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Direct Economic Inputs from Internationally Funded Science Projects to the Abaco Islands, The Bahamas

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Abstract—**International expenditures for scientific research are important for small island developing nations, especially for those local communities that directly support research activities. We used the Abaco Islands, The Bahamas, as a case study to quantify the direct monetary inputs to a local economy via internationally funded scientific research. We found that over two years the external monetary influx was $995,310, via 24 research teams, spent across diverse business sectors on Abaco Island. A direct survey approach ensured this was a conservative estimate, leaving out numerous indirect economic impacts, thereby suggesting the actual monetary infusion was significantly higher. The highest expenditures were for services (e.g., local salaries and boat guides), lodging, food/drink, and major equipment (e.g., vehicles). While we do not have data from research teams working on other islands, significant research expenditures are made elsewhere in The Bahamas, including through government-sponsored efforts, environmentally-focused non-governmental organizations, and research centers. In addition to the research-based contributions that give rise to conservation and management decision-making, scientific activity brings benefits through the injection of money into local island economies. This relationship warrants study at larger regional scales, including across The Bahamas archipelago.**

Quantifying the value of ecosystem services is a primary tool for developing natural resource conservation approaches and promoting environmental sustainability for human well-being (Kubiszewski et al. 2017; Paul et al. 2020). This approach can provide frameworks for regional conservation planning, as has been done for the Caribbean (Schuhmann and Mahon 2015; Hernández-Blanco et al. 2020). Core to assigning a dollar value to ecosystem services is translating ecosystem "functions" (e.g., fishery yields or shoreline protection) into a unit (money) that people can recognize and relate to, providing a guide as to how ecosystems support local and regional economies. This valuation approach is now commonly used to link ecosystems and economics—via science—yet it is only one aspect of the complex interplay between the two. For example, local economic expenditures are necessary to support research activities, yet economic activity derived from scientific research is rarely quantified. This dynamic leads to a counterintuitive scenario where estimates of the abstract value of a region's ecosystems are available, whereas quantifications of concrete monetary flows to local economies from scientific research are not.

Science-based expenditures are especially relevant for the local communities that support internationally funded research—research often focused on the ecosystems that local communities depend on. In the Commonwealth of The Bahamas, an estimated 84% of the $13 billion economy is service-based (estimate from The Economist 2019), driven by the tourism industry. Directly or indirectly, natural resources form the base of the tourism industry, and thus the economy and the well-being of the Bahamian people. At least partially because of the fundamental importance of the environment to the national economy, scientific research is extensive and broad-reaching. This is highlighted by recent studies with direct economic relevance, including on recreational fisheries (Adams et al. 2019; Ruga et al.

