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Juliet Vallejo

Katia Sanchez

Evelyn Roozee

Owen Temby

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## Disaster Resilience Versus Ecological Resilience and the Proposed Second Causeway to South Padre Island

JULIET VALLEJO, KATIA SANCHEZ, EVELYN ROOZEE, AND OWEN TEMBY

School of Earth, Environmental, and Marine Sciences, The University of Texas Rio Grande Valley, Brownsville, TX, USA  
Email: owen.temby@utrgv.edu

**ABSTRACT** The barrier island of South Padre is located off the coast of Texas's southern tip in Cameron County and is a popular tourist destination with over 4 million annual visits. The only road access to and from the island is a four-lane causeway, 2.3 miles in length, that routinely experiences heavy traffic. Twenty years ago, a barge crashed into the Queen Isabella Causeway, destroying a portion of the bridge. It quickly became apparent how reliant South Padre Island (SPI) is on the causeway and raised questions regarding its lack of disaster resilience. Local boosters and government responded by proposing and planning for the construction of a second causeway that would provide an additional emergency response route and facilitate economic development. However, the planned location for the new bridge crosses through sensitive seagrass beds that this construction would permanently fragment. The habitats for numerous threatened and endangered species would be destroyed, thereby reducing the ecological resilience of the area. Social-ecological theory focuses on the interconnectedness between humans and ecosystems and their symbiotic nature. Yet in the case of SPI, these two dimensions of social-ecological resiliency are in competition with one another. The proposed causeway would ostensibly enhance disaster preparedness and foster economic development but at the expense of the degradation of crucial ecological habitats. This case study provides insight into the contradictions between ecological resilience and disaster resilience from the standpoint of various stakeholders.

**KEYWORDS** disaster resilience, social-ecological resilience, Texas, bridge, seagrass

### INTRODUCTION

On September 15, 2001, one of the barges regularly plying the Intracoastal Waterway in southern Texas slammed into a pillar supporting the Queen Isabella Causeway. A 140-foot portion of the bridge fell 80 feet into the navigation channel's waters. Automobiles crossing from Port Isabel to South Padre Island (SPI), Texas, in the morning darkness, failed to see that the roadway before them had disappeared. Eight people died when their cars plunged. For 2 months, the island of some 3,000 inhabitants (and many more tourists) had no road to the mainland. Rental cars were stranded, grocery stores closed, hotels and restaurants emptied, and the vast majority of the island's workers (who lived on the mainland) had to find alternative means to get to work. A noncar ferry system was put in place until the bridge was repaired and put back into service in November 2001.

SPI is a barrier island off the coast of Texas's southern tip in Cameron County, one of the four counties comprising the Rio Grande Valley (RGV). The RGV is considered America's most impoverished region. Every November retirees, known colloquially as "Winter Texans," swarm the RGV (especially SPI) to spend the colder months enjoying the region's subtropical climate. The island receives over 4 million annual visits and maintains an average population of nearly 12,000 [1]. Particularly important in attracting tourists are the RGV's bird watching opportunities and SPI's beaches. Across from SPI, on the mainland, is Port Isabel, a more impoverished town with 76% of families with all children under 5 years old living in poverty [2]. Port Isabel's economy has for many years been dependent on the seasonal habitation by Winter Texans and traffic crossing the main drag into SPI. Increasingly, however, Port

Isabel houses people working on SPI who seek a less expensive place to live. As a result, the Queen Isabella Causeway often backs up for several miles during the morning commute to the island.

The collapse of the causeway highlighted the problems of the island's reliance on a single human-made structure and raised questions about the population's and economy's vulnerability to a similar event or a natural disaster. A recent report by the U.S. National Ocean Service (NOS) projected Gulf Coast sea levels to rise substantially in the next 30 years, resulting in increased tide and storm surge heights and more frequent major flooding events [3]. SPI is at heightened (and increasing) risk [4]. As a barrier island, SPI would bear the brunt of a hurricane storm surge and need to be promptly evacuated. One of the principles of community resilience is infrastructural redundancy. Thus, it seemed reasonable that after the causeway collapse, the island's community leaders would question whether one way off the island was sufficient for its long-term viability as a site of economic development and as a growing tourist destination.

