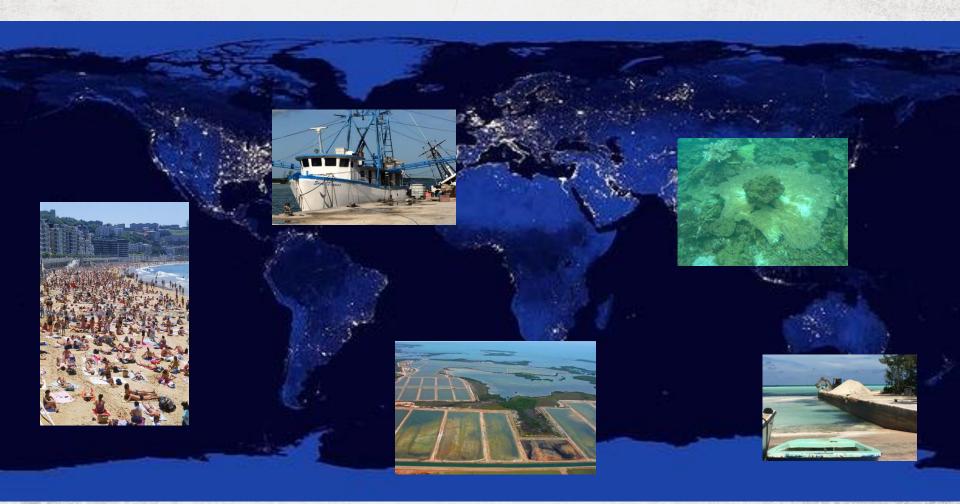
ECONOMIC VALUATION OF ECOSYSTEM SERVICES IN BAHAMIAN MARINE PROTECTED AREAS



Katie Arkema, Dave Fisher, Katherine Wyatt Stanford University



The Natural Capital Project • Economic Valuation of Bahamian MPAs • December, 2017



people environment











ECOSYSTEM SERVICES benefits nature provides to people









people environment



Designated marine protected areas of The Bahamas

management plan status: finalized (x) drafted (*)



10. Pelican Cays Land & Sea Park (*) 11. South Abaco Blue Holes NP 35. Southeast Bahamas MMA

39. West Coast Marine Park (*) 100 km

ECONOMIC VALUATION OF ECOSYSTEM SERVICES IN BAHAMIAN MPAS

This work

- 1. Reviews past studies of economic value of marine ecosystems, species, and MPAs
- 2. Makes the economic case and build awareness and support for MPA declaration by quantifying the economic value of ecosystem services within the existing MPA network
- 3. Explores management issues and quantifies ecosystem services at the island-scale for 5 regions with MPAs with varying management regimes

CCI '20 BY 20' CHALLENGE

PROTECTING AND SUSTAINABLY MANAGING 20% OF THE CARIBBEAN'S MARINE AND COASTAL ECOSYSTEMS BY 2020.

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SUMMARY OF ECONOMIC HABITAT VALUES IN EXISTING STUDIES

- Coral reefs: \$44,500-\$1.35 million km²/yr
- (fisheries, coastal protection, tourism, non-use etc.)
- Mangroves & wetlands: \$850,000-\$1.2 million km²/yr (fisheries, coastal protection, tourism, water quality etc.)
- Tidal Creeks: \$35,000-\$1.75 million km²/yr
- (coastal protection, fisheries, carbon sequestration)
- Seagrass: \$500-\$150,000 km²/yr
- (fisheries, coastal protection, tourism)



13 studies include Hargreaves-Allen 2010, 2011, 2016; SFG 2014; Micheletti et al. 2016

VALUE OF ECOSYSTEM SERVICES EXPLORED IN PREVIOUS STUDIES

- > Fisheries: \$124.5 million an. in lobster and reef fish export value
 - 33,100 tons/yr in subsistence catch, 4,000 fishing vessels, 9,300 directly employed
- Tourism: \$402 million from stop-over visitor (2007)
 - > \$150 million in aggregated econ. impact from rec fishing; \$115 shark-related
 - > 300 fishing guides nationally, 500 nature-based tourism employees on Andros
- Coastal Protection: \$3.9 billion km²/yr in coastal protection by habitats
 - > > 50% of Andros coastline protected by habitats
 - > \$33,000 in avoided cost to government from erosion control on Great Abaco

22 studies including Hargreaves-Allen 2010, 2011, 2016; Hargreaves-Allen and Pendleton 2010; Smith and Zeller 2016; DMR; FAO 2009; Gittens and Braynen; Sullivan Sealey 2011; Fedler 2010; Ministry of Tourism; Micheletti et al. 2016

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Production function models

changes in ecosystems → changes in ecosystem services → changes in benefits to people



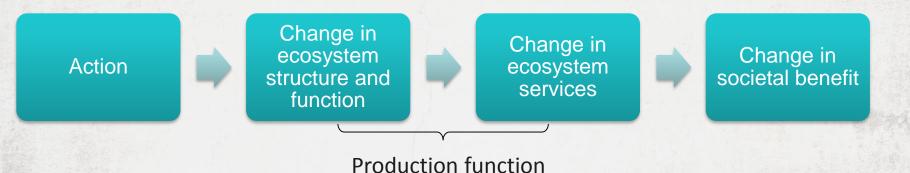
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ECONOMIC VALUATION OF ECOSYSTEM SERVICES IN BAHAMIAN MPAS

This work

- 1. Reviews past studies of economic value of marine ecosystems, species, and ecosystem services.
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A. General framework for an ecosystem services assessment



B. Ecosystem services assessment for coastal protection services provided by habitats



2. QUANTIFY THE ECONOMIC VALUE OF FOUR ECOSYSTEM SERVICES IN THE EXISTING NETWORK OF MPAS

Nursery habitat for spiny lobster fishery



Tourism



Coastal protection



Carbon storage & sequestration



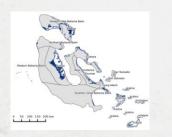


VALUING NURSERY HABITAT FOR LOBSTER

Inputs

- Mangrove distribution
- Seagrass distribution
- Shelf
- Stock assessment parameters