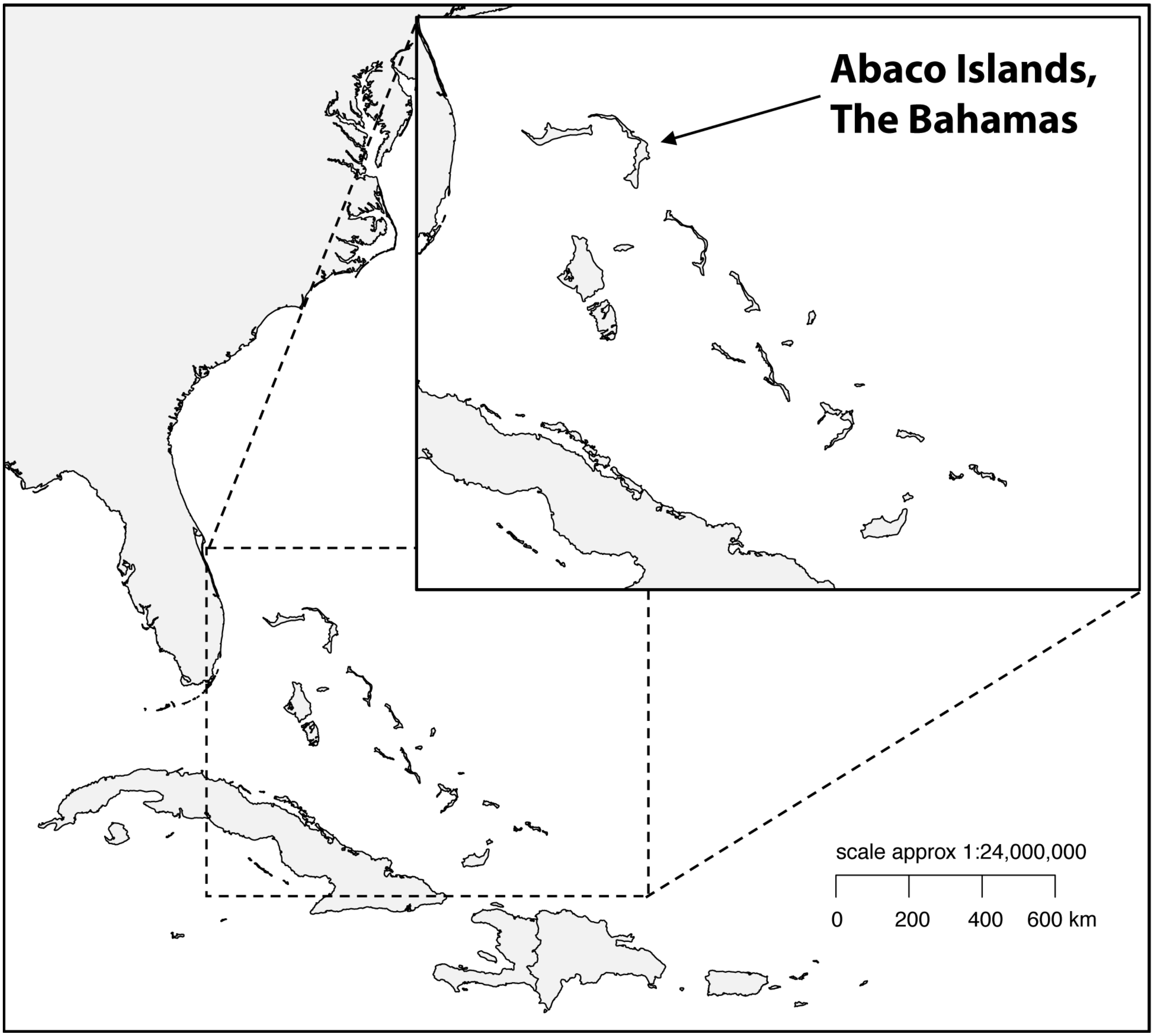

FIG. 1. The Abaco Islands are in the northern portion of the Lucayan Archipelago (inset). The Abaco Islands comprise the main islands of Great Abaco and Little Abaco along with several smaller barrier cays.

2019), coral reefs (Rogers et al. 2014), fishery species (Harborne et al. 2008; Sherman et al. 2018; Arkema et al. 2019), marine protected areas (Wielgus et al. 2008), and mangroves (Micheletti et al. 2016), as well as the study of events affecting natural resources, such as hurricanes (Wallace et al. 2019, 2021; Winkler et al. 2020).

We use the Abaco Islands, The Bahamas, as a case study to quantify direct monetary inputs to a local economy from internationally-funded environmental research. We aimed to depict one component of the multidimensional links between science and society (Penfield et al. 2014; Weisshuhn et al. 2018; Fryirs et al. 2019). In The Bahamas, the complex interrelationship between science and local communities was thoughtfully reflected on by Moore (2019), and here we extend information specifically regarding ties between science and economics. We take a conservative approach in that only direct influxes of money are included ("new money"— Southwick et al. 2016), providing a figure that defines the minimum economic impact. We then discuss ways in which collaborations between Bahamian and international scientists, as well as with Bahamian non-governmental organizations (NGOs) and the Government of The Bahamas, drive additional local economic activity. This study builds on previous reflections of the relationships between science and society for other small island developing nations—countries that share many common challenges for sustainable development (Wong 2011; Lowitt et al. 2015; Mycoo 2018; Walshe and Stancioff 2018; Moore 2019; Rao and McNaughton 2019).

Survey Approach

The Commonwealth of The Bahamas consists of hundreds of islands and cays encompassing a territory of 470,000 km2. The population was around 390,000 in 2019 (The Economist 2019), of which ~70% of people are on the island of New Providence, with the rest of the population spread across other islands. The Abaco Islands comprise the main islands of Great Abaco and Little Abaco along with several smaller barrier cays (Fig. 1); it is the third most populated island after New Providence and Grand Bahama. The Abacos were impacted by Hurricane Dorian in 2019, one of the strongest landfalling Atlantic hurricanes on record, causing catastrophic damage. The ongoing sustainable development challenges following Hurricane Dorian provide one background context for this study.

