LANDSCAPE APPROACHES TRAINING SERIES

Session 3: Ecosystem Services and Tourism

THE WORLD BANK
Environment, Natural Resources & Blue Economy

GPS Global Program on Sustainability

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In her current role, Jade acts as a bridge between the science and training teams. With her scientific expertise, she supports capacity building, and connects applications to the resources coming out of the training program. Prior to joining NatCap, Jade worked in collaboration with decision makers, local communities, and NGOs in Hawai'i, Fiji, Vanuatu, and the Solomon Islands to advance science and co-develop place-based tools that can answer their questions. Her research interests lie in bridging land and sea to support people and nature in a changing world.

learning objectives

- Learn how to apply the InVEST Recreation model and interpret the results.

about our workshop

This session connects biodiversity to tourism revenue, and demonstrates how the InVEST model can be used to identify places important for tourism, determine what draws tourism to those places, and assess how future management can impact tourism opportunities. The facilitator elaborates on the way InVEST can be used to highlight most visited places, and the features that make those places popular among tourists.

Keywords: InVEST, biodiversity, tourism, Photo-User Days, wildlife

InVEST Tourism Model

JUNE 06, 2022

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Outline

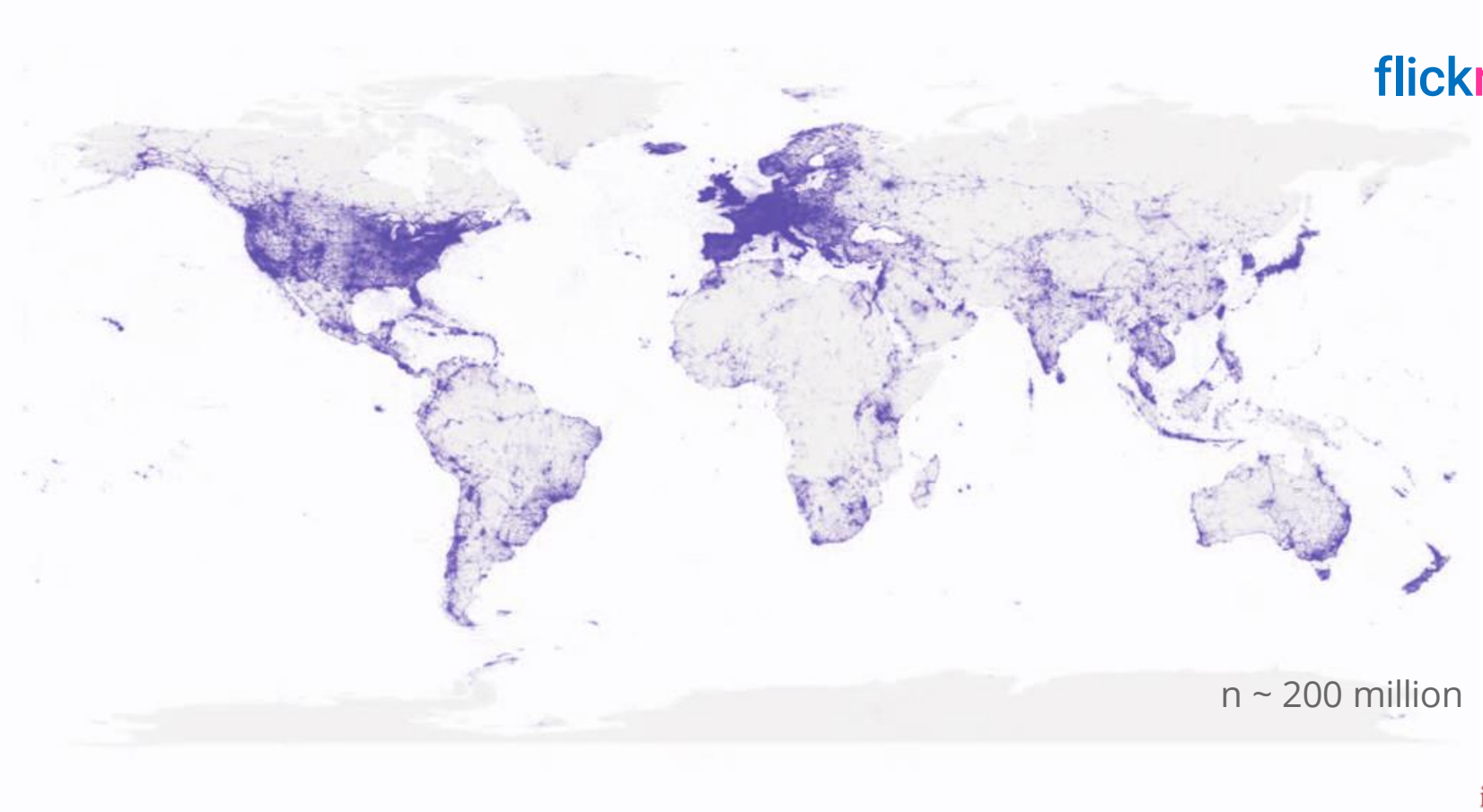
- 1/ Identifying places important for tourism
  - Overview of the InVEST Tourism model
  - Identifying places important for tourism
- 2/ Determining landscape features that draw tourism
  - Examining tourism input data layers
  - Running the InVEST model on baseline condtitions
- 3/ Assessing the effect of management on tourism
  - Incorporating scenarios into the tourism model
  - Running the InVEST model on future conditions
- 4/ Discussion: Incorporating Wildlife information in the InVEST Tourism Model

1/ Where are people visiting across a landscape? (Which places are most important for tourism?)

2/ What features of the landscape are drawing tourists?

3/ How might management actions affect future tourism?

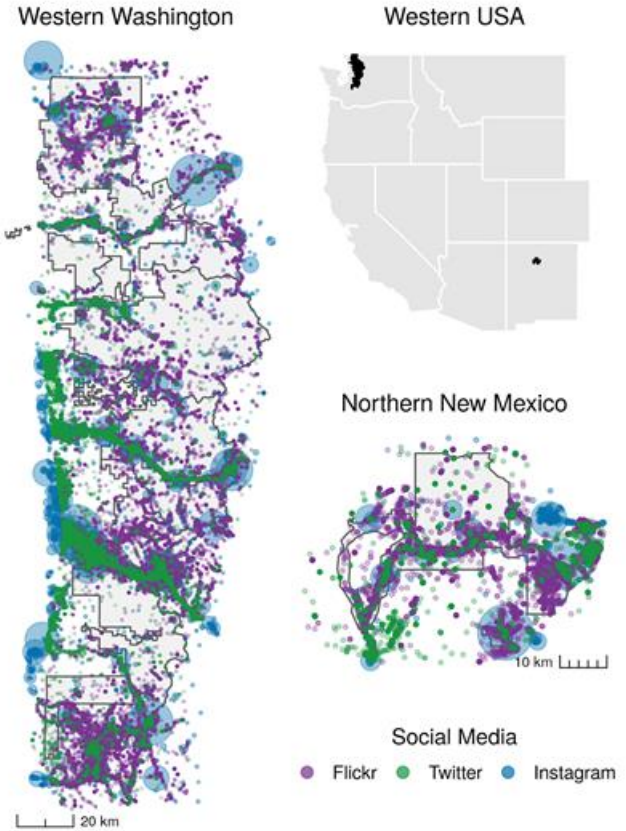
Where are people visiting?