Outputs

Catch of spiny lobster



Revenue from catch



 Value of habitats for contribution to catch and revenue



Bank region	МРА	Proportion of region's nursery mangrove within MPA	Proportion of region's nursery seagrass within MPA
Abaco	Marls of Abaco NP	0.54	0.21
	South Abaco Blue Holes NP	0.04	0.01
	Cross Harbour NP	0.02	0.01
	Pelican Cays Land And Sea Park	0.00	0.01
	East Abaco Creeks - Snake Cays	0.00	0.01
	East Abaco Creeks - The Bight	0.01	0.01
	East Abaco Creeks - Cherokee	0.01	0.00
Acklins	Southeast Bahamas MMA	0.00	0.09
	Bight of Acklins NP	0.01	0.06
	Hogsty Reef Protected Area	0.00	0.01
Andros	Westside NP	0.69	0.53
	Joulter Cays NP	0.02	0.04
	Southern MP	0.00	0.02
Caysal	Cay Sal MMA	NA	1.00
Exuma	Exuma Cays Land & Sea Park	0.05	0.18
	Jewfish Cay MR	0.09	0.04
	Moriah Harbour Cay NP	0.02	0.03
Inagua	Little Inagua NP	0.17	0.05
New Providence	Southwest New Providence MMA	0.00	0.10
	Green Cay MP	0.00	0.02
	Bonefish Pond NP	0.16	0.01
Northern Bahama Bank	South Berry Islands MR	0.16	0.15
San Salvador	Graham's Harbour	0.00	0.17
	West Coast Dive Site	0.05	0.15
	Conception Island NP	0.00	0.10
	Pigeon Creek & Snow Bay NP	0.73	0.09
	Greens Bay NP	0.00	0.02
Vestern Little Bahama Bank	Northshore / The Gap NP	0.47	0.44
	East Grand Bahama NP	0.17	0.10

Amount of nursery habitats in MPAs for lobster fishery

*MPAs with less than 0.3% of their region's mangrove and seagrass are left out of this table.



Value of nursery habitats in MPAs for lobster fishery

Nursery habitats in MPA's contribute **6.01 million pounds** to the annual lobster catch,

Generating **\$22.52 million** in revenue per year.

Bank region	Annual contribution of nursery habitat in MPAs to lobster catch (millions of pounds)	Annual contribution of nursery habitat in MPAs to lobster revenue (\$ millions)
Abaco	1.13	4.42
Acklins	0.10	0.37
Andros	0.58	2.28
Cay Sal	0.21	0.84
Eleuthera	0.22	0.87
Exuma	0.23	0.90
Inagua	0.03	0.10
Long Island	0.06	0.25
New Providence	0.22	0.86
Northern Bahama Bank	0.22	0.87
San Salvador	0.10	0.38
Southern Great Bahama Bank	0.96	3.77
Western Bahama Bank	0.43	1.68
Western Little Bahama Bank	1.52	5.93
totals	6.01	23.52

2. QUANTIFY THE ECONOMIC VALUE OF FOUR ECOSYSTEM SERVICES WITHIN THE EXISTING NETWORK OF MPAS

Nursery habitat for spiny lobster fishery



Tourism



Coastal protection



Carbon storage & sequestration





TOURISM

Inputs

- Ministry of Tourism visitor surveys (# visitors—cruise and stopover, length of stay, \$/stay)
- Industry job surveys
- Spatial distribution of visitors



Wood et al 2013 Scientific Reports

Outputs

- Visitor nights per area
- Visitor expenditure
- Number of jobs







Southwest New Providence MMA Exuma Cays Land & Sea Park West Coast Dive Site Westside NP Southeast Bahamas MMA Marls of Abaco NP Moriah Harbour Cay NP South Berry Islands MR Conception Island NP Pigeon Creek & Snow Bay NP Joulter Cavs NP Cay Sal MMA Lucayan NP East Grand Bahama NP Graham's Harbour Fowl Cays NP East Abaco Creeks - Cherokee Pelican Cays Land And Sea Park Northshore / The Gap NP Little Inagua NP Exuma (Jewfish Cay) MR Crab Cay MR Andros Southern MP Hogsty Reef Protected Area Bonefish Pond NP Abaco NP South Abaco Blue Holes NP Peterson Cay NP No Name Cay MR East Abaco Creeks - The Bight Andros Northern MP Walker's Cav NP Union Creek Reserve Tilloo Cav Reserve Greens Bay NP Green Cay MP East Abaco Creeks - Snake Cavs Cross Harbour NP Black Sound Cay NP Bight of Acklins NP 0

25,000

50,000

annual visitor-days (cruise visits in gray)

~383,000 visitor-days are spent annually at sites within the MPA network.

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100,000

75,000



~\$67.6 million in expenditures are associated with annual visits to sites within MPAs

Southwest New Providence MMA Exuma Cays Land & Sea Park West Coast Dive Site Westside NP Southeast Bahamas MMA Marls of Abaco NP Moriah Harbour Cay NP South Berry Islands MR Conception Island NP Pigeon Creek & Snow Bay NP Joulter Cavs NP Cay Sal MMA Lucayan NP East Grand Bahama NP Graham's Harbour Fowl Cavs NP East Abaco Creeks - Cherokee Pelican Cays Land And Sea Park Northshore / The Gap NP Little Inagua NP Exuma (Jewfish Cay) MR Crab Cay MR · Andros Southern MP Hogsty Reef Protected Area Bonefish Pond NP Abaco NP South Abaco Blue Holes NP Peterson Cay NP No Name Cay MR East Abaco Creeks - The Bight Andros Northern MP Walker's Cav NP Union Creek Reserve Tilloo Cav Reserve Greens Bay NP Green Cay MP East Abaco Creeks - Snake Cavs Cross Harbour NP Black Sound Cay NP Bight of Acklins NP 5 10 0

annual visitor expenditures (\$ millions)

2. QUANTIFY THE ECONOMIC VALUE OF FOUR ECOSYSTEM SERVICES WITHIN THE EXISTING NETWORK OF MPAS

Nursery habitat for spiny lobster fishery



Tourism



Coastal protection



Carbon storage & sequestration





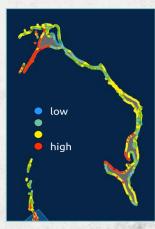
COASTAL PROTECTION

Inputs

- Geomorphology
- Habitats
- Wind exposure
- Wave exposure
- Storm surge (continental shelf)
- Relief
- Sea level rise
- Census data (population, income)

Outputs

- Exposure
- Reduction in exposure attributable to habitat
- People protected
- Income protected









COASTAL PROTECTION

Coastal habitats in MPAs reduce exposure to **39,000 people** and **\$806 million** in annual income