Researchers supported by international funding sources who visited the Abaco Islands from the 1st of August 2017 to the 1st of August 2019 were included in this data compilation. The primary contact list was generated through Friends of the Environment (FRIENDS), an environmental education-driven NGO in the most populated settlement, Marsh Harbour. Many of the researchers stayed in the Kenyon Centre (administered by FRIENDS), a facility established in 2015 to facilitate research and education by providing affordable accommodations and basic lab capabilities for scientists, with specific intentions to build connections between scientists and the local community. Additional researchers were contacted for the survey based on other projects taking place in the Abacos known to the authors of this study. In June 2020, an email invitation to participate was sent to all researchers identified. We conveyed a priori in the email that the source(s) of the data for this study would remain anonymous, as we were interested in the overall monetary inputs proper, not identifying individual research teams or funding sources. Some researchers volunteered itemized expenditure lists which allowed for general assessments of how money was spent. The Bahamian dollar has been the currency of the country since 1966 and is pegged one-to-one to the U.S. dollar; hereafter, the $ sign is used for simplicity.

Results

Twenty-four research groups responded to the request; 18 of the 24 (75%) were from the United States and the others from the United Kingdom, Continental Europe, or Bahamas-based organizations supported by international funding. Eight additional groups responded and said that they had researched in the country but not during the time frame we identified. Groups included university professors and students, NGOs, independent research groups, and conservation organizations. Research topics ranged widely across terrestrial and aquatic systems, including threats to coral reefs, mangrove die-off, artificial reef deployment, recreational fisheries, geological structures unique to the island, paleoecology, and threatened bird species. All of the researchers received necessary permits from the Bahamian government and developed programs with non-commercial outcomes—the fundamental purpose of the research was knowledge acquisition and applying that information toward the development of conservation or management strategies. Other respondents noted that they had expenditures on Abaco for environmental education activities during the period; these data were not included, thus rendering our estimated expenditure values conservative. Further, we are aware of research teams that did not respond to the survey, again indicating that the actual science-based expenditures are higher than the values reported here. Thus, this study provides a minimum baseline value from which to infer the impacts international funding has on the local economy via research activities.

Total recorded expenditures for the two years were $995,310 (Table 1). For international academic research teams (the most common researcher category) the average expenditure was $30,621 per team. Twenty of the respondents provided itemized estimates allowing us to assess areas where expenditures were targeted (Fig. 2). Fifteen sub-categories were identified representing money spent in diverse sectors of the economy. Four categories accounted for 73% of all expenditures: services (primarily salaries and boat guides), lodging, meals, and major equipment.

TABLE 1. The categorized expenditures by each scientific team in the Abaco Islands from August 1st, 2017, to August 1st, 2019.