Geolocated social media follows visitation patterns

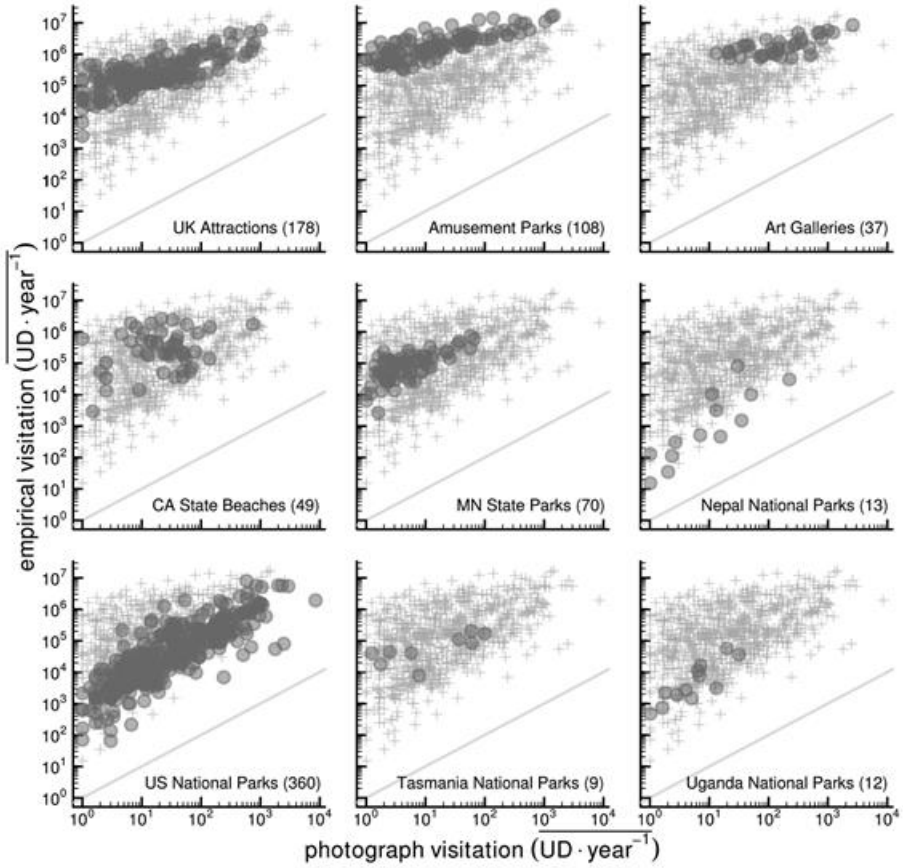
Photo User-Days (PUDs)

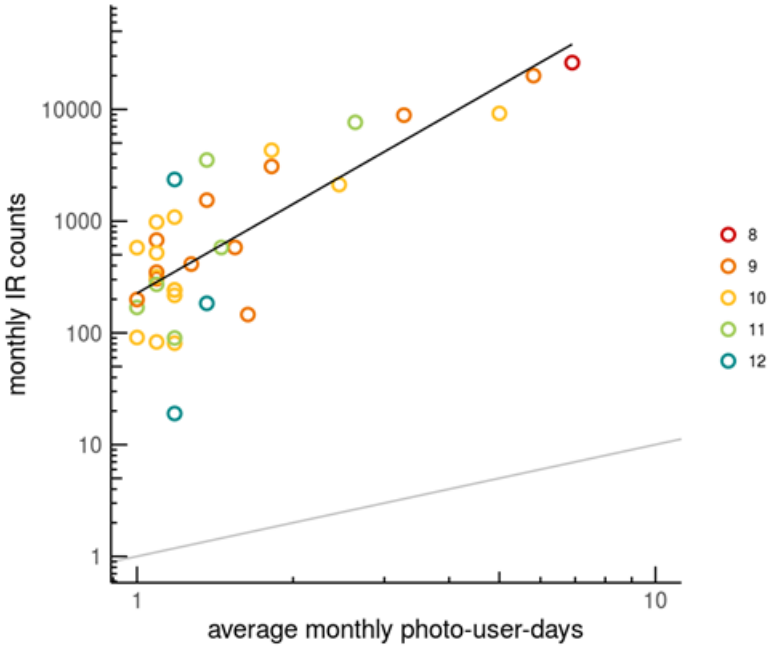
- Flickr metadata includes
  - Photo Lat/Long
  - Date photo was taken
  - User ID
- Calculate unique users per day within a defined area



Purple points are Flickr posts (Wood et al. 2020)