	Island group	Current MPAs	Reduction in exposure (\$ millions annual income)	Reduction in exposure (# of people)
	Abaco	Abaco NP – Black Sound Cay NP – No Name Cay MR – Fowl Cays NP – Tilloo Cay Reserve – Pelican Cays Land And Sea Park – Cross Harbour NP – Marls of Abaco NP – East Abaco Creeks (The Bight) – East Abaco Creeks (Snake Cays) – East Abaco Creeks (Cherokee) – South Abaco Blue Holes NP	\$32.32	3,630
6	Acklins/Crooked	Bight of Acklins NP	\$0.00	0
	Andros	Northern Marine Park – Southern Marine Park – Westside NP – Joulter Cays NP	\$6.40	782
	Berry Islands	South Berry Islands MR	\$1.92	238
	Exuma	Exuma Cays Land & Sea Park – Exuma (Jewfish Cay) MR – Moriah Harbour Cay NP	\$15.89	1,482
	Grand Bahama	Northshore/The Gap NP – East Grand Bahama NP – Peterson Cay NP – Lucayan NP	\$16.63	1,027
	Inagua	Union Creek Reserve – Little Inagua NP	\$0.00	0
	New Providence	Bonefish Pond NP – Southwest New Providence MMA	\$717.53	30,416
	San Salvador	West Coast Dive Site – Greens Bay NP– Graham's Harbour – Pigeon Creek & Snow Bay NP	\$15.76	1,403
	totals		\$806.45	38,978

2. QUANTIFY THE ECONOMIC VALUE OF FOUR ECOSYSTEM SERVICES WITHIN THE EXISTING NETWORK OF MPAS

Nursery habitat for spiny lobster fishery



Tourism



Coastal protection



Carbon storage & sequestration

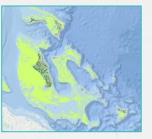




BLUE CARBON MODEL

Inputs

- Mangrove distribution
- Seagrass distribution
- Biomass
- Litter
- Soil
- Rates of decay
- Social value



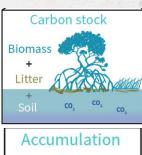


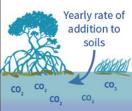


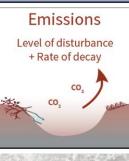
Outputs

- Carbon storage
- Carbon accumulation
- Carbon emissions
- Net sequestration
- Net present value

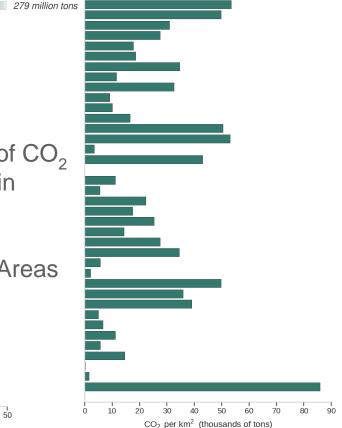








CARBON STORAGE BY MPA



Westside National Park Marls of Abaco National Park Northshore / The Gap National Park East Grand Bahama National Park Exuma Cavs Land & Sea Park Bight of Acklins National Park South Abaco Blue Holes National Park Joulter Cays National Park Cross Harbour National Park South Berry Islands Marine Reserve Exuma (Jewfish Cay) Marine Reserve Southwest New Providence Marine Managed Area East Abaco Creeks - Cherokee Union Creek Reserve Little Inagua National Park East Abaco Creeks - The Bight Southeast Bahamas Marine Managed Area Hogsty Reef Protected Area Moriah Harbour Cay National Park Andros Northern Marine Park Pigeon Creek & Snow Bay National Park East Abaco Creeks - Snake Cays Graham's Harbour Andros Southern Marine Park Pelican Cays Land And Sea Park West Coast Dive Site Conception Island National Park Bonefish Pond National Park No Name Cay Marine Reserve Crab Cay Marine Reserve Walker's Cay National Park Green Cay Marine Park Fowl Cavs National Park Lucayan National Park Greens Bay National Park Abaco National Park Peterson Cay National Park Tilloo Cav Reserve Black Sound Cay National Park 0

404 million tons of CO₂

equivalent stored in mangroves and seagrasses within Marine Protected Areas

10

20

millions of tons CO2

30

40

\$3.5 billion

Value of avoided emissions by MPA

Westside National Park Marls of Abaco National Park Northshore / The Gap National Park East Grand Bahama National Park Exuma Cays Land & Sea Park **Bight of Acklins National Park** South Abaco Blue Holes National Park Joulter Cavs National Park Cross Harbour National Park South Berry Islands Marine Reserve Exuma (Jewfish Cay) Marine Reserve Southwest New Providence Marine Managed Area East Abaco Creeks - Cherokee Union Creek Reserve Little Inagua National Park East Abaco Creeks - The Bight Southeast Bahamas Marine Managed Area Hogsty Reef Protected Area Moriah Harbour Cay National Park Andros Northern Marine Park Pigeon Creek & Snow Bay National Park East Abaco Creeks - Snake Cays Graham's Harbour Andros Southern Marine Park Pelican Cays Land And Sea Park West Coast Dive Site Conception Island National Park Bonefish Pond National Park No Name Cay Marine Reserve Crab Cay Marine Reserve Walker's Cay National Park Green Cay Marine Park Fowl Cays National Park Lucayan National Park Greens Bay National Park Abaco National Park Peterson Cav National Park Tilloo Cay Reserve Black Sound Cay National Park

\$5 billion in avoided damages from emissions (at \$12.58/ton market price)

Lack of data available for Cay 1 1 1 1 0Sal 100 200 300 400 500 600 700 800 value of carbon stock (\$ millions)

Ecosystem Service	Values provided ecosystems within the existing MPA network	Factors that influence spatial variation in ecosystem service (not comprehensive)
Tourism	383,000 visitor-days and \$67.6 million in expenditures annually	Island differences in visitation, expenditure, habitat extent, access, infrastructure
Coastal protection	Reduced exposure to 39,000 people and \$806 million in income annually	Habitat type and quality, coastal elevation, shoreline type, surge potential, wave characteristics, sea-level rise, proximity of habitats in MPA to coastal population
Nursery habitat for spiny lobster	6 million lbs. and \$23.5 million in revenue from the lobster fishery is attributable to nursery habitat annually	Habitat type and extent, larval recruitment to nursery habitat, proximity of nursery habitat to shallow shelf habitat for adults
Carbon storage for climate mitigation	400 million tons of CO ₂ stored and \$5 billion in avoided damages from emissions globally	Relative abundance of mangroves and seagrass, carbon stored in soil and aboveground biomass (based on climate).