But any additional access to the island would be costly in dollars and ecosystem destruction. The dollar figure, estimated at close to US\$1 billion, ensures that it must be accompanied by the promise of a sizable economic return. It would need to reach the undeveloped northern portion of the island for that to occur. Community resiliency, to evacuate when disasters strike, comes at a price. Direct access for the north part of the island access entails crossing through sensitive and unspoiled land and seagrass beds, permanently fragmenting and destroying habitats of numerous threatened and endangered species. One of the casualties of the "national imperative" of community resiliency might be ecosystem resiliency [5, 6].

This case study illustrates the competition between these dueling resiliencies. It highlights the often-overlooked problem that well-established conceptions of social and ecological resilience may pull in different directions. What happens when efforts to foster social-ecological resilience must prioritize one dimension over another?

### COMMUNITY VERSUS SOCIAL-ECOLOGICAL RESILIENCE

The concept of the social-ecological system underpins the modern era of environmental management scholarship and policy [7, 8]. The basic idea is that humans and

ecosystems are intertwined and mutually implicated. Collectively, they are complex adaptive systems, meaning that they change on multiple spatial and temporal scales, often unpredictably, in response to interventions and their internal cyclical processes. They may be resilient and absorb a shock, transitioning back to a relatively stable state, or they may transition to a new state of relative stability. A great deal of scholarship and government policy focuses on maintaining human-cultural resilience in the face of unavoidable environmental change and ecosystem resilience despite demands for natural resource exploitation [9, 10].

Scholarship on social-ecological resilience sometimes takes on a functional characteristic, in which the various elements play a role in keeping the complex-adaptive system in a resilient state [11, 12]. There is, it seems, a narrow path to navigate. We need to prevent habitat loss. We need to enable communities to bounce back when a disaster or environmental change happens. Because humans and the environment represent the same system, one form of resilience should support another.

The present era of rapid environmental change (represented primarily by climate change), means that preserving Earth's biodiversity, indigenous cultures, and the usability of our urban areas, will require expensive interventions. Adaptation measures must take place, and these must be tailored to each affected region based on a range of risks they face. The NOS now prioritizes research in natural and nature-based "green" infrastructure such as living shorelines with natural features like marshes and mangroves [13–16]. Other necessary interventions will include changes to electricity generation and transmission, modifications to public and private transportation systems, and flood risk management [17–19]. A recent report by the National Academies spelled out the characteristics of a "resilient nation" as one in which "Proactive investments and policy decisions including those for preparedness, mitigation, response, and recovery have reduced the loss of lives, costs, and socioeconomic impacts of disasters" [5, p. 14].

But as the case of the proposed second causeway to SPI shows, a resilient nation is not necessarily one in which ecosystem health (and resilience) is prioritized. The symbiotic connotations of the social-ecological system concept masks trade-offs without clearly best alternatives. Environmentally friendly green infrastructural developments to prevent flooding may be helpful, but conventional hard "gray" infrastructure is needed too. The

proposed second causeway to SPI would make the island easier to evacuate in the case of a hurricane or earthquake, especially if such an event makes the current evacuation route unavailable. Economic development resulting from it would enhance the tax base in America's poorest county. For this enhanced social resilience, the region's ecological resilience would suffer. This case study is just one example of the trade-offs between community and ecological resilience that societies will face as the rapidly warming climate presents new challenges that call for infrastructural adaptations.