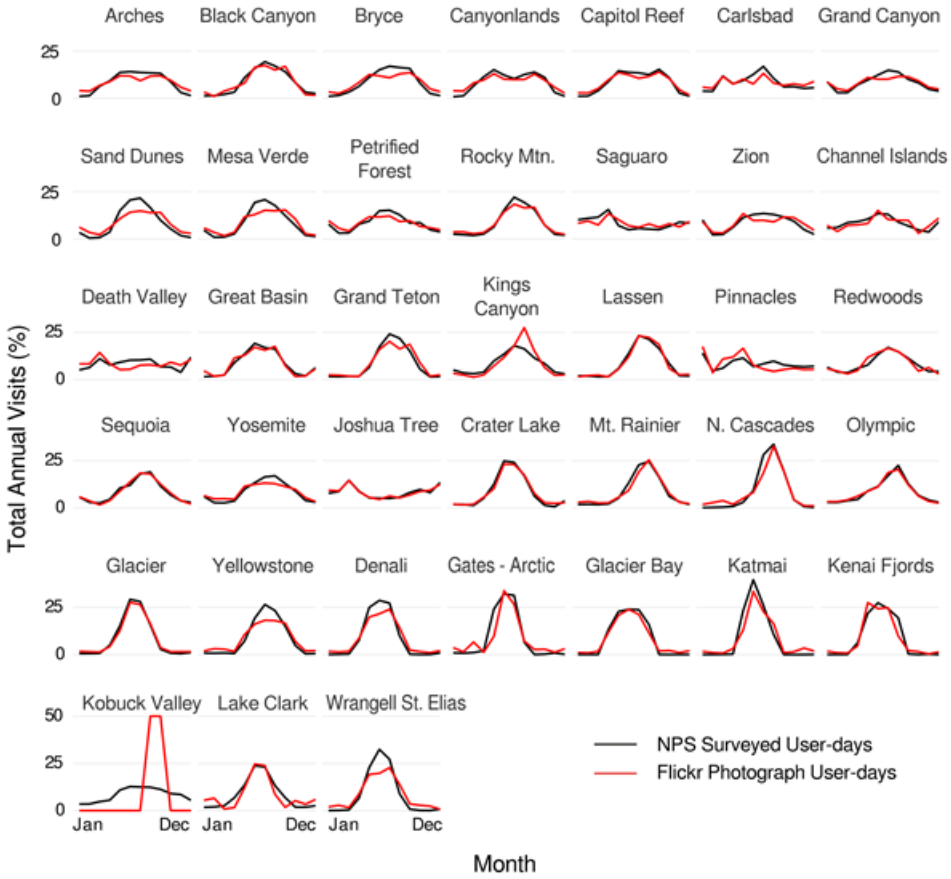
Strong relationship between PUD and empirical visitation data





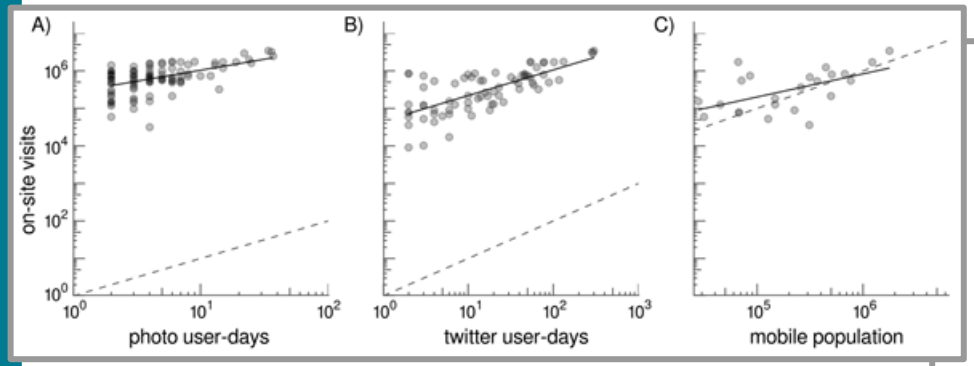
(Wood et al 2013 Sci Rep; Fisher et al 2018 J Env Man)

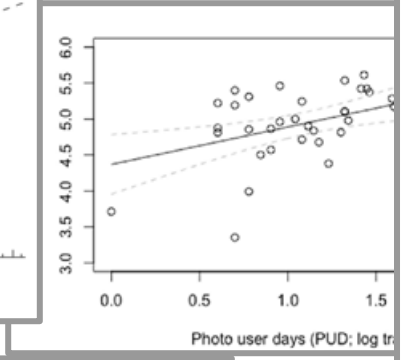
Geolocated social media - Seasonal trends

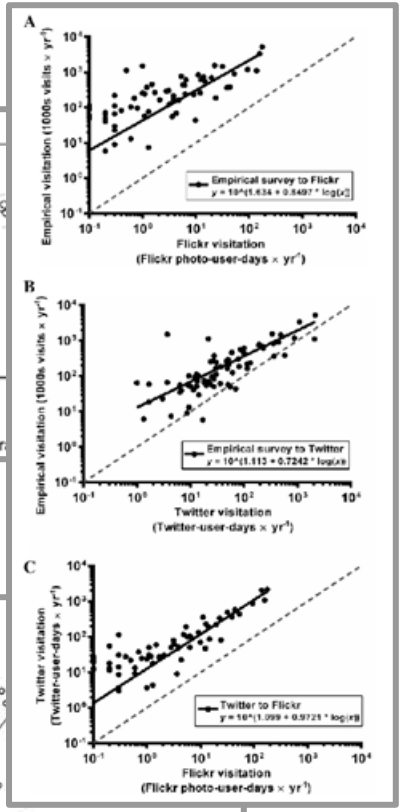


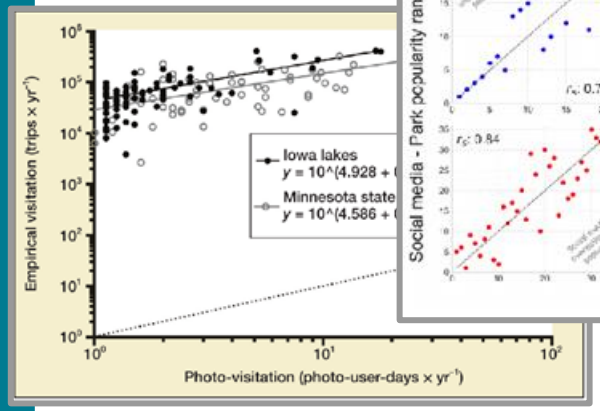
(Sessions et al 2016)

