Online Study Design Tool for Offshore Automated Radio Telemetry Stations

Please rename yourself as "First and Last Name, Affiliation" by hovering over your name in the “Participants” tab and clicking Rename

Stakeholder Workshop

January 13, 2021

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

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BIODIVERSITY RESEARCH INSTITUTE
innovative wildlife science

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NYSERDA
Sponsored

Project Team

USFWS Migratory Birds: Pam Loring, Scott Johnston

Biodiversity Research Institute: Kate Williams, Andrew Gilbert, Evan Adams, Julia Gulka, Ed Jenkins

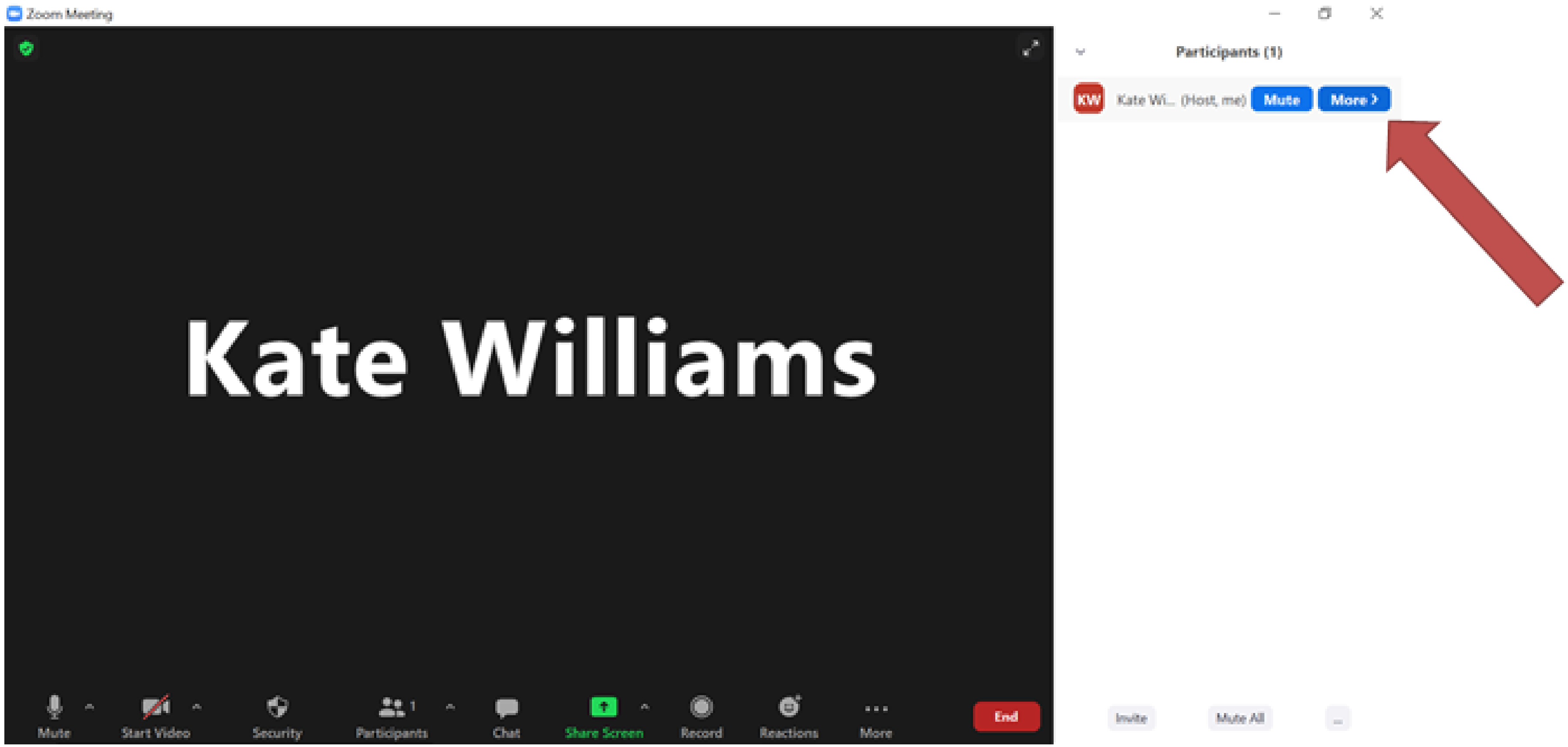
Univ. of Rhode Island: Peter Paton, Doug Gobeille, Erik Carlson, Rob Deluca