Researcher Classification	Supplies	Major Equipment	Gas	Food and Drink	Car Rental	Car Other	Boat Expenses	Conferences	Lodging	Other Transportation	Services	Communications	Permits/Licensing	Shipping	Contracts	Other	Total per Team
US Researcher	$1,700		$2,095	$10,293	$3,624		$2,309	$591	$5,868	$225	$6,594						$33,298
US Researcher				$1,751	$1,517				$11,000	$88	$9,954					$45	$24,355
US Researcher				$400	$300					$100							$800
US Researcher	$125			$2,197					$1,341	$278	$100	$35	$56			$68	$4,200
US Researcher	$3,884	$54,622	$1,183	$5,000		$1,900	$296		$9,000		$27,500	$73		$1,567		$300	$105,324
US Non-profit	$370		$4,200	$6,590	$260		$4,600		$9,890		$4,000					$240	$30,150
Bahamas-based Non-profit	$1,000		$6,000	$16,200	$400	$1,700	$400		$5,800		$108,044	$2,000	$56			$1,500	$143,044
US Researcher/ Non-profit			$33	$954	$420				$600		$4,000						$6,007
UK/Bahamas Researcher	$175		$1,292	$5,120	$4,136		$3,432		$15,360							$800	$30,315
US Researcher	$534		$953	$2,043	$1,548		$1,780		$597							$115	$7,570
US company				$5,500			$9,000		$11,520	$150	$8,400	$200			$30,663		$65,433
US Researcher				$1,200	$353				$480	$150							$2,183
Independent research support	$467		$3,005	$4,246	$179				$486	$175	$3,805	$584				$7,043	$19,990
US Researcher			$103	$34					$161							$484	$782
US Researcher																	$40,000
US Researcher			$200	$800					$800								$1,800
US Researcher	$4,150		$400	$4,300		$671			$1,150	$300						$200	$11,171
US Researcher																	$14,265
UK Researcher	$20			$350			$120		$429							$400	$1,319
US Researcher	$767	$11,300	$1,553	$3,467	$2,521		$14,312		$8,758	$336	$66	$70		$1,769			$44,919
US Researcher			$100	$280		$250											$630
European Researcher	$400		$800	$4,500	$4,000		$2,000		$6,000		$1,000	$50				$200	$18,950
US Organization																	$35,000
Bahamas-based Organization																	$353,805
	Supplies	Major Equipment	Gas	Food and Drink	Car Rental	Car Other	Boat Expenses	Conference	Lodging	Other Transportation	Services	Communications	Permits/Licensing	Shipping	Contracts	Other	Total
Totals:	$13,592	$65,922	$21,916	$75,225	$19,258	$4,521	$38,249	$591	$89,240	$1,802	$173,463	$3,012	$56	$3,336	$30,663	$11,395	$995,310

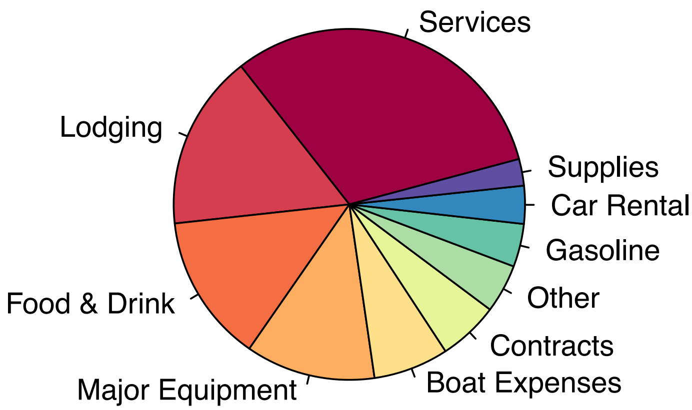

FIG. 2. The relative proportion of expenditures by scientists on Abaco Island from August 1st, 2017, to August 1st, 2019.

DISCUSSION

The Bahamas is a country fundamentally dependent on its natural resources, and science-based input is necessary to protect and manage these resources. Although science contributions can be quantified through output metrics (such as the number of publications stemming from research in the country), and they form a direct basis for policy-making (as can be seen in codified environmental regulations), science has multidimensional societal outcomes that are often less appreciated and difficult to quantify (Weisshuhn et al. 2018; Moore 2019; Chams et al. 2020; Marti et al. 2020; Williams 2020). These outcomes include direct economic impacts associated with scientific research, the focus of the present study. The minimum estimated direct monetary input was $995,310 over two years in the Abaco Islands, and a more complete estimate would be higher because of the caveats outlined in the Methods and the reasons discussed in the following paragraphs.

We identified only one somewhat similar study in the primary literature (Royuela et al. 2019). This study analyzed the Safe Islands for Seabirds project on Corvo Island—the smallest, most remote, and least populated island in the Azores Archipelago. The project was coordinated by Sociedade Portuguesa para o Estudo das Aves (a BirdLife International partner), in partnership with the municipality of Corvo, the Secretary of Environment and Sea (on behalf of the Azores Regional Government), and the Royal Society for the Protection of Birds. It comprised 35 actions related to the conservation of bird species and habitats, scientific research, and science communication to the public. The science revolved around the eradication of invasive mammalian species (cats, rodents, goats, and sheep) and assessing the impact of these animals and alien plant species (e.g., cane and tamarisk) on seabird breeding success. Over three years, the estimated direct external expenditures on the project were €344,212 (equivalent to ~$400,000 depending on the current exchange rate used). The authors noted that there is no standardized method to assess such economic impacts of scientific activities (because such studies are so rare), so we drew from their study in designing the present project.