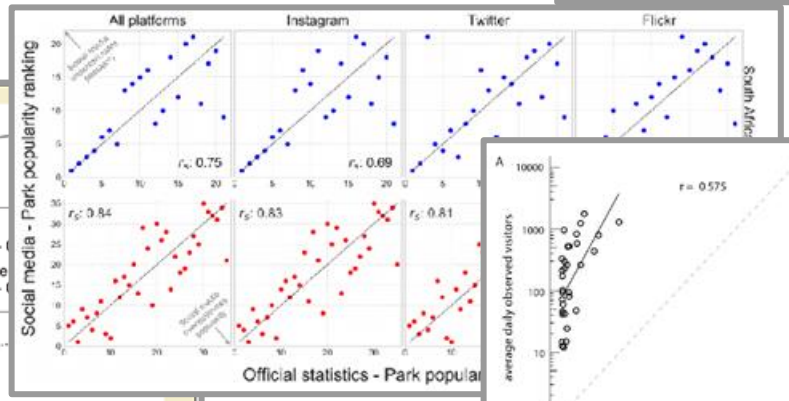
Geolocated social media

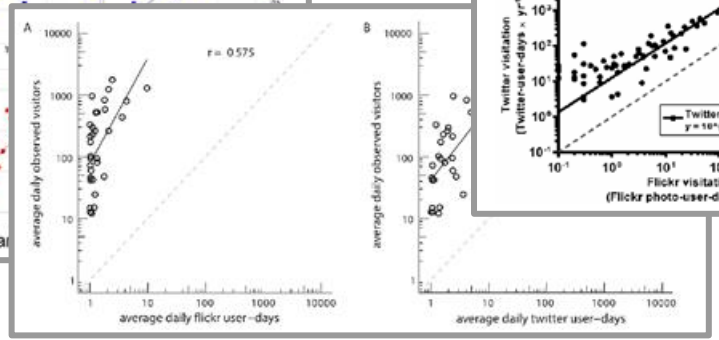






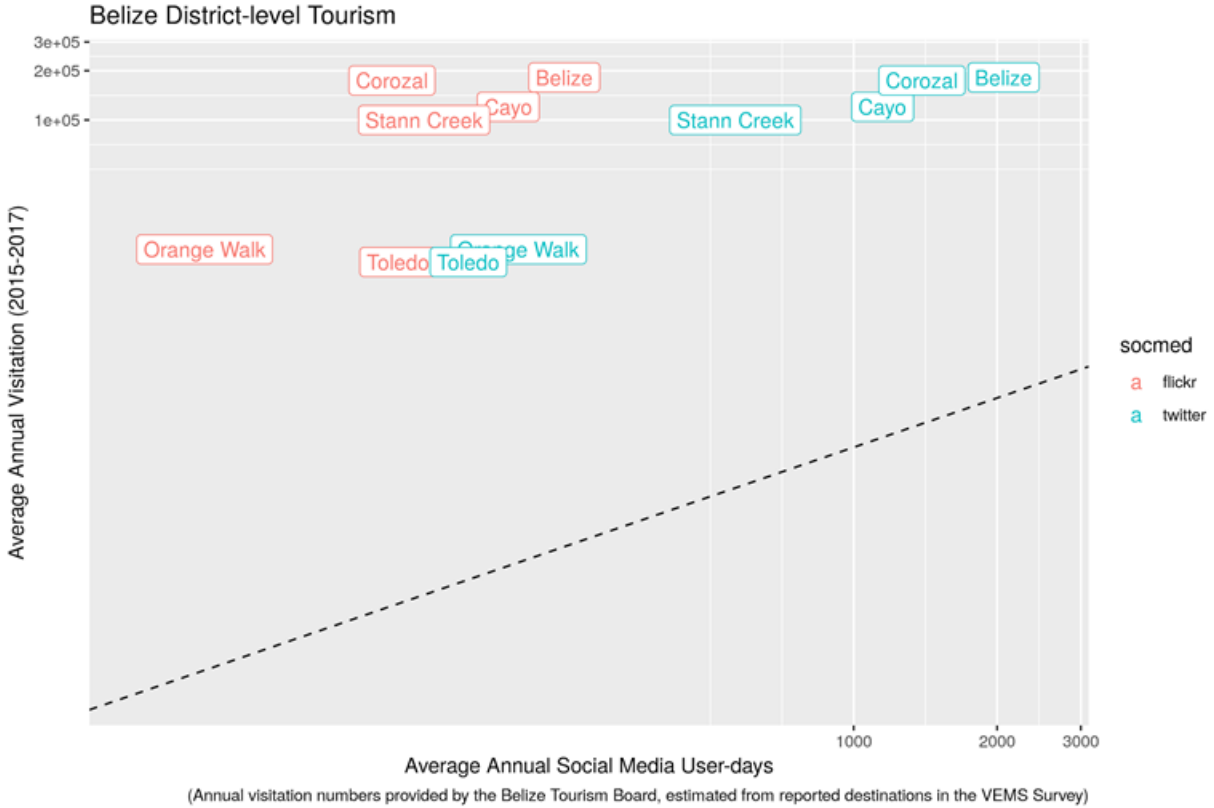






(Keeler et al 2016, Sonter et al 2016, Tenkanen et al 2017, Donahue et al 2018, Hamstead et al 2018, Fisher et al 2019)