ECONOMIC VALUATION OF ECOSYSTEM SERVICES IN BAHAMIAN MARINE PROTECTED AREAS

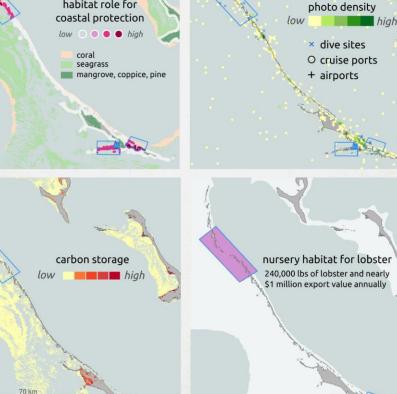
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EXUMA

Entire coastline protected

\$130 million in avoided damages due to emissions by storing 10.7 million tons of carbon



habitat role for

\$6.6 million in visitor expenditure from 23,000 visitordays (annually)

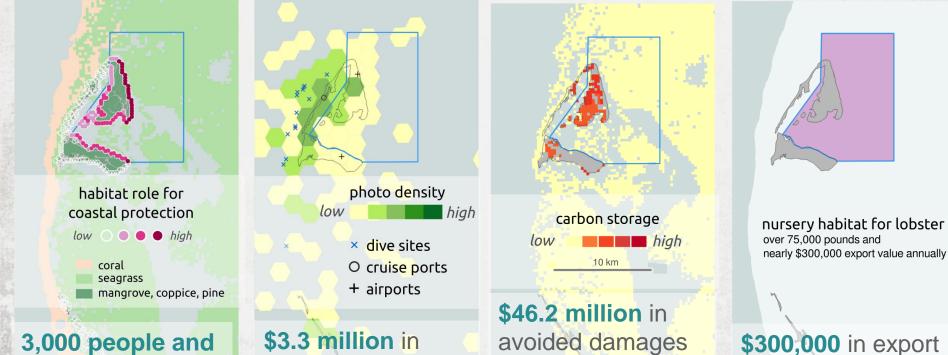
\$1 million in export value from 240,000 lbs of catch (annually)

BIMINI

\$31.2 million in

annual income

protected



visitor expenditure

from 19,500 visitor-

days (annually)

due to emissions,

3.5 million tons of

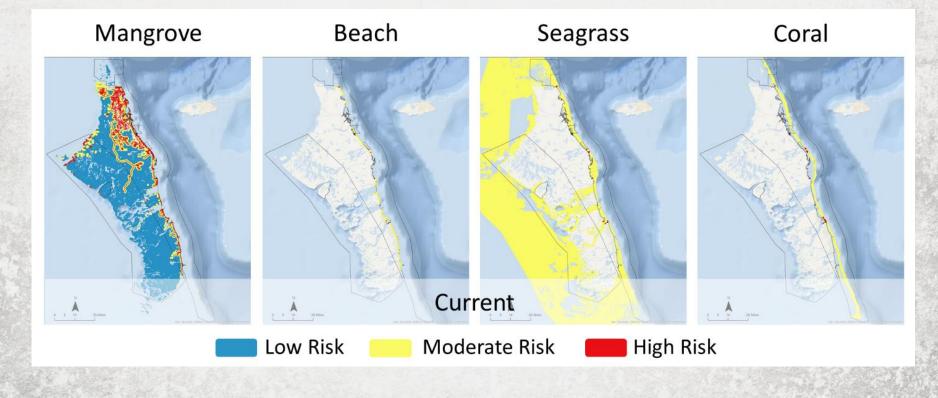
carbon stored

\$300,000 in export value from 76,505 lbs. of catch

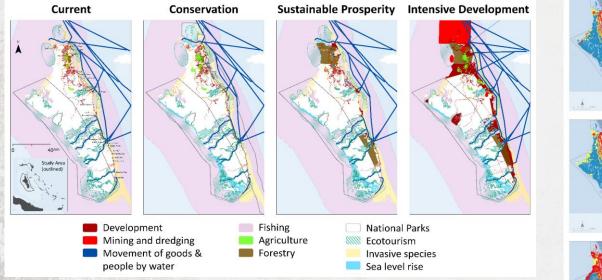
(annually)

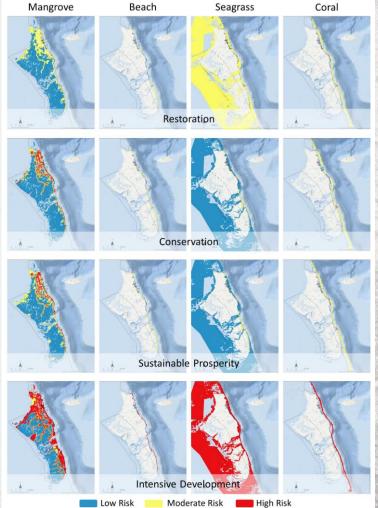
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ANDROS CURRENT RISK ASSESSMENT



ANDROS ALTERNATIVE FUTURE SCENARIOS & ASSOCIATED RISK

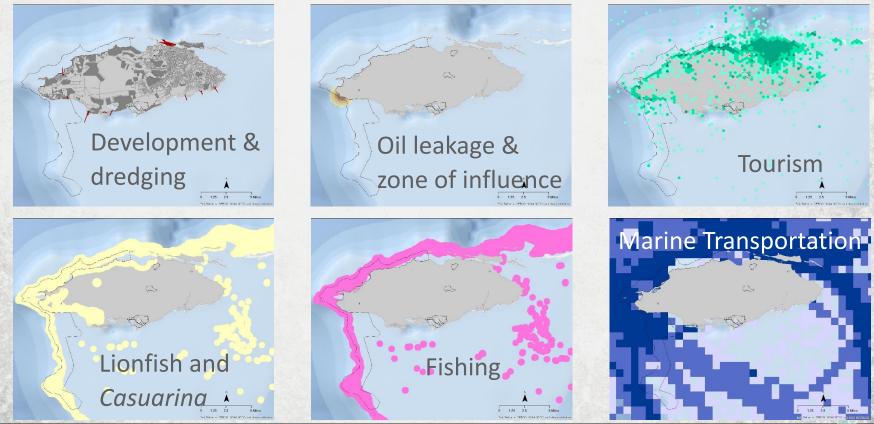




ANDROS RESULTS

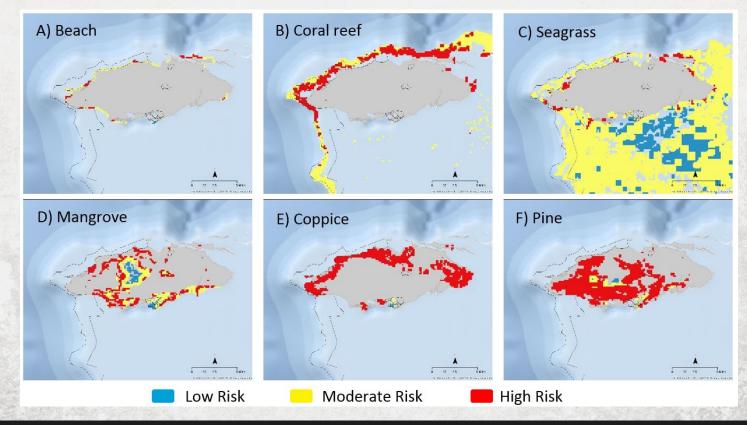
- Nursery habitats within Andros's MPAs contribute 3.5 million lbs. in lobster catch and \$14.5 million in export value
 - The Master Plan (sustainable prosperity scenario) could increase export value to \$21. million
- Andros' MPAs support \$113 million in visitor expenditure
 - The Master Plan would increase expenditure to \$170 million
- Coastal habitats such as mangrove and coppice forests, coral reefs and seagrass reduce the risk to 50% of the islands' population, protecting \$2.4 million in income
 - The Master Plan would protect 60% of the islands' population
- Carbon storing mangrove and seagrass in Andros West Side National Park are worth \$6 billion in avoided damages from emissions.
 - These assets could increase by 3% under the Master Plan