As in Royuela et al. (2019), an advantage of our economic assessment for the Abaco Islands was that expenditure information was compiled directly from researchers. Collecting data directly from scientists avoids indirect inferences and assumptions regarding visitors to The Bahamas (e.g., Maycock 2015). Since university-based scientists primarily fund their research activities with grants from public money (e.g., the National Science Foundation in the United States) or private foundations (e.g., National Geographic Society), their budgets are readily available and expenditures well-documented. Fedler (2019) used a similar, direct survey approach to estimate the economic impact of the recreational bonefishing fishery for The Bahamas. Specifically, they compiled data from bonefishing lodges and independent bonefish guides through in-person interviews, e-mail, or telephone calls. They collected information on the number of fishing days and number of anglers serviced by each lodge or independent guide, focusing on their direct expenditures locally. Such direct approaches provide a reliable way to estimate actual expenditures instead of inferring potential economic activity through alternative means.

Our approach yielded the minimum economic impact, namely, we did not provide estimates that incorporated multiplier effects. A multiplier is a measure of how dollars brought into a community are re-spent, thereby leading to additional economic activity. The output multiplier measures the combined effect of a $1 change in money spent on the output of all participants in a specified economy (Hughes 2018). This framework is often broken into three components: direct, indirect, and induced effects. Direct effects are the values we report, i.e., the sum of all money spent by scientists that was sourced from international funding agencies—

external (new) money transferred to local businesses, organizations, or individuals. Indirect effects refer to the increase in economic activity that occurs when the recipient of the external money re-invests it into other local goods or services that support their businesses (e.g., a fishing guide paying a mechanic to service a boat engine). Induced effects are changes in spending patterns that are caused by the increased income of those persons directly and indirectly supported by the initial spending (e.g., the boat mechanic has more money to dine in a local restaurant). These effects together are represented by the multiplier that is applied to direct expenditures (direct effects) to yield a total estimated economic impact. Multipliers are not available for the type of scientific economic activity we quantified, and any multiplier assumptions, such as for tourism (Crompton et al. 2016) or recreational fisheries (Southwick et al. 2016), are wrought with challenges. One analog we can use is ecological restoration, for which multipliers ranging from 1.6 to 2.6 have been applied (BenDor et al. 2015). Taking the midpoint of this range (a multiplier of 2.1) would suggest that the minimum economic impact of scientific research on Abaco is more than double the dollar value we estimate in this paper—more than $1 million annually.

The application of multipliers alone does not include other contributions that can be parlayed into additional economic returns. Direct partnerships between Bahamian scientists and international researchers open possibilities for ongoing project development, drawing on local knowledge complemented with international support. NGOs benefit by using scientific research for procuring additional grant dollars and to support fundraising (such as building and maintaining the Kenyon Centre on Abaco). Local organizations also benefit from research through capacity building and enhancing existing projects, thereby allowing those organizations to direct more of their funds to the local economy. Other activities involving researchers include working with Bahamian students to move into STEM fields, developing educational materials, assisting with the justification for new protected areas, participating in the scientific review of conservation and development projects, and providing expertise for community-based habitat restoration projects. While some of these activities are incorporated in permitted research projects and thus encompassed by the direct economic assessment outlined in this study, many represent additional "hidden" economic value to local economies. Educational and applied science activities are now further emphasized in The Bahamas scientific permitting process, which will further solidify and extend external monetary inputs to local communities.

Research enables network development between Bahamian and international scientists, leading to future research projects, and attracting funding to the country to advance natural resource management. Science has led to internationally-recognized documentaries, e.g., through National Geographic (Todhunter 2010), that are promotional tools for the Ministry of Tourism. Science- and conservation-based research trips introduce people to the island who may return subsequently (for scientific research or as tourists), generating future revenue. Although money can "leak" out of the economy (Southwick et al. 2016), e.g., some businesses are internationally-based (e.g., many airlines) and supplies (e.g., food) are imported from other countries, research activities still provide support for job creation locally. A logical way to extend this study is to identify those expenditures that best support local communities and do not move out of the country. Also, more attention is warranted to assess the proportion of internationally funded expenditures that go directly to the Bahamian government via the value-added tax and other government fees. We acknowledge we are using simple monetary values to represent a complex interrelationship of science and society, and we do not consider various other important economic and sociological perspectives (Moore 2019). Regardless, the external economic stimulus is a real outcome that should be considered.