Geolocated social media - Belize Districts



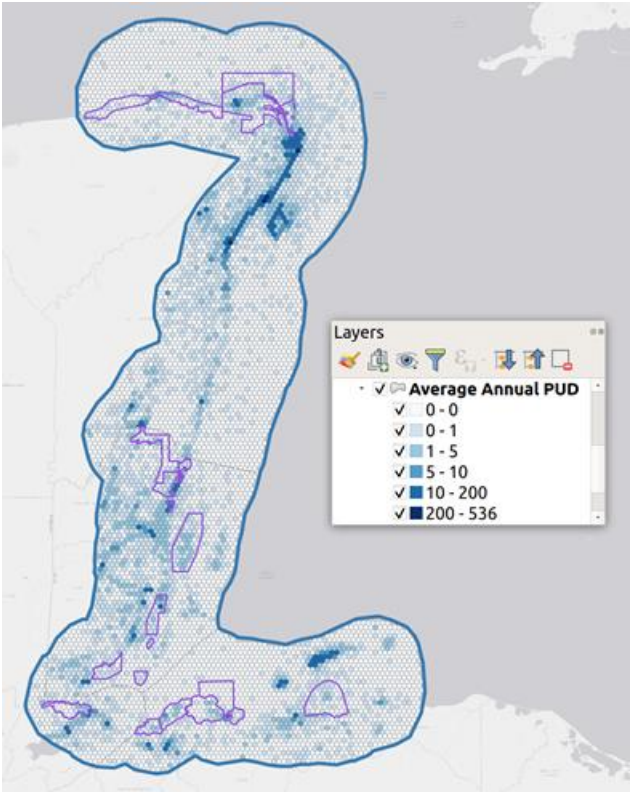
InVEST Tourism Model – Step 1

CALCULATES THE **AVERAGE NUMBER OF FLICKR PHOTO USER-DAYS (PUD) PER YEAR** ACROSS THE LANDSCAPE

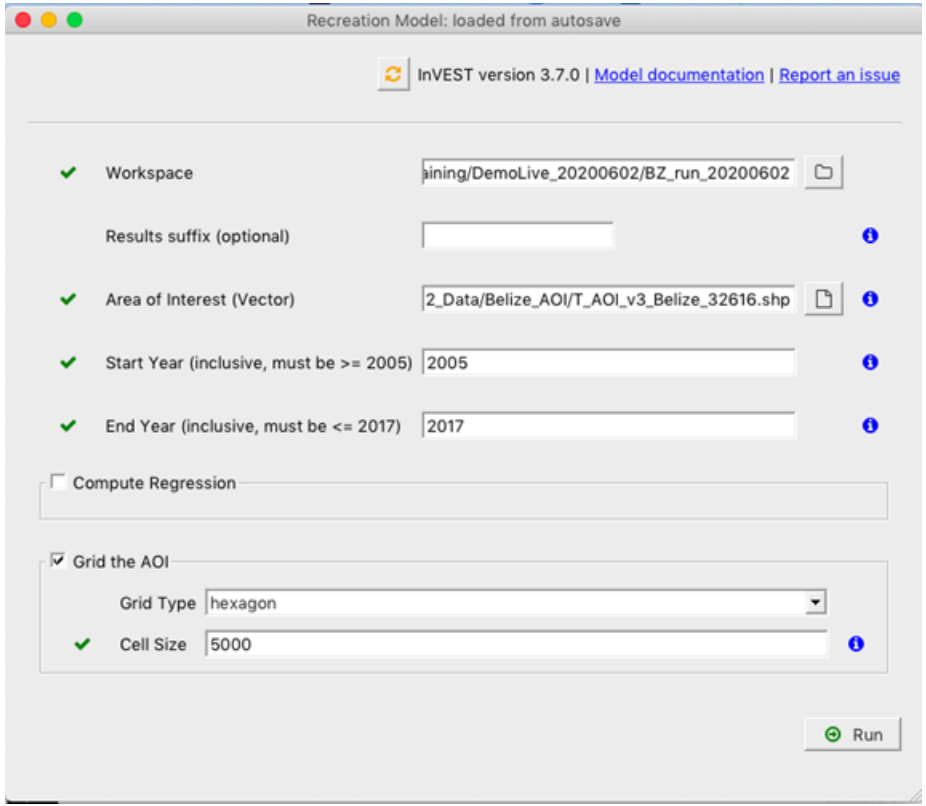
- GRID CELLS OR USER-DEFINED POLYGONS
- AVERAGE ANNUAL PUD (2005-2017)
  - Average Monthly PUD also an option

TELLS YOU ABOUT THE **SPATIAL PATTERNS** OF VISITATION

PRIMARY OUTPUT OF INVEST STEP 1: ONLY REQUIRES AN AOI!



Step 1 - Calculate PUD in InVEST



I recommend always using 2005 - 2017

Units match the projection of your AOI

Step 1 – InVEST model outputs

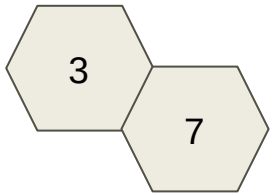
- Log file (records your inputs, and also any errors)
- PUD_RESULTS.SHP
  - Shapefile of Photo User-Days (PUD) across the landscape
  - PUD_YR_AVG = average annual PUD
  - Often requires a few tries to figure out how to display it well
- MONTHLY_TABLE.CSV
  - Total PUD per month for every grid cell

Getting from PUD to People (outside InVEST)

- Requires on-site data about the total number of visitors to the region
- Uses the proportion of PUD from each grid cell to "spread" the visitors across the landscape (assumes proportion PUD = proportion tourists)

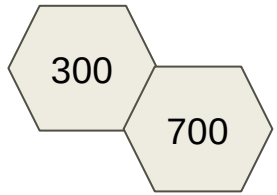
PUD (Avg Annual)

Total: 10 (3+7, from InVEST)



People

Total: 1000 (from local data)



1/ Where are people visiting across a landscape? (Which places are most important for tourism?)

2/ What features of the landscape are drawing tourists?

3/ How might management actions affect future tourism?

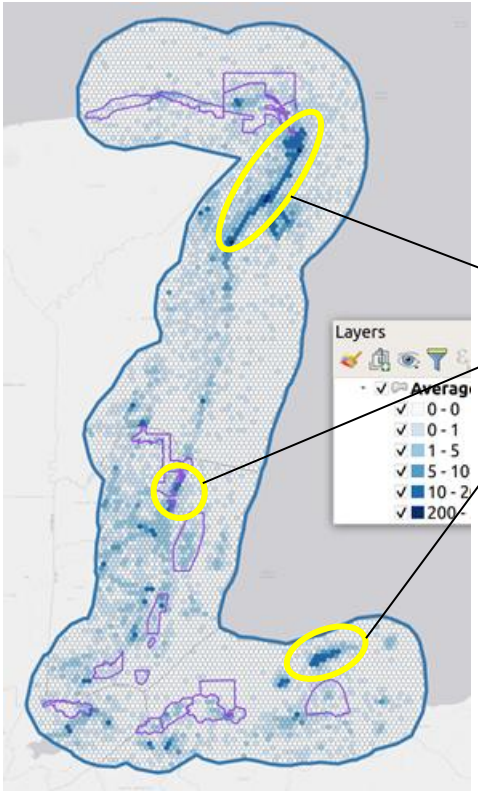
What draws people to particular locations?

WHY ARE THERE MORE VISITORS TO SOME PLACES THAN OTHERS?

Wat Phra Kaew
Bangkok, Thailand

Sam Roi Yot Beach
Thailand

What draws people to particular locations?



Why are these places tourism "hotspots"?

- NATURAL FEATURES?
- CULTURAL FEATURES?
- ACCESS & INFRASTRUCTURE?

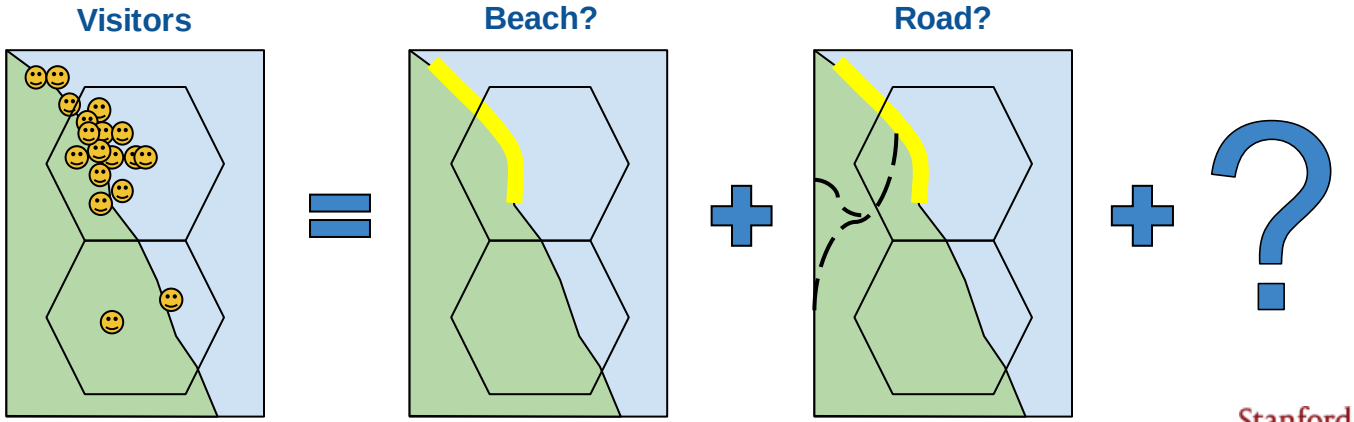
REGION SPECIFIC!