SOUTHWEST MARINE MANAGED AREA MAPPING HUMAN USES

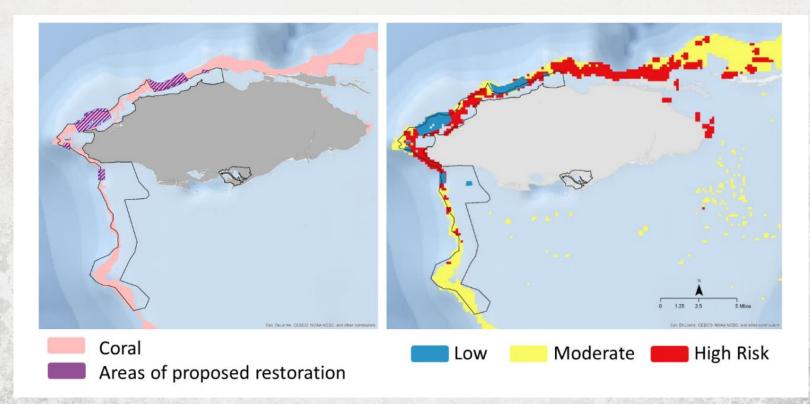


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SOUTHWEST MARINE MANAGED AREA RISK ASSESSMENT APPROACH



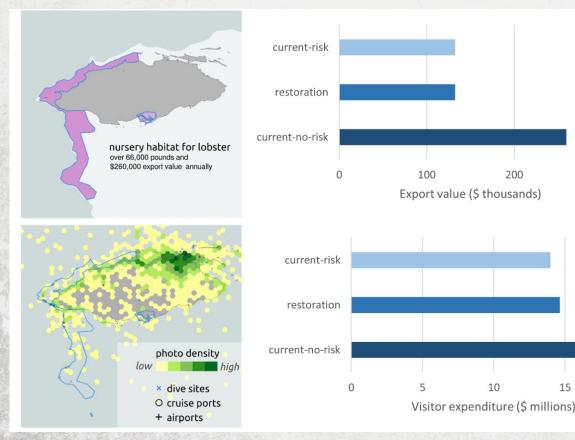
SOUTHWEST MARINE MANAGED AREA PROPOSED CORAL RESTORATION



SOUTHWEST MARINE MANAGED AREA

300

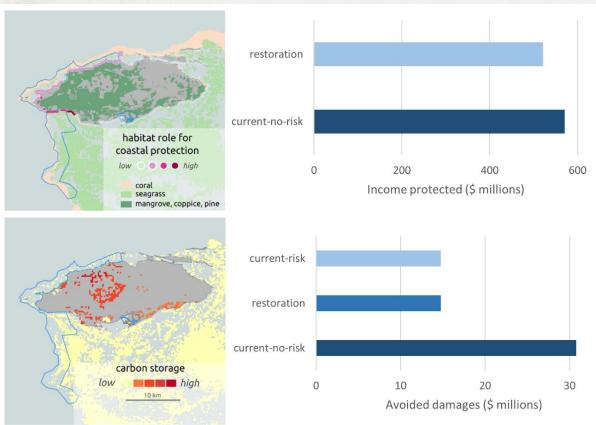
15



Risk from current activities reduce the export value attributable to nursery habitat by 50%, \$127,000

\$14 million in visitor expenditure from currently, could increase by 14% with lower risk

SOUTHWEST MARINE MANAGED AREA

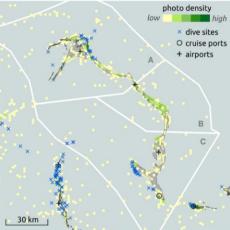


6% of people at greater risk from storms as a result of risk to habitats. Habitats could protect 30,000 people

Under current risk, habitats store ½ as much carbon, worth \$16 million

ELEUTHERA



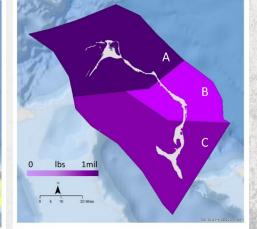


All 11,000 people protected by coastal habitats, \$130 million in protected income **\$58.5 million** in visitor expenditure (annually)



C stored 1500mt/ha

500



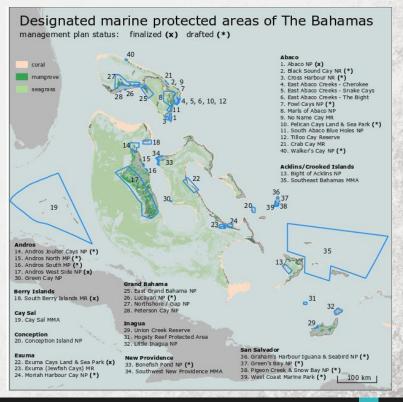
\$5.7 million in export value from 1.5 million lbs. of catch (annually)

ISLAND-SCALE EVALUATION

- In-depth analysis of specific MPAs shows value of ecosystem services in these areas
 - E.g. Bimini and Exuma Cays Land and Sea Park
- Including human activities in a risk assessment highlights the potential gains of effective management
 - E.g. Andros and Southwest Marine Managed Area
- An ecosystem services approach can be used to explore locations for future MPAs
 - E.g. Eleuthera

IMPLICATIONS OF FINDINGS FOR MPA POLICY, PLANNING, AND MANAGEMENT

- The economic benefits are large, and vary between locations
- Effective management is needed to maintain and grow the economic value
 - 4 of 40 MPAs have finalized management plans (as of Nov, 2017) and 15 have draft plans



IMPLICATIONS OF FINDINGS FOR MPA POLICY, PLANNING, AND MANAGEMENT

- MPA planning and management should be part of comprehensive efforts
 - E.g. National Development Planning (Vision 20140) & Integrated Coastal Zone Management
- MPA contribute to the Sustainable Development Goals (and other international commitments)
- An ecosystem services approach can help evaluation possible sites for future protection under the 20-by-20 challenge
- Iteration between ecosystem service valuation and stakeholder engagement can ensure local support and the future sustainability of MPAs