An obvious next step is to scale this project beyond Abaco to the entire country. Such a project would encompass research centers supporting science, including the Cape Eleuthera Institute, Gerace Research Centre, Bimini Biological Field Station, and Forfar Field Station. Research on other islands is supported by The Bahamas National Trust, The Nature Conservancy, and The Bahamas Reef Environmental Education Foundation, among other organizations. Likewise, funding from international organizations, such as the United Nations and the Inter-American Development Bank, that is directed to the Government of The Bahamas and earmarked for science and conservation efforts, should be considered as additional sources of international support that eventually have concrete, local economic impacts. Quantifying the broader economic impacts of research activities, from both national and international funding sources, will reveal a more complete picture of scientific research for The Bahamas and other countries in the region.

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LITERATURE CITED

Adams, A. J., J. S. Rehage, and S. J. Cooke. 2019. A multi-methods approach supports the effective management and conservation of coastal marine recreational flats fisheries. *Environmental Biology of Fishes* 102: 105–115.

Arkema, K. K., L. A. Rogers, J. Toft, A. Mesher, K. H. Wyatt, S. Albury-Smith, S. Moultrie, M. H. Ruckelshaus, and J. Samhouri. 2019. Integrating fisheries management into sustainable development planning. *Ecology and Society* 24: 1.

BenDor, T., T. W. Lester, A. Livengood, A. Davis, and L. Yonavjak. 2015. Estimating the Size and Impact of the Ecological Restoration Economy. *PloS ONE* 10: e0128339.

Chams, N., B. Guesmi, and J. M. Gil. 2020. Beyond scientific contribution: Assessment of the societal impact of research and innovation to build a sustainable agri-food sector. *Journal of Environmental Management* 264: 12.

Crompton, J. L., J. Y. Jeong, and R. M. Dudensing. 2016. Sources of Variation in Economic Impact Multipliers. *Journal of Travel Research* 55: 1051–1064.

Fedler, T. 2019. *The 2018 Economic Impact of Flats Fishing in The Bahamas*. Bonefish and Tarpon Trust.

Fryirs, K. A., G. J. Brierley, and T. Dixon. 2019. Engaging with research impact assessment for an environmental science case study. *Nature Communications* 10: 10.

Harborne, A. R., P. J. Mumby, C. V. Kappel, C. P. Dahlgren, F. Micheli, K. E. Holmes, and D. R. Brumbaugh. 2008. Tropical coastal habitats as surrogates of fish community structure, grazing, and fisheries value. *Ecological Applications* 18: 1689–1701.

Hernández-Blanco, M., R. Costanza, S. Anderson, I. Kubiszewski, and P. Sutton. 2020. Future scenarios for the value of ecosystem services in Latin America and the Caribbean to 2050. *Current Research in Environmental Sustainability* 2: 100008.

Hughes, D. W. 2018. *A Primer in Economic Multipliers and Impact Analysis Using Input-Output Models*. University of Tennessee Institute of Agriculture.

Kubiszewski, I., R. Costanza, S. Anderson, and P. Sutton. 2017. The future value of ecosystem services: global scenarios and national implications. *Ecosystem Services* 26: 289–301.

Lowitt, K., A. Saint Ville, P. Lewis, and G. M. Hickey. 2015. Environmental change and food security: the special case of small island developing states. *Regional Environmental Change* 15: 1293–1298.

Marti, T. S., R. Flecha, J. A. Rodriguez, and J. L. C. Bosch. 2020. Qualitative inquiry: a key element for assessing the social impact of research. *Qualitative Inquiry* 26: 948–954.

Maycock, D. 2015. *Measuring economic impacts of recreational fishing in The Bahamas*. Prepared for the United Nations Food and Agricultural Organization. Abaco, Bahamas.

Micheletti, T., F. Jost, and U. Berger. 2016. Partitioning Stakeholders for the Economic Valuation of Ecosystem Services: Examples of a Mangrove System. *Natural Resources Research* 25: 331–345.

Moore, A. 2019. *Destination Anthropocene: Science and Tourism in The Bahamas.* University of California Press, Oakland, California.