InVEST Tourism Model - Step 2

THE TOURISM MODEL RELATES THE **NUMBER OF VISITORS (PUD)** TO A SPECIFIC PLACE TO **CHARACTERISTICS** OF THAT PLACE

UNDERLYING THEORY: REVEALED PREFERENCE LINEAR MODEL

- PEOPLE CHOOSE TO GO TO DESIRABLE PLACES, SO:
  MORE PEOPLE = MORE DESIRABLE PLACE



Data Inputs

Landscape features ("predictors") that you believe may drive tourism in your region

- Natural features
- Cultural features
- Access/Infrastructure features
- Others? Region specific! (water quality, glaciers, etc)

Gather/create spatial layers for each feature you want to include. The layers should be at least as large as the AOI

Beaches

Archaeological sites

Airports & Ports

Examples of Data Inputs used in the MesoAmerican region

Visitation = Nature + Climate + Culture + Infrastructure

Nature:

- Beaches
- Corals
- Mangroves
- **Wildlife (sharks, whales, flamingos, turtles, manatees)**
- Forests

Climate:

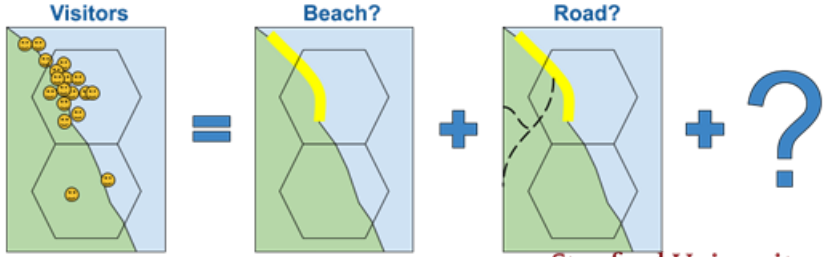
- Temperature (average)
- # of Days of Extreme Heat (> 35C)
- Rainfall (average)

Culture:

- Archaeological sites

Infrastructure:

- Distance from Airport/Port
- Roads
- Development



Predictor Table (example)

Tell InVEST how to incorporate each layer by building a “Predictor Table”

Short, informative name

File name

What to calculate per grid cell

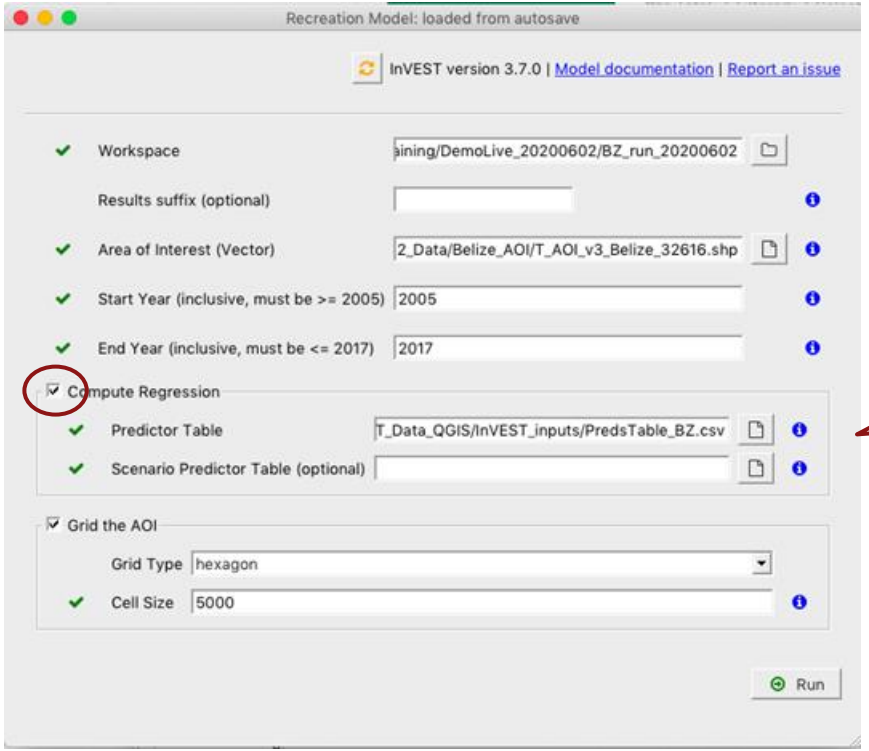
id	path	type
beach	beach_from_geomorph_MAR_v4_shift_BZ_MX_32616.shp	line_intersect_length
coral	corals_all_32616.shp	polygon_percent_coverage
wildlife	wildlife3_32616.shp	polygon_percent_coverage
ruins	archaeological_sites_combined_32616.shp	point_count
ports_air	ports_air_32616.shp	point_nearest_distance
roads	roads_MAR_clip_32616.shp	line_intersect_length
develop	lulc_developed_national_baseline_32616.shp	polygon_percent_coverage

Save as a .csv file, in the same folder as your predictor files

Choices for incorporating different types of predictors

Predictor Type	InVEST Choices (What to calculate)	Example
Lines (shapefile)	line_intersect_length	"How many meters of roads are in each grid cell?"
Polygons (shapefile)	polygon_percent_coverage polygon_area_coverage	"What percent of each grid cell includes coral?" "What is the area covered by coral in each grid cell?"
Points (shapefile)	point_count point_nearest_distance	"How many ruins are inside each grid cell?" "How far is it from each grid cell to the nearest airport?"
Raster	raster_sum raster_mean	"How many people live in each grid cell?" "What's the average rainfall in each grid cell?"