### CASE STUDY EXAMINATION

#### The Story of the Proposed Causeway

SPI was first connected to the mainland town of Port Isabel with the construction of a wooden swing bridge in 1954. Twenty years later it was removed and converted into a fishing pier. The replacement causeway, adjacent the existing structure, was opened in 1974. A four-lane concrete cable-stayed bridge rising 85 feet above the Laguna Madre water line, and stretching 2.3 miles in length, it is an imposing landmark in an otherwise underdeveloped region.

Rapid population growth in SPI and the need to plan for an eventual replacement to the existing structure at the end of its expected life span encouraged political efforts to build a second access. In 1997, a bill was introduced to the Texas Senate directing the Texas Department of Transportation (TxDOT) to complete a study examining alternative routes. This early momentum ground to a halt in July 2001. A competing study, commissioned by Port Isabel, indicated that a second causeway would devastate the town economically. It estimated that a second causeway would divert nearly 3 million motorists from the town, costing it 57% of its retail sales, one-third of its jobs, and 40% of its sales and property tax revenue [20, 21]. The TxDOT study (which the Port Isabel government complained it was excluded from) was shelved.

This abruptly changed with the accident. Now, the second access was not merely a replacement bridge promising or hindering economic growth. It had the added rhetorical currency of contributing to the island's security and the region's risk mitigation and disaster preparedness. The existing bridge arguably represented a bottleneck in the county's evacuation procedures (figure 1). Reflecting on the change of perceptions that occurred as a result of the accident, one observer with family living on the island

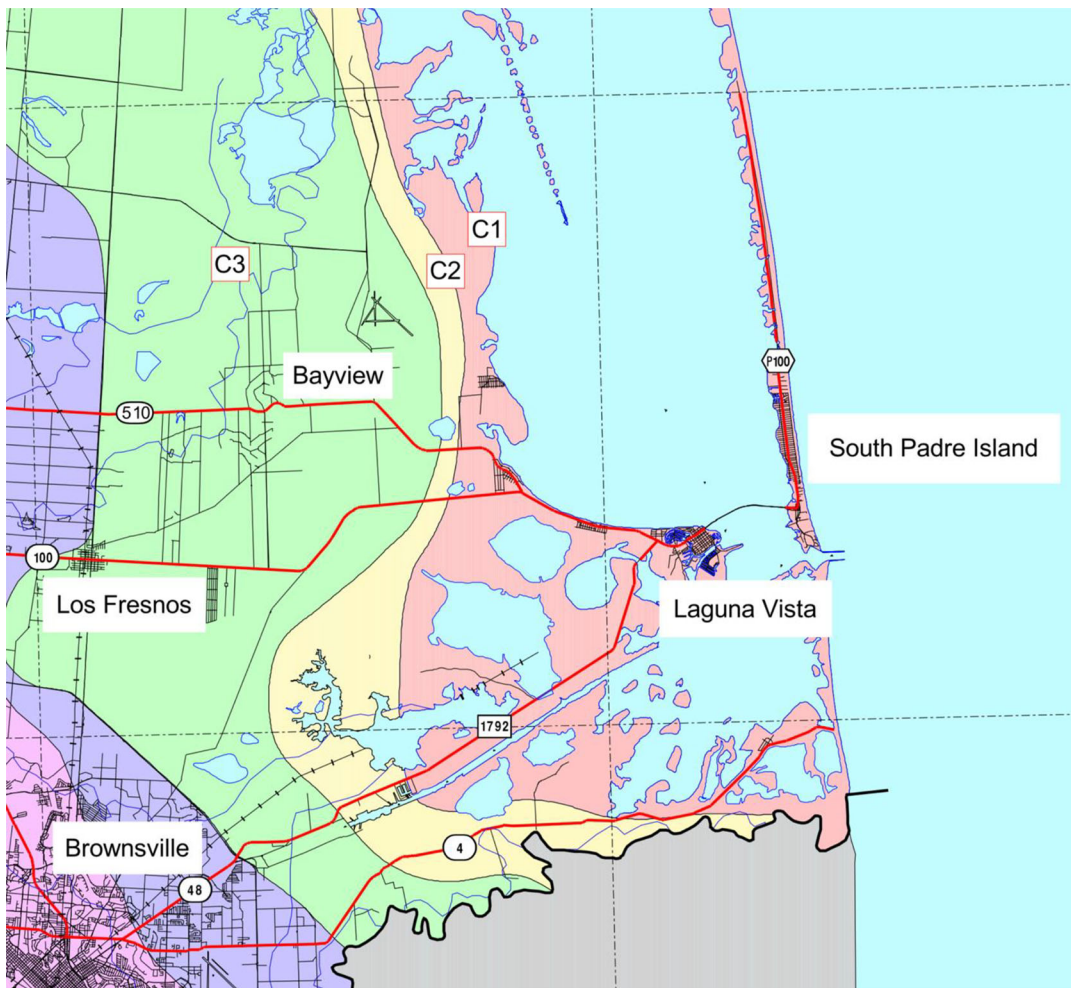
indicated, "With the causeway out, it became all too clear just how isolated South Padre really is—how dependent on services and people from the mainland, how reliant on tourists and money they spend" [22].