QUESTIONS? <u>karkema@stanford.edu</u> <u>kwyatt@stanford.edu</u> <u>davefisher@stanford.edu</u>









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EXTRA SLIDES

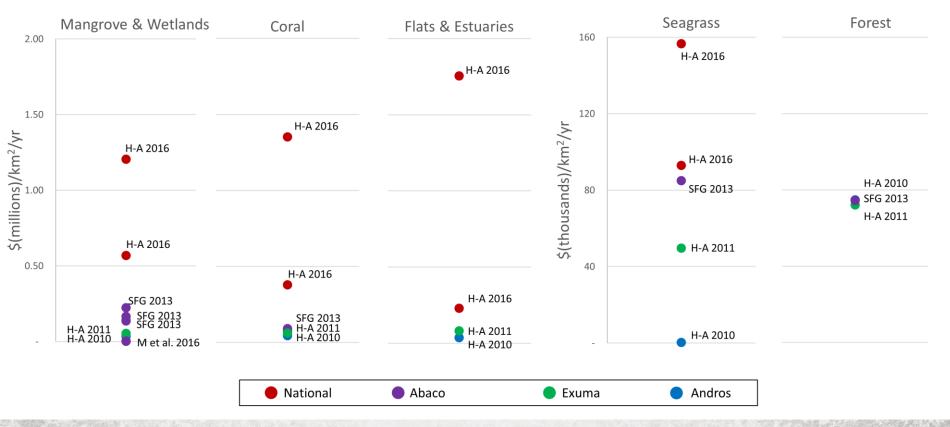
ECONOMIC VALUATION OF ECOSYSTEM SERVICES IN BAHAMIAN MARINE PROTECTED AREAS

We reviewed the existing literature to glean useful information and to give context for our analysis

Approach:

- We focused on existing studies of economic value (variety of metrics) of species, habitats, and marine protected areas in The Bahamas
- We searched the peer-reviewed literature, reports and citations within, and studies by local experts
- Values did not need to be monetary, but they did need to include demand from people for the services

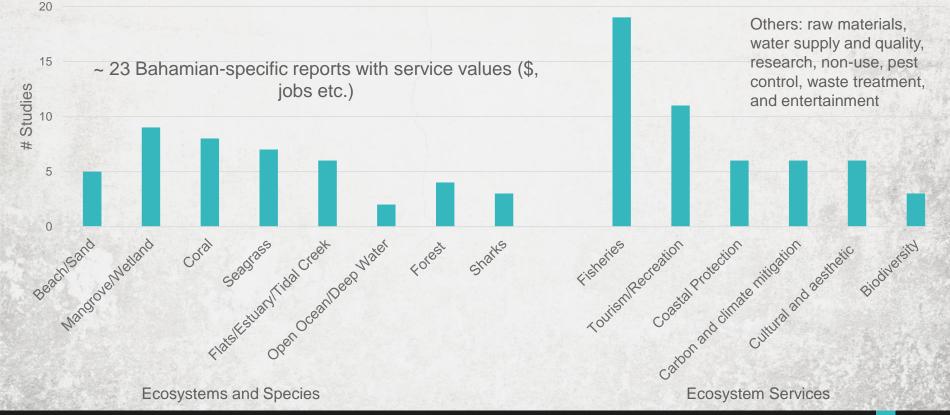
ECONOMIC VALUE OF HABITATS (PER UNIT AREA)



Sources: Hargreaves-Allen (H-A) 2010, 2011, 2016; Clavelle and Jylkka (SFG) 2014, Micheletti et al. (M et al.) 2016

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NUMBER OF VALUATION STUDIES BY ECOSYSTEMS AND SERVICES



PREVIOUS ECONOMIC VALUATION STUDIES

- 23 Bahamas-specific valuation studies
- Mangroves, coral, seagrass, and tidal flats the most commonly valued
 - Benefits-transfer approaches are the most common
 - Up to \$1.2 \$1.75 million per km², depending on the habitat
- Fisheries and tourism the most commonly studied
 - \$125 million in export value for fisheries, > \$400 million in visitor expenditure
- Opportunities for new work
 - Focus on coastal protection benefits of habitats from storms
 - Spatially-explicit approaches
 - Specific contribution of MPAs

ECONOMIC VALUE OF FISHERIES

Lobster

- > \$64.5 million annually in export value from 2,301 tons/yr (2000-2009)
- Reconstructed catch was 4.5x greater, 10,500 tons/yr
- Reef fish
 - > \$60 million annually in export value
- Subsistence fishery
 - > 33,100 tons/yr supporting food security for thousands of Bahamians
- Employment
 - > 4,000 Bahamian fishing vessels
 - > 9,300 directly employed in the fishing industry
 - 1,300 active lobster fisherman

Sources: Hargreaves-Allen and Pendleton 2010, Smith and Zeller 2016, DMR, FAO 2009, Gittens and Braynen, Sullivan Sealey 2011

ECONOMIC VALUE OF TOURISM

- > \$402 million annually from stopover visitors (2007)
 - > 4.5 million visitors annually contributing 60% to the national economy (2007)
- \$50 million in annual expenditure related to sharks with aggregated economic impact of \$115 million
- \$75 million in annual expenditure from guided and non-guided fishing with aggregated economic impact more than \$150 million
- Employment figures are limited
 - > 500 employees in nature-based tourism on Andros (2010)
 - > 300 fishing guides nationally (2010)

Sources: Hargreaves-Allen 2010, Hargreaves-Allen and Pendleton 2010, Fedler 2010, Ministry of Tourism

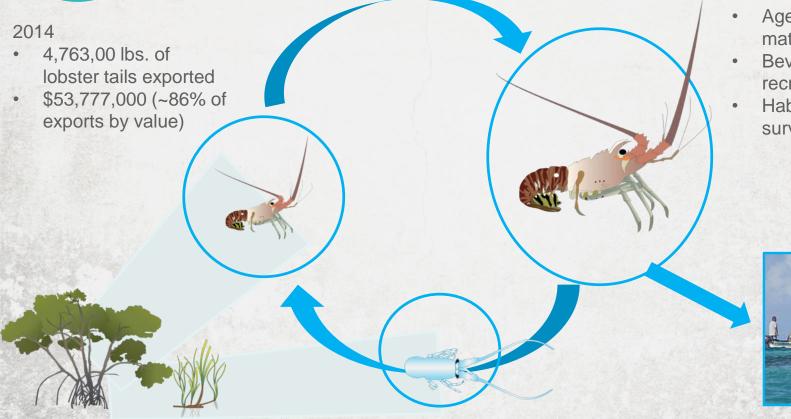
ECONOMIC VALUE OF COASTAL PROTECTION

- Habitats in The Bahamas provide an estimated \$3.9 billion km²/yr in coastal protection and \$120 million in erosion control
- Exuma
 - > \$8.5 million km²/yr in disturbance regulation
- Andros
 - \$6.8 million km²/yr in disturbance regulation
 - > 95 km of shoreline and 50% of the coastal population protected by natural habitats
- Great Abaco
 - > \$1,137 in avoided costs for communities from disturbance protection
 - > \$1,348 in avoided costs for government from disturbance protection
 - > \$33,423 in avoided costs for government from erosion protection