Step 2 – compute the regression model in InVEST

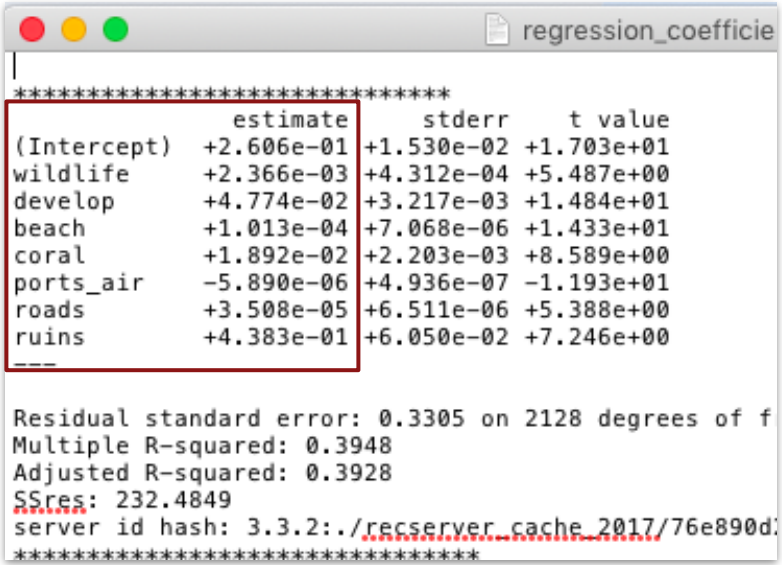


The predictor table tells InVEST where to find your predictors and what to do with then

Step 2 – InVEST Model output

Statistical relationship between each feature you choose and tourism (as represented by photo user-days (PUD))

- Linear model: Log(PUD) = Predictor 1 + Predictor 2 + …



- ↑ Wildlife +
- ↑ Development +
- ↑ Beach +
- ↑ Coral +
- ↓ Distance from Airport / Port +
- ↑ Roads +
- ↑ Ruins

Tells you how much people value each feature that you included

1/ Where are people visiting across a landscape? (Which places are most important for tourism?)

2/ What features of the landscape are drawing tourists?

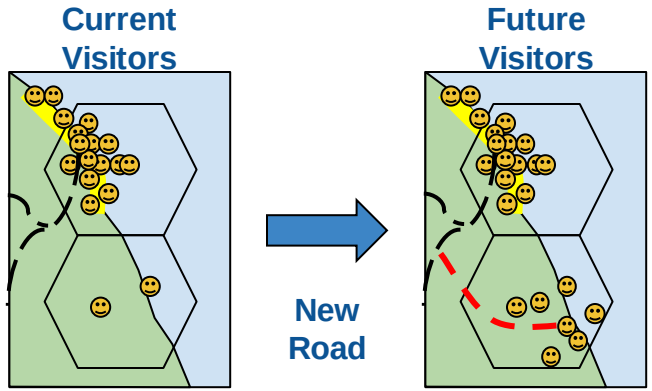
3/ How might management actions affect future tourism?

How might tourism patterns change in the future?

Under a specific management action? If a species' range changes? Under a changing climate?

Uses the relationships found in the linear model to predict future PUD under changed landscape features

Example: If we increase access to a specific area, how will tourism respond?

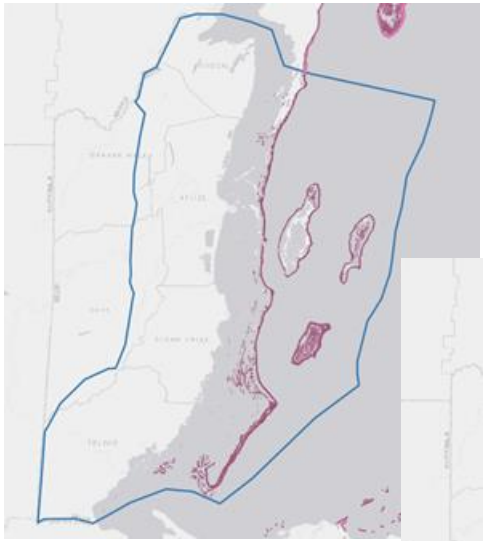


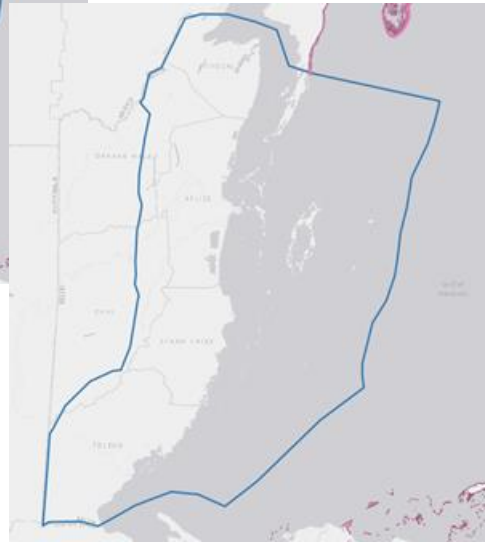
Scenario Case Study - Protect Belize Coral

What effect will protecting coral have on future tourism?

Create two possible maps of coral in the future

1. Coral is protected, and continues to persist in all the places it is currently found
   a. Coral shapefile does not change
2. Coral is not protected, and disappears in Belize
   a. Create a new shapefile which does not include any coral in Belize





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Scenario Case Study - Protect Belize Coral

Create a "Scenario Predictor Table" for InVEST for each map of coral

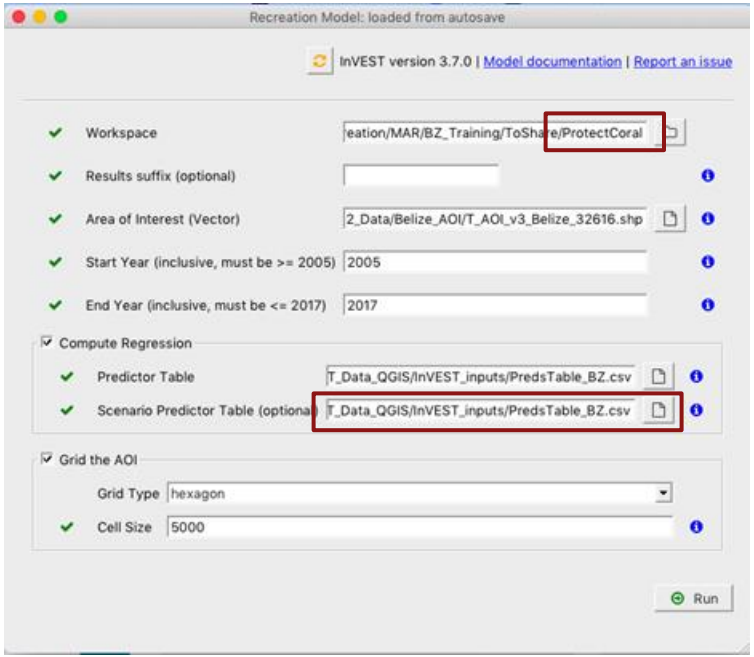
1. Coral is protected
   a. Identical to the "Predictor Table" (because the coral map is the same)
2. Coral is lost
   a. Identical to the "Predictor Table", but the "path" points to the new coral shapefile

id	path	type
beach	beach_from_geomorph_MAR_v4_shift_BZ_MX_32616.shp	line_intersect_length
coral	MAR_coral_WGS8416N_eraseBelize.shp	polygon_percent_coverage
...	...	...