Birds Canada: Stu Mackenzie

NYSERDA (funding): Kate McClellan Press, Gregory Lampman

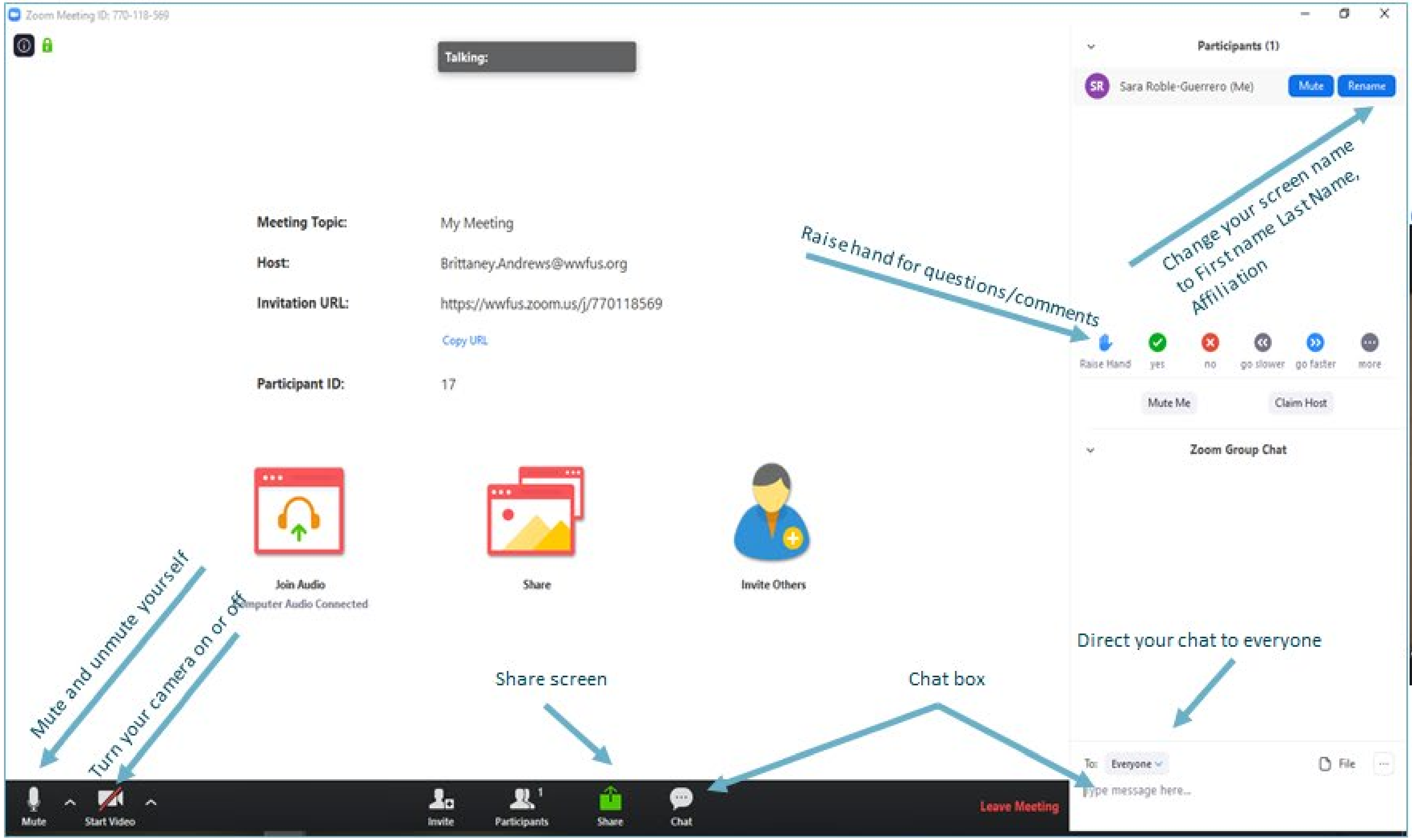
Zoom controls

- **Please rename yourself** as "First and Last Name, Affiliation" by hovering over your name in the Participants tab

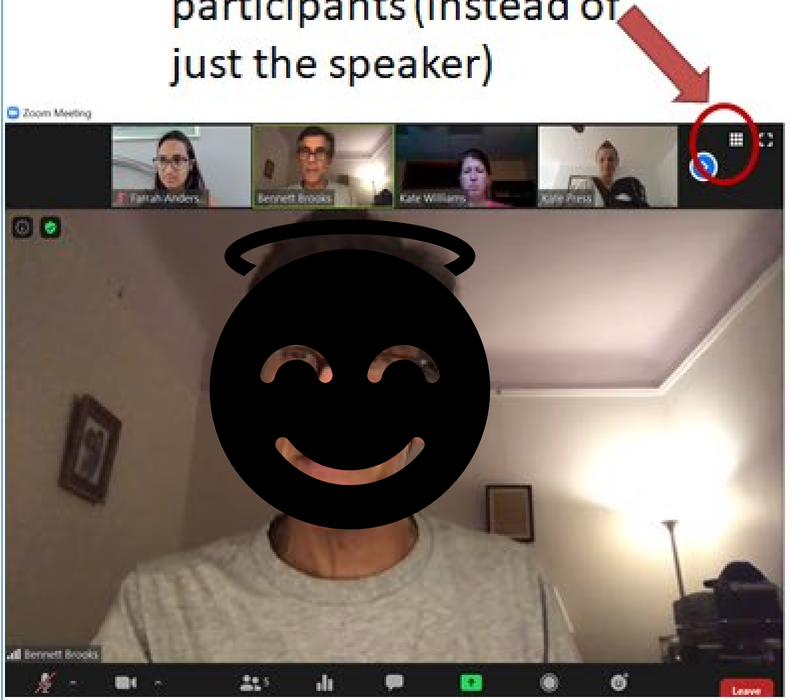


Zoom controls

- **Please mute yourself when you are not speaking**
- **Use the chat box and raise hand functions** (or feel free to unmute and talk if that makes the most sense in the moment)