Mycoo, M. A. 2018. Beyond 1.5 degrees C: vulnerabilities and adaptation strategies for Caribbean Small Island Developing States. *Regional Environmental Change* 18: 2341–2353.

Paul, C., N. Hanley, S. T. Meyer, C. Fürst, W. G. Weisser, and T. Knoke. 2020. On the functional relationship between biodiversity and economic value. *Science Advances* 6: 17.

Penfield, T., M. J. Baker, R. Scoble, and M. C. Wykes. 2014. Assessment, evaluations, and definitions of research impact: A review. *Research Evaluation* 23: 21–32.

Rao, L. L. and M. McNaughton. 2019. A knowledge broker for collaboration and sharing for SIDS: the case of comprehensive disaster management in the Caribbean. Information *Technology for Development* 25: 26–48.

Rogers, A., J. L. Blanchard, and P. J. Mumby. 2014. Vulnerability of Coral Reef Fisheries to a Loss of Structural Complexity. *Current Biology* 24: 1000–1005.

Royuela, J. B., S. Hervías Parejo, A. de la Cruz, P. Geraldes, L. T. Costa, and A. Gil. 2019. The socio-economic impact of conservation: the Safe Islands for Seabirds LIFE project. *Oryx* 53: 109–116.

Ruga, M. R., D. L. Meyer, and J. W. Huntley. 2019. Conch fritters through time: human predation and population demographics of Lobatus gigas on San Salvador Island, The Bahamas. *Palaios* 34: 383–392.

Schuhmann, P. W. and R. Mahon. 2015. The valuation of marine ecosystem goods and services in the Caribbean: A literature review and framework for future valuation efforts. *Ecosystem Services* 11: 56–66.

Sherman, K. D., A. D. Schultz, C. P. Dahlgren, C. Thomas, E. Brooks, A. Brooks, D. R. Brumbaugh, L. Gittens, and K. J. Murchie. 2018. Contemporary and emerging fisheries in The Bahamas: conservation and management challenges, achievements and future directions. *Fisheries Management and Ecology* 25: 319–331.

Southwick, R., D. Maycock, and M. Bouaziz. 2016. *Recreational fisheries economic impact assessment manual and its application in two study cases in the Caribbean: Martinique and The Bahamas*. FAO Fisheries and Aquaculture Circular No. 1128. Bridgetown, Barbados.

The Economist. 2019. *World in Figures 2020*. Profile Books Ltd., London.

Todhunter, A. 2010. *Deep Dark Secrets*. National Geographic Magazine.

Wallace, E. J., J. P. Donnelly, P. J. van Hengstum, C. Wiman, R. M. Sullivan, T. S. Winkler, N. E. d'Entremont, M. Toomey, and N. Albury. 2019. Intense hurricane activity over the past 1500 years at South Andros Island, The Bahamas. *Paleoceanography and Paleoclimatology* 34: 1761–1783.

Wallace, E. J., J. P. Donnelly, P. J. van Hengstum, T. S. Winkler, K. McKeon, D. MacDonald, N. E. d'Entremont, R. M Sullivan, J. D. Woodruff, A. D. Hawkes, and C. Maio. 2021. 1050 years of hurricane strikes on Long Island in The Bahamas. *Paleoceanography and Paleoclimatology* 36: e 2020PA004156.

Walshe, R. A., and C. E. Stancioff. 2018. Small island perspectives on climate change. *Island Studies Journal* 13: 13–24.

Weisshuhn, P., K. Helming, and J. Ferretti. 2018. Research impact assessment in agriculture—A review of approaches and impact areas. *Research Evaluation* 27: 36–42.

Wielgus, J., E. Sala, and L. R. Gerber. 2008. Assessing the ecological and economic benefits of a no-take marine reserve. *Ecological Economics* 67: 32–40.

Williams, K. 2020. Playing the fields: Theorizing research impact and its assessment. *Research Evaluation* 29: 191–202.

Winkler, T. S. 2020. Revising evidence of hurricane strikes on Abaco Island (The Bahamas) over the last 700 years. *Scientific Reports* 10: 16556.

Wong, P. P. 2011. Small island developing states. *Wiley Interdisciplinary Reviews-Climate Change* 2: 1–6.