Sources: Hargreaves-Allen 2010, 2011, 2016; Micheletti et al. 2016



VALUE OF LOBSTER CATCH ATTRIBUTABLE TO MANGROVES AND SEAGRASS IN MPAs



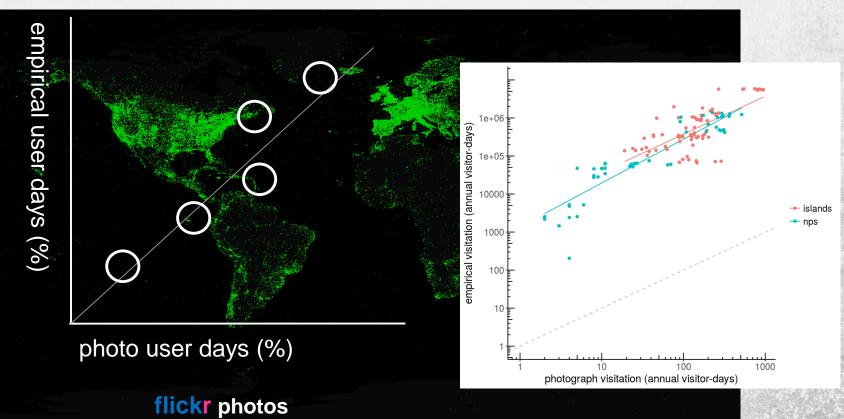
- Age-structured
 matrix model
- Beverton-Holt
 recruitment
- Habitat dependent survivorship





TOURISM APPROACH TO TRACK PEOPLE

Wood et al 2013 Scientific Reports



The Natural Capital Project • Economic Valuation of Bahamian MPAs • December, 2017

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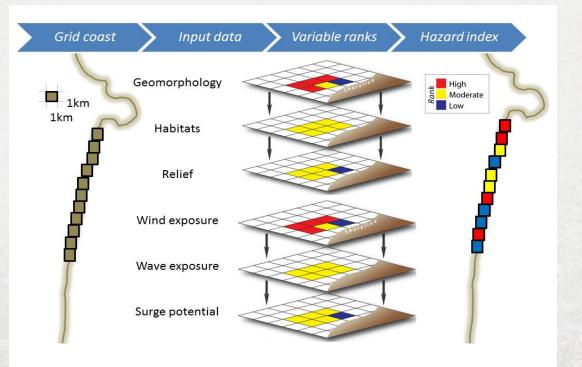
43 Source: Immigration Card and Research & Statistics Dept. Ministry of Tourism

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COASTAL PROTECTION APPROACH



Arkema et al. Nature Climate Change 2013

The Natural Capital Project • Economic Valuation of Bahamian MPAs • December, 2017



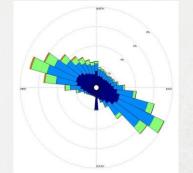
COASTAL PROTECTION DATA INPUTS



Geomorphology



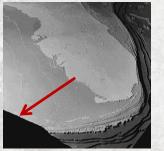
Habitats



Wind exposure



Wave exposure



Storm surge



Relief

Sea level rise



Social & Economic metrics

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CARBON STORAGE/SEQ PROVIDED BY MANGROVES AND SEAGRASS IN MPAS

CARBON SEQUESTRATION AND STORAGE

Carbon dioxide (CO₂)

Sequestered by coastal vegetation

Incorporated into biomass, litter and soils



Soil carbon can make up 50-99% of total carbon

CARBON SINK

CARBON EMISSIONS

Carbon dioxide (CO₂)



Destruction of coastal habitats leads to release in stored carbon

CO2



Rate of release depends on disturbance type

CO

CARBON SOURCE

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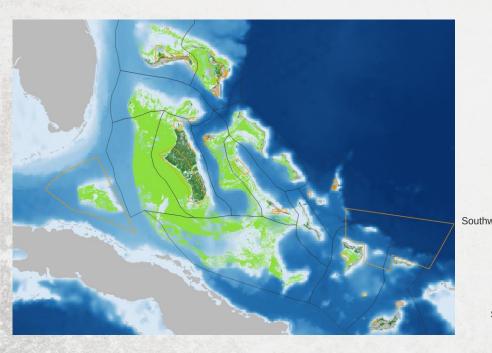
CO

CO

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CARBON-STORING HABITATS



Westside National Park Northshore / The Gap National Park Marls of Abaco National Park Exuma Cays Land & Sea Park East Grand Bahama National Park **Bight of Acklins National Park** Joulter Cays National Park South Abaco Blue Holes National Park South Berry Islands Marine Reserve mangrove Southwest New Providence Marine Managed Area seagrass Jewfish Cay Marine Reserve **Cross Harbour National Park** Southeast Bahamas Marine Managed Area Hogsty Reef Protected Area 500 1000 0

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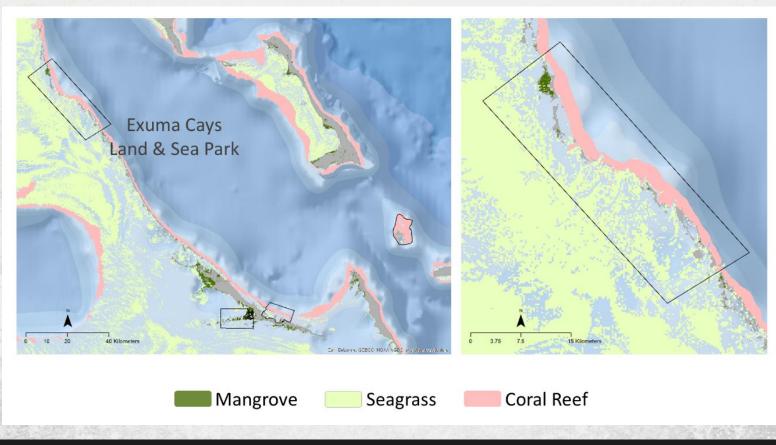
MPAs

1500

habitat area (sq km)