Select **"grid view"** to see a grid of all participants (instead of just the speaker)



Agenda

- 10:00-10:10 – introductions
- 10:10-10:15 – overview: project components, goals for study design tool
- 10:15-10:35 – capabilities and limitations of Motus technologies
- 10:35-10:55 – what questions do we want to ask with Motus in the offshore environment?
- 10:55-11:00 – coffee break
- 11:00-11:55 – study design tool demo and discussion
- 11:55-12:00 – next steps

Overall project goal:

To develop standardized protocols for using automated radio telemetry to monitor bird and bat movements at offshore wind energy areas throughout the U.S. Atlantic.

Overall Project Components

- **Monitoring Framework -** tags and study design
- **Guidance Document –** offshore receiving stations
- **Online Study Design Tool –** map detection coverage
- **Simulation Study –** model animal movement data
- **Motus Data Framework –** centralized portal for data management, coordination, and summary reports

Objectives of Online Study Design Tool

- Develop a free online tool to help optimize site-specific study designs at offshore wind projects
- Input data:
  - Birds - flight height, taxa, movement/distribution patterns
  - Wind project - area, number & locations of potential receiver locations (turbines, substations, met tower)
  - Antenna data - type, height, gain, frequency
- Outputs:
  - Map of antenna coverage for station
  - Optimization for % coverage, % simultaneous detections, etc.
  - Study design report – output TBD

Automated Radio Telemetry:

- **Radio transmitters:** "tags" attached to birds and bats, emit signals on a shared frequency
- **Receiving stations:** antennas and data-logger that monitors shared frequency and records detections of "tagged" birds or bats flying by
- **Motus Wildlife Tracking System:** international network of collaborative automated radio telemetry studies

Motus Wildlife Tracking System

- Central hub for detection data and metadata
- > 900 collaborators across four continents
- > 900 tracking stations
- > 25,000 animals tagged
- >200 species

Operating Frequencies

Two different frequencies on Motus Network

- 166 MHz (original frequency)
- 434 MHz (new frequency)

Previous studies used 166 MHz (2012 – 2019)

- Good detection range (5-15 km) from Yagi (directional) antennas, but need long antennas (e.g. 11 dB gain = 10 ft antennas)
- High electromagnetic interference in marine environments (boats, etc.)

Currently field testing 434 MHz

- Higher frequency = smaller antennas for same amount of gain
- 434 MHz Yagi with 11 dB gain = 3.25 ft

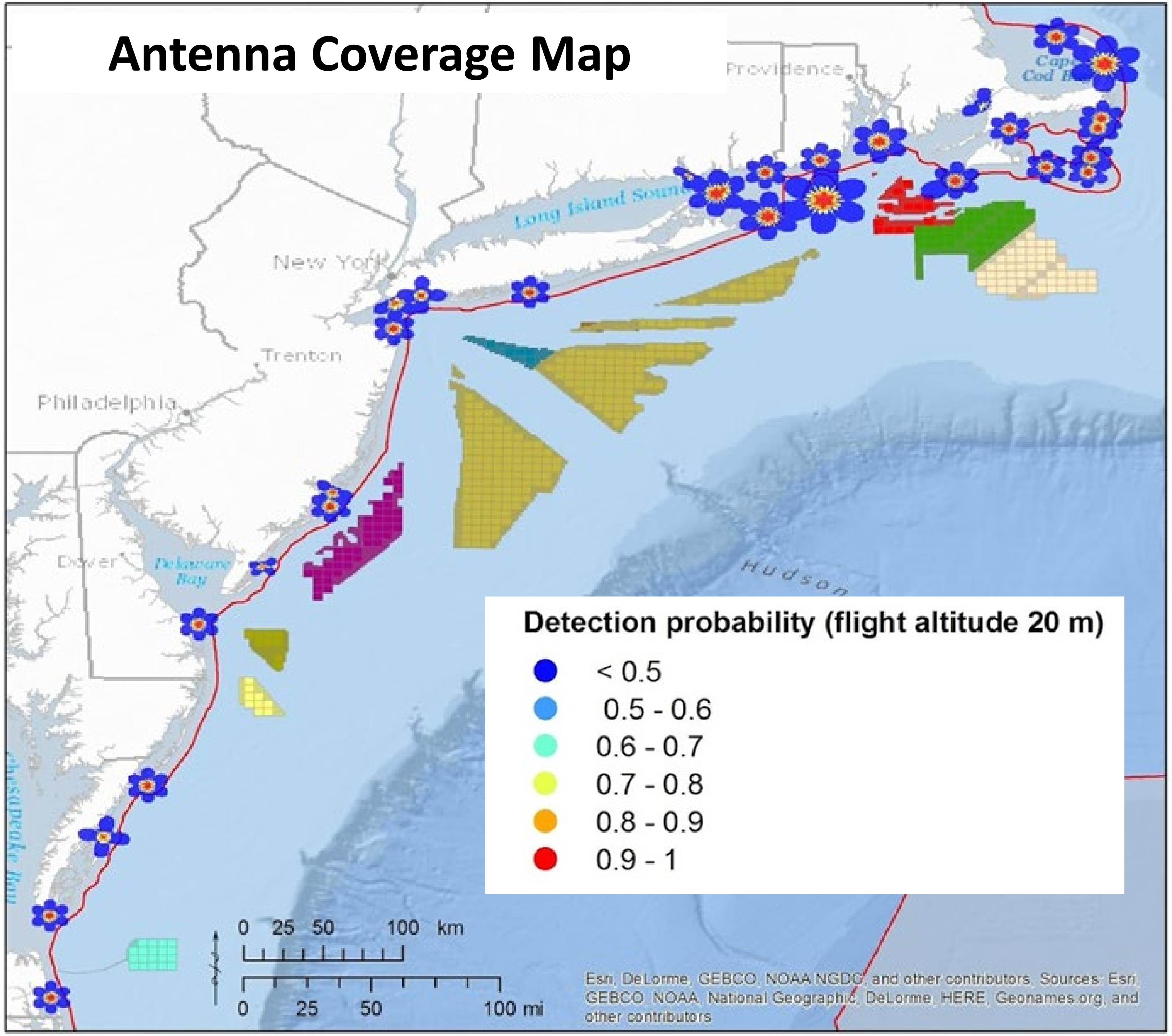
Strengths of automated radio telemetry:

- Light-weight tags (range: 0.2 to 3 g) - suitable for small-bodied species
- Thousands of uniquely identifiable tags shared frequency – large sample size leveraged by Motus (centralized data hub)
- Tags transmit every 5 seconds (high temporal resolution)
- Receiving stations continuously monitor presence of tagged animals within detection range, around the clock, and during all types of weather conditions
- Data from antennas at multiple receiving stations detecting the same animal at the same time can be used to model coarse estimates of flight paths and altitude (methods are under development)

Limitations of automated radio telemetry:

- Tag detections limited to antenna coverage of receiving stations
- Various factors affect antenna coverage: antenna type, gain, number, height, and configuration; flight height of tagged animals
- Antennas do not work very well for detecting birds sitting on water (signal scatter) - best for tracking flights
- Metal or other objects between antennas and surrounding airspace will reduce or block tag detections
- Electromagnetic interference may reduce antenna coverage
- Due to site-specific variation in antenna coverage, important to ground truth antenna coverage of tracking stations using a test tag at various altitudes and distances from receiving antennas

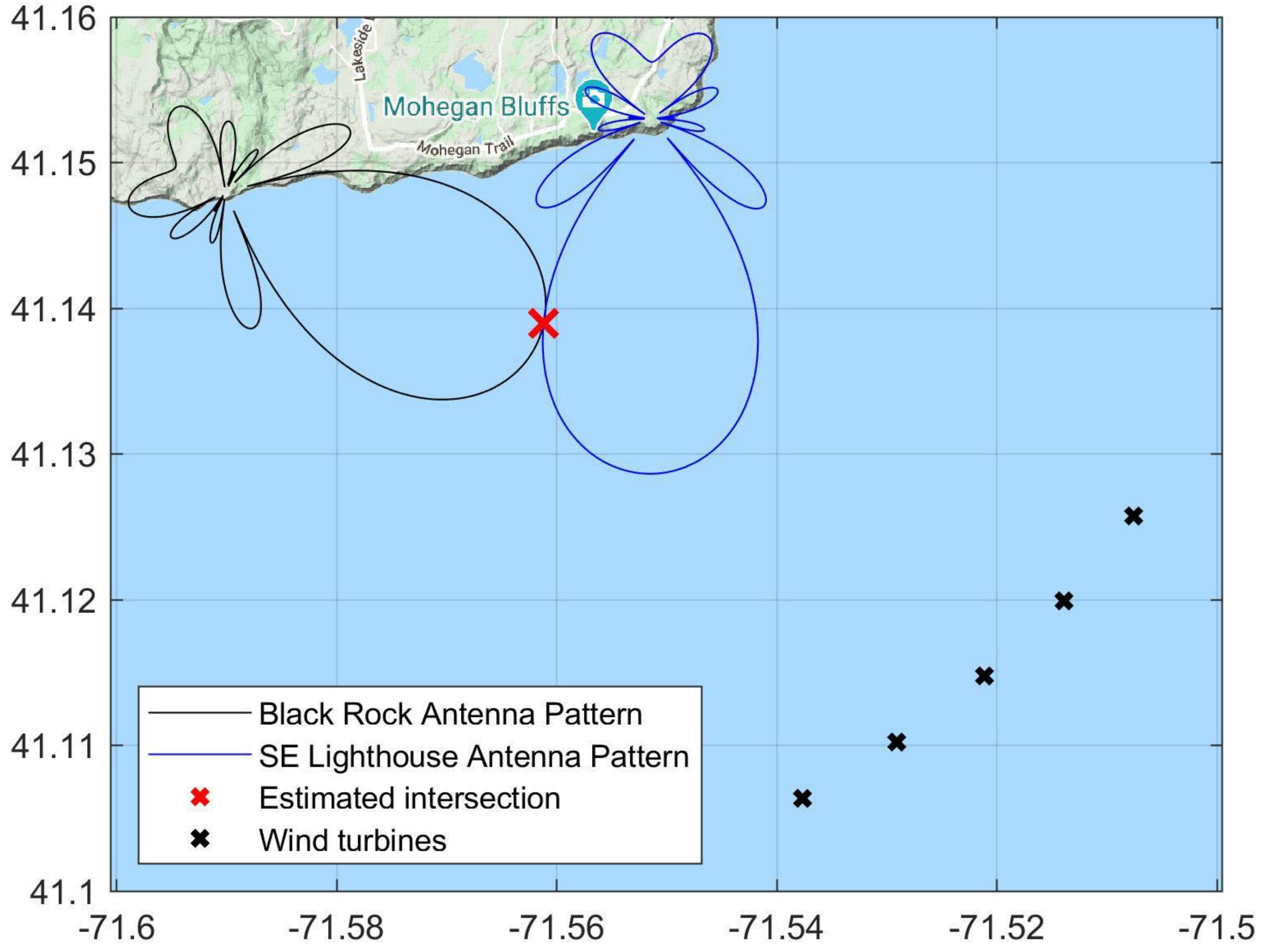
Antenna Coverage Map



Loring PH, Paton PWC, McLaren JD, Bai H, Janaswamy R, Goyert HF, Griffin CR, Sievert PR. 2019. Tracking Offshore Occurrence of Common Terns, Endangered Roseate Terns, and Threatened Piping Plovers with VHF Arrays. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-017.

Example Applications of Motus Technology With Stations in Project Area

- Presence of focal species (e.g. ESA-listed Piping Plover, Red Knot, Roseate Tern) within project area (with targeted tagging efforts)
- Inputs to collision risk models (passage rates, day vs. night, weather conditions) - currently under development
- Opportunistic monitoring of species tagged by Motus network collaborators that may pass through project area
- Movements of tagged animals between stations in different project areas throughout the U.S. Atlantic, in coordination with Motus
- Analyses of flight paths and altitude possible with sufficient antenna coverage (simultaneous detections from multiple stations) and modeling tools - methods currently under development