This time, instead of TxDOT moving forward with the studies, the county government sponsored the project. The task went to the Cameron County Regional Mobility Authority (CCRMA), a toll collection and transportation project development county agency created in late 2004. The causeway was one of its priority projects from the beginning. TxDOT would serve an advisory role, assisting the CCRMA in navigating the environmental impact assessment process required under federal law. In November 2005, the CCRMA received a resolution, passed by the governments of SPI, Port Isabel, and Cameron County supporting the construction [23].

From the point at which the CCRMA assumed sponsorship of the project, it had two stated rationales for its construction: to provide an emergency response route and to facilitate economic development [24]. The latter was used as justification to eliminate potential routes that landed too close to the existing bridge [25]. For the new causeway to be moved forward by the sponsoring agency, its contribution to SPI's economic growth had to be unquestionable.

The CCRMA settled on a proposed route in 2012. It was nothing like the existing causeway. The entire access project would be roughly 17 miles in length, including an 8-mile causeway crossing the Laguna Madre between the mainland and northern SPI. The mainland access would be a 10-mile drive northwest from the existing causeway's entrance, directly south of an unincorporated seaside community known as Holly Beach. On the island, it would extend south to the already-developed portion, opening new areas to development (figure 2). The CCRMA's estimated cost was between US\$400 and US\$480 million (this figure would later double) [26]. The proposed funding mechanism was a toll road, plus other unspecified sources from different levels of government. The agency expected completion of the project in 3 years, by the end of 2015 [26].

The CCRMA touted the causeway's benefits to the local economy. It addressed Port Isabel's previously expressed concerns about a loss of commercial activity by arguing that its economy would expand due to the creation of jobs on SPI. Port Isabel, it claimed, would serve as a home for an expanding number of commuters.



**FIGURE 1.** The South Padre Island hurricane evacuation bottleneck in Cameron county. Source: Cameron County, “Hurricane Evacuation Tips Map Interior,” [http://www.co.cameron.tx.us/evacuation\\_maps.php](http://www.co.cameron.tx.us/evacuation_maps.php).

The presence of these new residents, combined with a lack of developable retail space on SPI, would stimulate demand for stores and restaurants in Port Isabel. It would also alleviate the substantial traffic problems associated with Port Isabel residents’ daily commute over the existing causeway to SPI. Overall, the CCRMA claimed that the causeway would create over 2,500 new jobs (1,200 of which would be in tourism) and grow the region by about 3,500 residents, compared to the scenario of not building the causeway [26]. The additional tourism from easier access to the island would result in US\$50 million more in earnings for local business per year by 2045.