2000









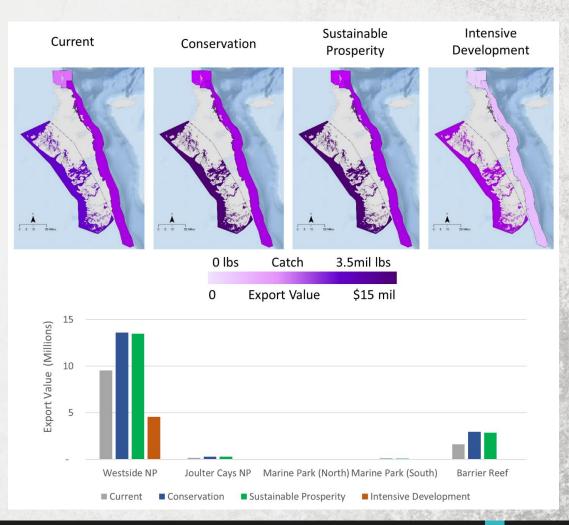
ANDROS







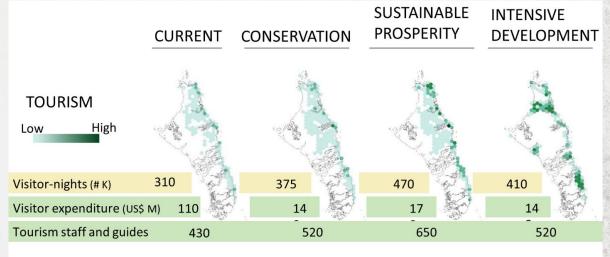
- Nursery habitats within Andros's MPAs contribute
 3.5 million lbs. in catch and
 \$14.5 million in export value
- The Master Plan (sustainable prosperity scenario) could increase this to \$21. million



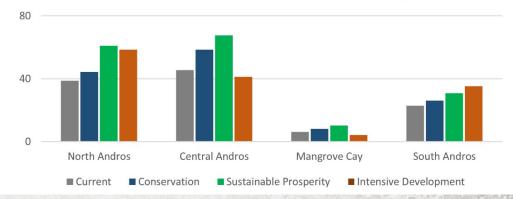
ANDROS TOURISM

Andros' MPAs support \$113 million in visitor expenditure

The Master Plan (Sustainable Prosperity scenario) would expenditure to \$170 million



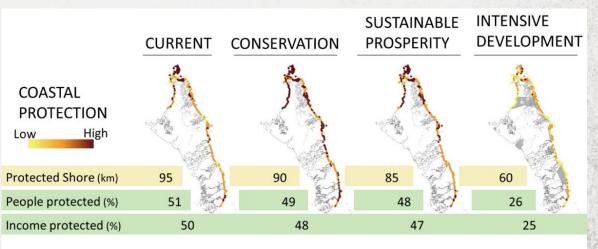
Visitor Expenditure (\$ millions annually)



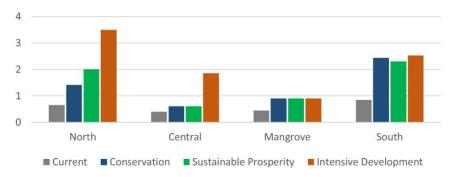


ANDROS COASTAL PROTECTION

- Coastal habitats such as mangrove and coppice forests, coral reefs and seagrass reduce the risk to 50% of the islands' population, protecting \$2.4 million in income
- The Master Plan (Sustainable Prosperity scenario) would protect 60% of the islands' population



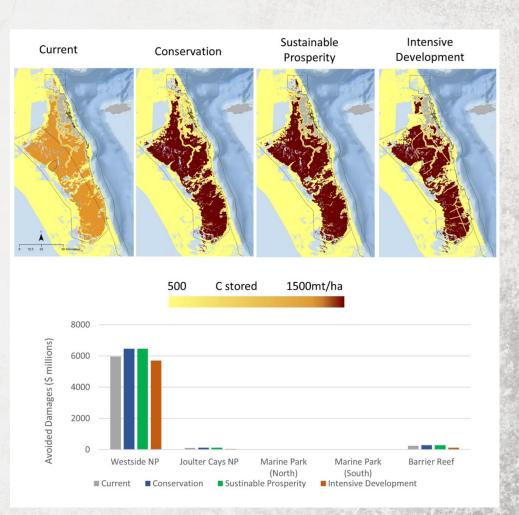




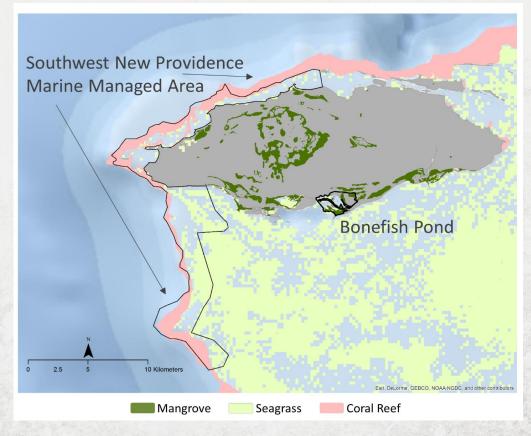


ANDROS CARBON STORAGE

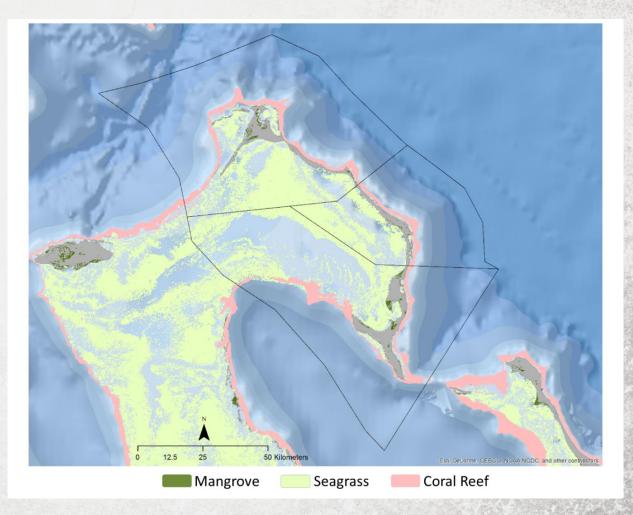
- Carbon storing mangrove and seagrass in Andros West Side National Park are worth \$6 billion in avoided damages from emissions.
- These assets could increase by 3% under the Master Plan (Sustainable Development Plan)



SOUTHWEST MARINE MANAGED AREA



ELEUTHERA





Distribution of mangroves and seagrass among shelf areas



The Natural Capital Project • Economic Valuation of Bahamian MPAs • December, 2017