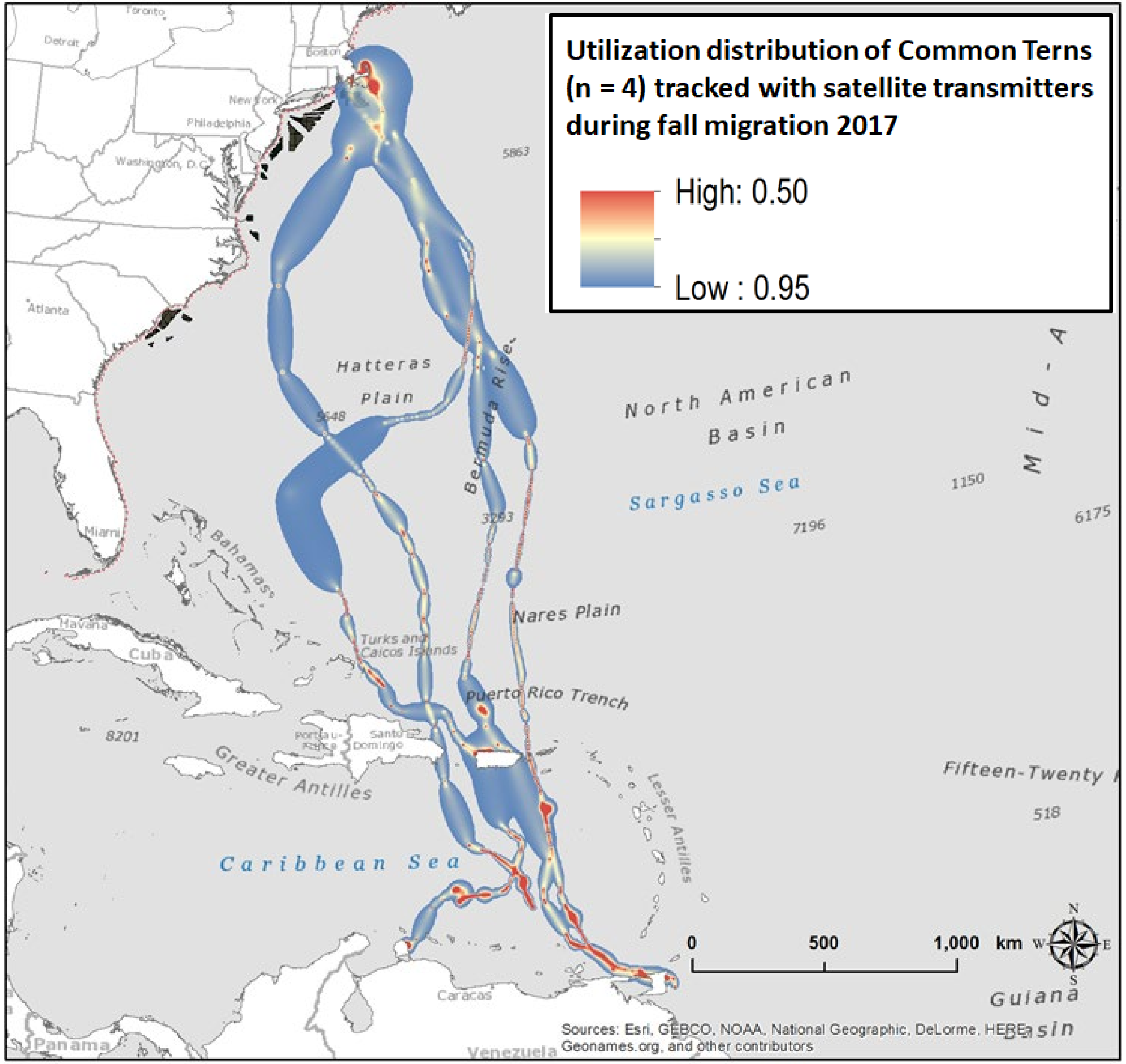


- **Example of the intersection the simultaneous detections by receiving antennas from two separate towers**
- **Red x represents the approximate location of the bird**

Paton PWC, Cooper-Mullin, C., Kouhi, S. Loring PH, Moore J, Miller J, Potty G. 2021. Assessing movements of birds using digital VHF transmitters: A validation study. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-009. 222 p.

Alternative technologies: Satellite/GPS

- Global tracking coverage via satellite
- In example – Common Terns tracked with 2-g Argos PTT tags, avg 11 locations per day. Spatial error of locations <250 - >1,500 m
- Spatial and temporal resolution varies with size of tag (battery)
- Heavier GPS tags (larger-bodied birds) - higher spatial and temporal resolution
- GPS technology complementary to Motus - help fill in data gaps
- Larger birds (e.g. gulls, gannets) can be double-tagged with GPS and Motus tags
    - Movement data at multiple scales
    - Useful for ground-truthing antenna coverage of Motus stations
    - Field work at Block Is to test on gulls this spring