The causeway project ended up more complex and challenging to fund than expected. The CCRMA submitted what it claimed as its final environmental impact statement (EIS) to TxDOT and the Federal Highway Administration in December 2014 [27]. It was found

deficient by TxDOT and withdrawn in late 2016. The second causeway’s design and route ran afoul of two related problems. First, it did not provide a convincing mitigation plan for the environmental effects that would result from its construction. In September 2016, Ken Dunton, a faculty member at the University of Texas at Austin Marine Science Institute, delivered a report to TxDOT assessing the CCRMA’s plan to replace seagrass that the causeway would destroy directly (through construction) and indirectly (through shading and increased turbidity). Dunton’s team found that the CCRMA’s plan would not provide a suitable habitat for this sensitive ecosystem feature [28].

Second, the project’s projected cost ballooned, with no solid plan to fund it. The existing plan, to use a toll road, became impossible in 2015, when the state attorney general interpreted two amendments to the Texas



**FIGURE 2.** The Cameron County Regional Mobility Authority’s (CCRMA) proposed second access route across the Laguna Madre. Source: CCRMA, “South Padre Island 2nd Access Project, Public Scoping Meeting,” slide presentation, South Padre Island Convention Centre, July 17, 2012.

constitution as permanently prohibiting the use of public funds for toll roads [29].

The toll road prohibition and complications with the EIS have left the causeway project on hold as of June 2022. Representatives from TxDOT maintain that the question of how to pay for the bridge should wait until the CCRMA develops a sufficiently robust seagrass mitigation plan. They contend that an accepted EIS will enable it to secure funds [30]. The CCRMA is presently assembling US\$3 million for another environmental study on seagrass impacts and has publicly stated that the causeway will move forward as a nontoll road project once the EIS is accepted [31, 32].

TxDOT’s current strategy for funding and building the causeway is to divide construction into three phases, each costing roughly US\$250 million. The first stage would be to construct a narrow one-lane bridge. The next phase would build the roads on the mainland and SPI to connect to the bridge. Finally, a parallel bridge would

comprise the opposing lane, resulting in a two-lane causeway with room between the opposing lanes for sunlight to reach the seagrass beds.

Supporters of the causeway, including former SPI Mayor Dennis Stahl, have expressed optimism that a new initiative to combine the RGV’s three metropolitan planning organizations (MPOs) into one large MPO for both Hidalgo and Cameron County will strengthen the region’s negotiating power with TxDOT for more discretionary transportation project funding [33]. They argue that a regional MPO will supply public funds for the causeway that are not presently available.

Ecological Effects of the Proposed Causeway  
Public works like the second causeway fall under the federal requirements of the National Environmental Policy Act to have an EIS approved by the Environmental Protection Agency. The EIS must show that the project has accounted for the range of environmental effects and

taken necessary steps to “mitigate” the short- and long-term damage. The mitigation requirement can be met by avoiding damage, minimizing damage, or compensating for any unavoidable damage caused [34].

From the mitigation standpoint, the proposed causeway is a complex project. It will cross sensitive terrestrial and coastal ecosystems, affecting a variety of habitats in one of the nation’s most biodiverse regions. These terrestrial habitats consist of thorn-scrub forest, grasslands, rangelands, farmlands, riparian forests, and coastal dunes. From the alternative routes assessed in the EIS, the total area of affected habitat ranges from 112 to 216 acres [26]. Many threatened and endangered species are dependent on these habitats and are at additional risk of continuous habitat loss even if the proposed mitigation process is achieved.

Another ecological impact of the proposed construction project will be damage to the highly sensitive habitats in the Laguna Madre and the coastal wetland complexes unique to the semiarid region of Texas. These include the seagrass beds, tidal mudflats, marshes, and the overall quality of the resources in the area. These are critical habitats to endangered and threatened species and are extremely difficult to mitigate [26, 35–37].