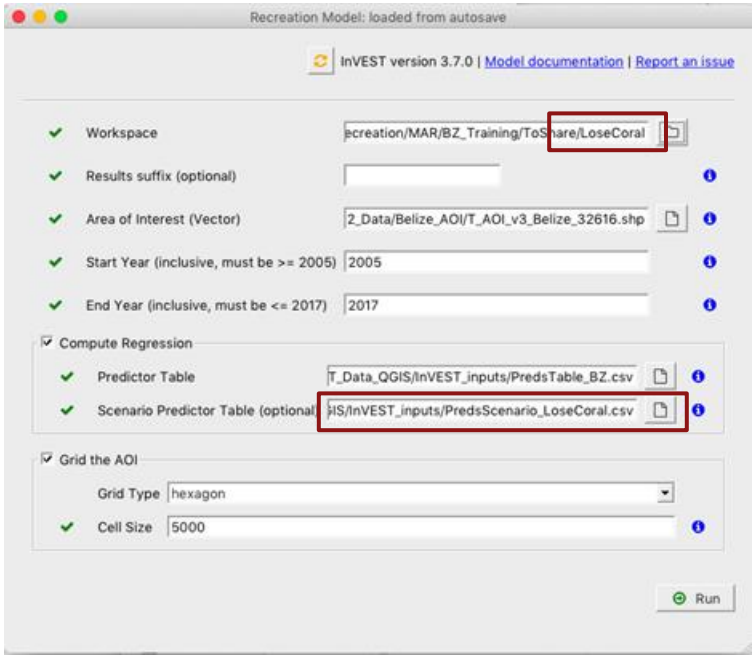
Step 3 – Scenario Case Study - Protect Belize Coral

Run InVEST Twice. What will tourism look like if:

Coral is protected



Coral is lost



Step 3 – InVEST model outputs

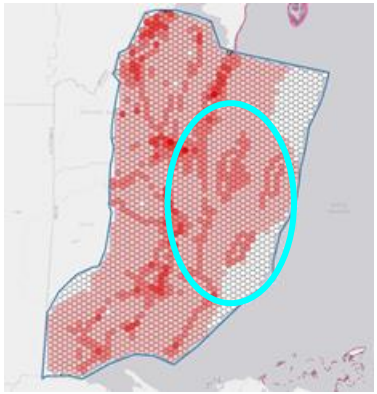
TWO FOLDERS, EACH WITH A COPY OF: "SCENARIO_RESULTS.SHP"

- Shows how tourism patterns may look in the future under different management scenarios (PUD_EST)
- Also includes calculations for each predictor based on the Scenario Predictor Table (can be compared to predictor_data.shp)

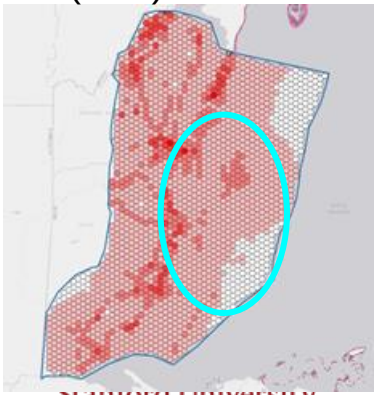
COMPARE PREDICTED TOURISM PATTERNS WITH AND WITHOUT CORAL PROTECTION:

1. OPEN "SCENARIO_RESULTS.SHP" FROM THE EACH OF THE TWO INVEST RUNS (PROTECTCORAL AND LOSECORAL)
2. DISPLAY THE PUD_EST COLUMN FOR EACH

With Coral (Protected)



Without Coral (Lost)



Model Limitations

- Relies on Flickr from 2005-2017 to learn about visitation patterns
- No temporal aspect (uses average annual PUD to learn about **SPATIAL** patterns)
- Determines the relationship between each feature and tourism for you - can't be specified ahead of time
- Limited model specification choices

Discussion:
Wildlife & Tourism

Mapping wildlife and incorporating it into the InVEST model

Wildlife can be mapped in 3 primary ways, ranging from simple filed surveys to more complex species distribution modeling.

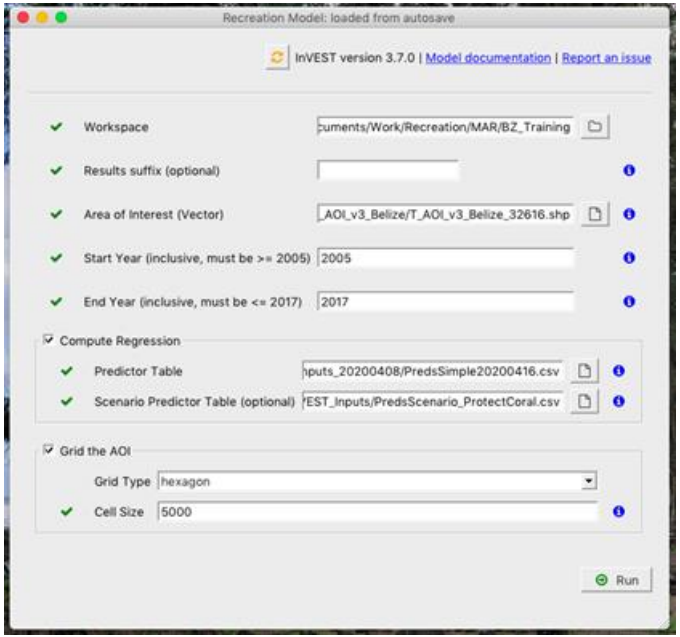
1/ Location (presence/absence) and abundance (count) of wildlife with their geolocations (point data).

2/ Leverage field data and geospatial information (land cover, topography, climate) to geographically extrapolate the location and abundance of wildlife data. This can help generate continuous maps of wildlife distribution.

3/ If data on wildlife distribution and abundance is not available, you can use habitat maps as proxy of presence/absence of wildlife. This requires ecological information about the species of interest. For instance, where species like to forage.

Next steps

- Identify data sources on wildlife distribution
- Determine other features that can draw tourism
- Map those natural and human features
- Run the InVEST Model following the steps described in this slide deck



Resources

InVEST Tourism Model User Guide:

http://releases.naturalcapitalproject.org/invest-userguide/latest/recreation.html

Natural Capital Project / InVEST Forum (Software and Science Support):

https://community.naturalcapitalproject.org/


Thank you!
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