Stakeholder Meeting: Study Design

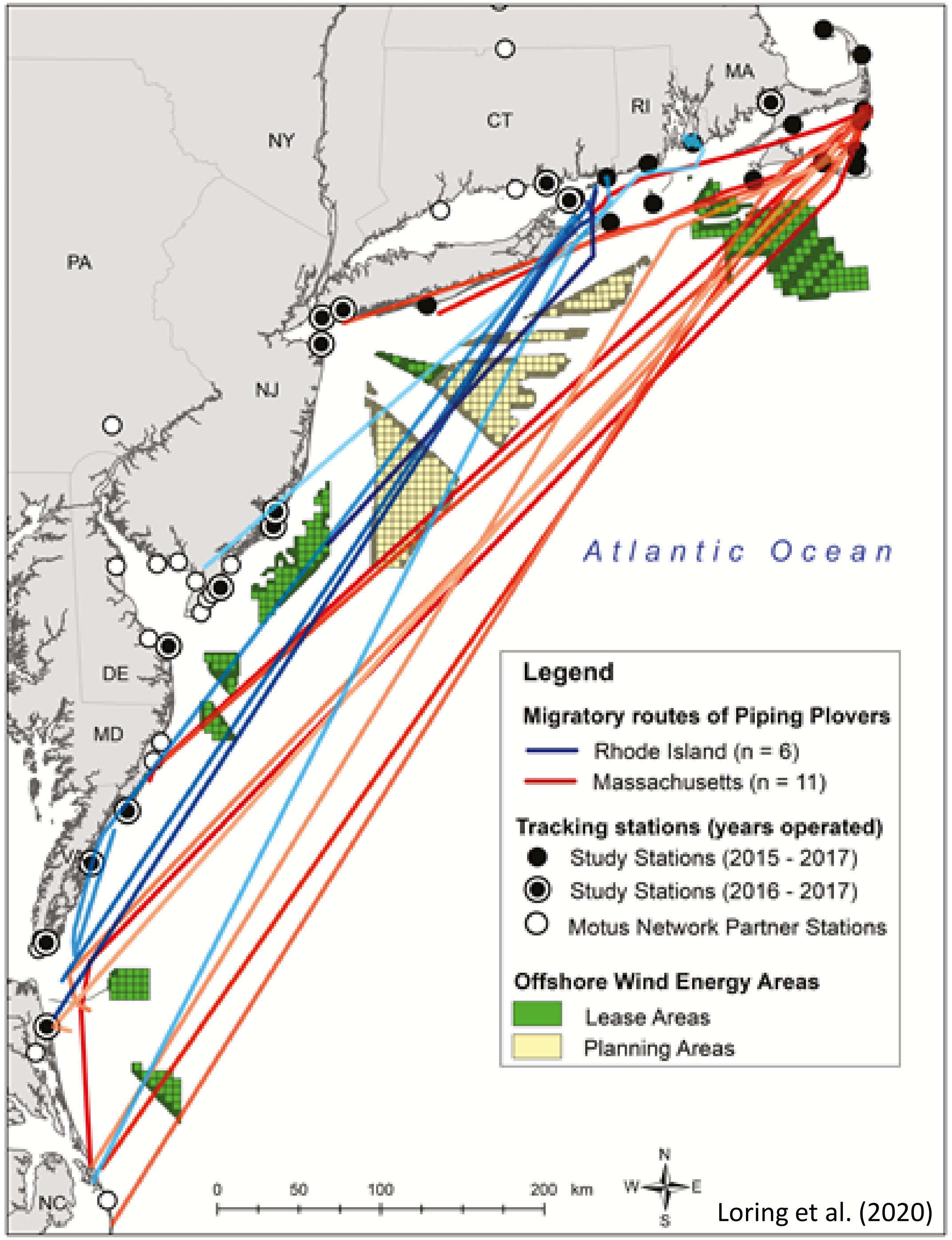
Evan Adams

Goals for offshore automated telemetry studies

1/13/2021

Automated Telemetry Offshore

- Researchers have begun to use automated telemetry to determine occupancy and flight paths for marine birds
- Telemetry receivers have mostly been placed on coastal lands
- As offshore wind buildout begins, we will have new option for distributing receivers



Loring et al. (2020)

What kinds of questions are we interested in answering offshore?

- Large-scale questions
  - Occupancy
    - Are individuals present in a study area?