The direct impact to the seagrass beds is of significant concern. Seagrasses are particularly valuable in the provision of ecosystem services (e.g., water regulation, erosion control, recreation) to both the coastal ecosystem and human populations whose economy depends on it [38]. The impacts expected to occur from the proposed causeway include changing water circulation patterns, undesirable algal blooms, invasive vegetation growth, reduction in light penetration affecting seagrass photosynthesis, and an overall reduction of vegetated areas that are used for nesting, spawning, nursery, and cover and forage areas by many aquatic species [35, 36]. The Laguna Madre accounts for around 75% of seagrass cover along the entire Texas coast with important seagrass species that provide critical habitat for fish and waterfowl [39]. Shoal grass, *Halodule wrightii*, is significant in supporting the redhead duck, *Aythya americana*, whose over 75% of the world population overwinters in the Laguna Madre and feed exclusively on that one seagrass species [28, 40]. Environmental consultants hired by the CCRMA estimated 0.62 acres of direct impact from the project’s actual construction

and 60 acres of indirect impact. Its analysis reported that 128 acres of seagrass mitigation is required to compensate for loss caused by the project. As discussed above, the CCRMA and its consultants have not designed a convincing mitigation plan with the best balance of requirements (e.g., water clarity, salinity, depth) to establish a new growth of seagrass [28, 40].

Another habitat affected by the proposed project, tidal mudflats, provide important foraging and nesting for wintering and migrating shorebirds and wading birds. Tidal mudflats also serve as natural flood and storm surge protection and prevent erosion on the island [26].

The many threatened and endangered species residing in the Texas Gulf Coast area where the second causeway is proposed include marine and estuary species, such as mammals, amphibians, and fish. In the study for the causeway EIS, four federally listed and seven state-listed species were recognized with immediate impact to their habitat. Two of these are midsized felines, namely, jaguarundi and the ocelot. They have low population numbers and will face significant ecological impacts due to the construction of the proposed project, with the estimated loss of 5% of their habitat, and detrimental fragmentation due to the region of South Texas being the only habitat in which these two species can be found [41–43].

## CASE STUDY QUESTIONS

Table 1 provides a list of stakeholders relevant to the proposed construction project. It indicates whether they support or oppose its construction and describes their position. Using table 1, answer the following questions:

- I. How would you argue for or against the construction of the causeway if you were in each of the seven roles?
- II. If these roles disagree on whether the causeway should be constructed, why is this?
- III. What do the stakeholders have in common? Are there any steps to resolving the question that all or most of the stakeholders could agree to take?
- IV. In this case, which type of resilience should be prioritized—disaster/community resilience or ecological resilience? Is there a way of bringing the two types together, so that a resolution could satisfy both?

