but also be able to navigate across different priorities, agendas and research approaches. Obstacles are, as a consequence, a normal outcome of working across diverse institutional settings.

Yet, as this case study shows, while agreements can be made at higher levels that indicate commitment to a unified goal, researchers must still struggle with rules for things such as technology sharing, public–private partnerships and data publication. This exposes participants to a complex set of challenges with considerable personal risks in terms of rigorous sanctions that go beyond professional careers. The potential for failure is high when parties are constrained from finding a common ground by bureaucratic structures (Stamm & Figueroa, 2012). In these scenarios, if no mechanisms are in place to maintain connections and despite the many incentives to collaborate, participants may discontinue their involvement (National Research Council, 2012). The situation is congruent with what we have observed in our collaboration where continued work has been achieved only at the expense of many sacrifices and through strong personal ties. It also helps explain the fate of other bilateral initiatives. In short, these obstacles, which are mostly political in nature, deprive countries from interactions that could benefit the scalability of research findings to other biodiversity conservation activities in the region (Roman, 2018).

As societies recognize that their futures rely on working together, it is critical that we strengthen transnational efforts to enhance knowledge sharing and collaboration in problem-solving (Dinar, 2011). To that end, we must foster research cooperation mechanisms that are truly inclusive and can overcome the constant reintroduction of an outdated isolationist rhetoric. A truly collaborative agenda requires not only enabling opportunities to build scientific exchanges, but also identifying and working with formal political and normative structures to support rather than restrict the co-production of new knowledge. While most countries still have significant difficulties to overcome in this respect, establishing a complementary approach that can foster a transnational culture of sustainability is dependent upon several steps (Fazey *et al.*, 2018b). First and foremost are the fostering of reflexivity and the deconstruction of social, political and economic values, interests and assumptions that can enable informed yet balanced participation. Second is the provision of intermediary spaces that can support the communication, development and implementation of joint solutions focused on sustainable socioecological transformations. Third is the recognition of the contrasts in different development models along with the processes of accepting and learning from these differences. In a world that is rapidly changing beyond our best predictions, a transnational understanding of the complexity of the threats faced by coastal ecosystems in the Gulf is essential for developing precautionary and early warning systems. The devastating impacts from events such as Hurricanes Harvey and Irma have shown us what is at stake. Now we must act.

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