    - Key metrics: frequency of study area use, proportion of sampled population using the study area
    - Receiver placement should consider the area that we want to confirm occupancy

What kinds of questions are we interested in answering offshore?

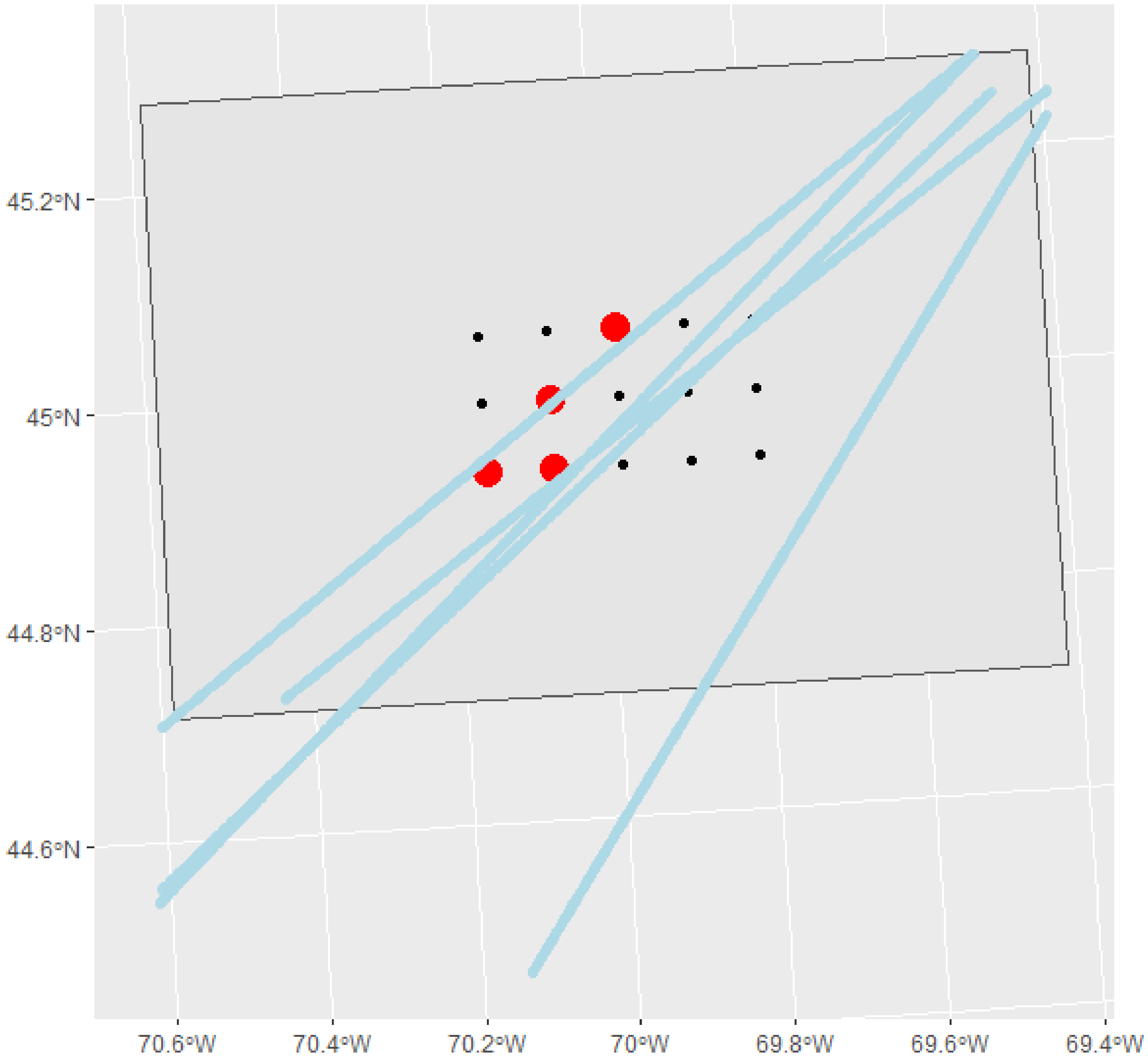
- Large-scale questions
  - Macro-avoidance
    - Are animals avoiding the turbine footprint?
    - Before/after comparisons are not usually possible
    - Receiver placement after construction will be key to detemining if the animal was inside the study area
    - Proximity to the turbine footprint is not likely measurable