**TABLE 1. Stakeholders for the Proposed Second Causeway.**

Stakeholder	Role	Description
Federal government	U.S. Fish and Wildlife Service	<p>Stance: Neutral</p> <p>The U.S. Fish and Wildlife Service's role is to review the project's plan and propose avoidance and minimization measures for threatened and endangered species found in South Texas that would be impacted by the initial and long-term effects of the proposed project. Unless the biological analysis shows that a certain species will go extinct with the construction of the project, they do not hold any stopping power. An example: Recommending that construction not be done at night, due to the endangered ocelot being nocturnal and active during this time.</p>
State government	Texas Department of Transportation	<p>Stance: For</p> <p>TXDOT is the liaison with the Cameron County Regional Mobility Authority (CCRMA), the lead in the project, and other government agencies (local, state, and federal). They ensure that the project is following all the rules and regulations properly and help coordinate the environmental clearance document through CCRMA consultants and the federal and state resource agencies. It also assists the CCRMA in procuring federal funding for the project and is one of the agencies who have final clearance on the project.</p>
Local government	Mayor of South Padre Island	<p>Stance: For</p> <p>Runs the city which the project will benefit for emergency response, hurricane evacuation, and economic expansion. While holding very little power regarding how the project is executed, he makes recommendations from the input of constituents and businesses that would benefit. The mayor does not believe the causeway will have much impact to the environment and that mitigation will solve that problem.</p>
	Cameron County Regional Mobility Authority	<p>Stance: For</p> <p>Responsible for overseeing everything on the second access project (e.g., construction, funding, research, environmental impact). Its main concern is providing a different method of access to SPI for emergency services, evacuation, and to facilitate economic growth. Its first alternative was to build the project next to the existing causeway, but due to established development on both SPI and Port Isabel, it is not an option. The CCRMA is open to alternative suggestions than what is currently proposed.</p>
Local business and development coalitions	Realtor and SPI Economic Development Corporation Board Member	<p>Stance: For</p> <p>Resident and business owner at SPI who was present when the causeway collapsed and saw the firsthand effect it had on the community. Her business is affected by the traffic congestion on the existing causeway. She is aware that there might be environmental drawbacks but believes the safety of the human community should be the top priority.</p>
	SPI Convention Center and Visitor's Bureau	<p>Stance: For</p> <p>Responsible for supporting the tourism structure of SPI and has assisted in the causeway project by providing current visitation numbers and future estimates for SPI. The leadership recognizes the economic and safety benefits of the second causeway project because it will allow an increase in visitors, and would expand the safety spectrum for events that happen on the island.</p>
Environmental organizations	Nature Conservancy	<p>Stance: Against</p> <p>A nonprofit organization that advocates for the conservation of land for wildlife. It is aware of the safety and economic rationale for the project but is concerned about the</p>

*(continued)*



TABLE 1. (continued)

Stakeholder	Role	Description
		long-term destructive effects. It does not support the current EIS for the project, which it views as insufficiently extensive in accounting for loss of habitat. It is also concerned about the negative impact the northern development of SPI will have on the preserved land near the SPI portion of the proposed causeway.
	Friends of Laguna Atascosa National Wildlife Refuge	Stance: Against A volunteer-based organization that works to support and assist in enhancing ongoing conservation projects on the local national wildlife refuge. It is concerned about the habitat destruction and fragmentation resulting from the project and the increase in pollution caused by more human visitation to the area. Of particular concern are the preserved lands owned by the U.S. Fish and Wildlife Service that are on the north side of SPI. It would support the proposed project only if there were legal assurances that the route would not travel through sensitive habitats.
Research scientist	University of Texas—Austin Marine Science Institute	Stance: Neutral The role of the research scientist is to investigate the effects of constructing the second proposed causeway. This scientist does not believe that the second causeway is necessary. He says that the location for the second proposed causeway is not ideal and does not understand why a replacement bridge cannot be built in the location of the previous causeway. He says that the proposed construction project will affect the natural makeup of the Laguna Madre and damage its seagrass beds, and that the mitigation project to account for this would be substantial. However, he also acknowledges that SPI residents would benefit from having another access to the mainland when the current causeway is having delays or is unavailable.
Citizen	Resident of Bayview	Stance: Against Acknowledges second proposed causeway would be beneficial to lessen the traffic congestion to and from the island. However, this resident enjoys the rural characteristic of his town and the region and believes that the construction project would threaten this by encouraging construction on the island, bringing more traffic through his town, and damaging the environment. He believes that the towns surrounding SPI, such as Bayview, will be highly affected by the second proposed causeway, causing a decline in tourism and local businesses. Regarding evacuation from a natural disaster, such as a hurricane, this citizen is confident that there will be a warning or notice given with enough time to evacuate the area using the current causeway.

Source: Interviews with stakeholders representing each of these roles, conducted February and March 2019.

### AUTHOR CONTRIBUTIONS

Conceptualization, OT; funding acquisition, OT; investigation, OT and KS; supervision, OT; writing—original draft, OT and JV; writing—review and editing, JV, KS, and ER.

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### COMPETING INTERESTS

The authors declare that they have no known competing financial interests or personal relationships that could

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## SUPPLEMENTAL MATERIALS

Teaching Notes.docx

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