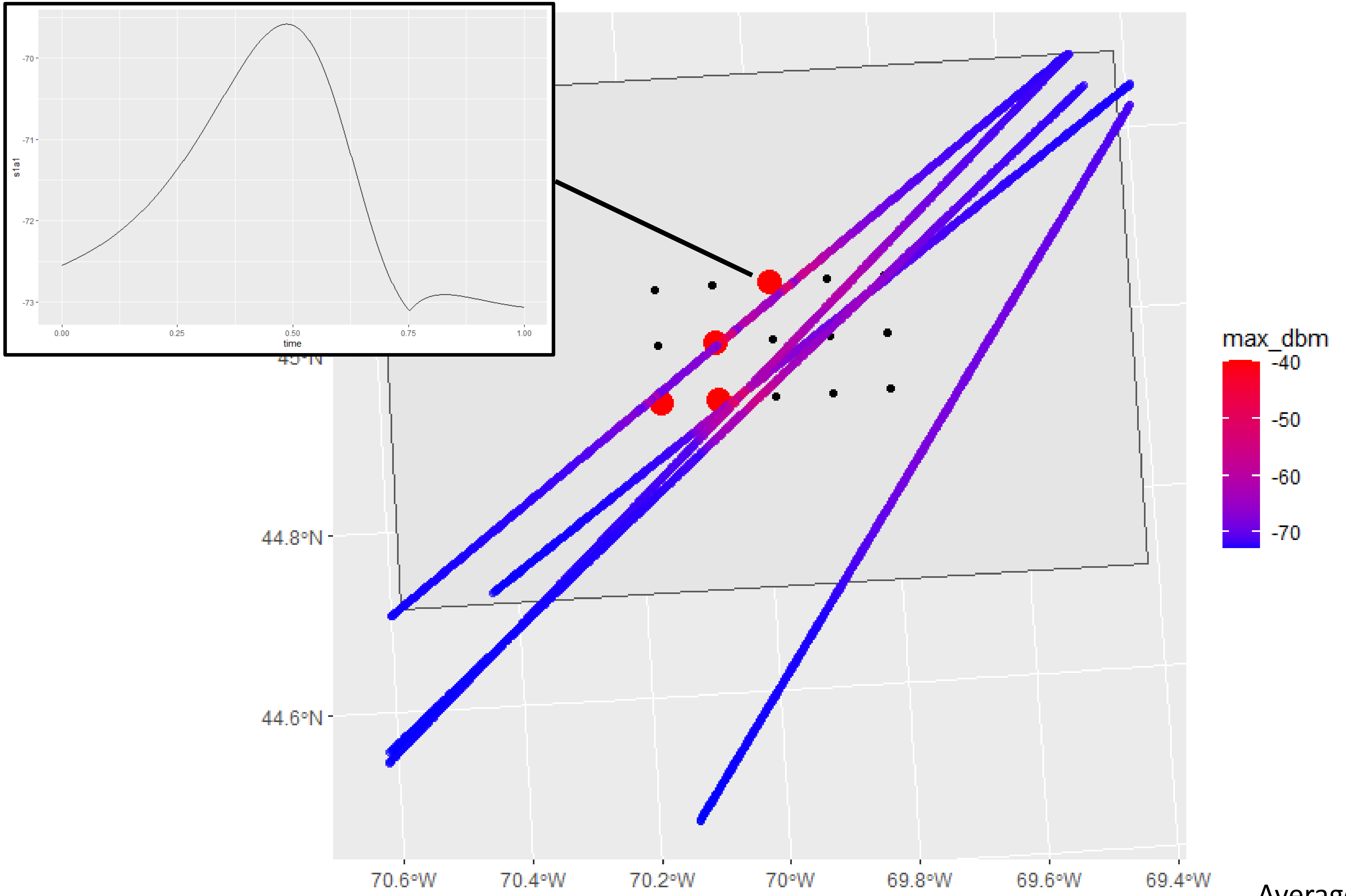
What kinds of questions are we interested in answering offshore?

- These questions rely on more accurate position estimation, which is an area of ongoing research
  - Generally, we should be cautious about assuming that accurate positions can be estimated with automated telemetry
  - To estimate flight paths, we need an accurate estimate of flight height
  - Perhaps we can make some reasonable assumptions to get us out of this identifiability issue
- Small-scale questions that telemetry could help with
  - Flight height estimation
  - Space/Habitat-use
  - Meso-scale avoidance
- Small-scale questions that telemetry would not be helpful with:
  - Micro-avoidance
  - Collisions

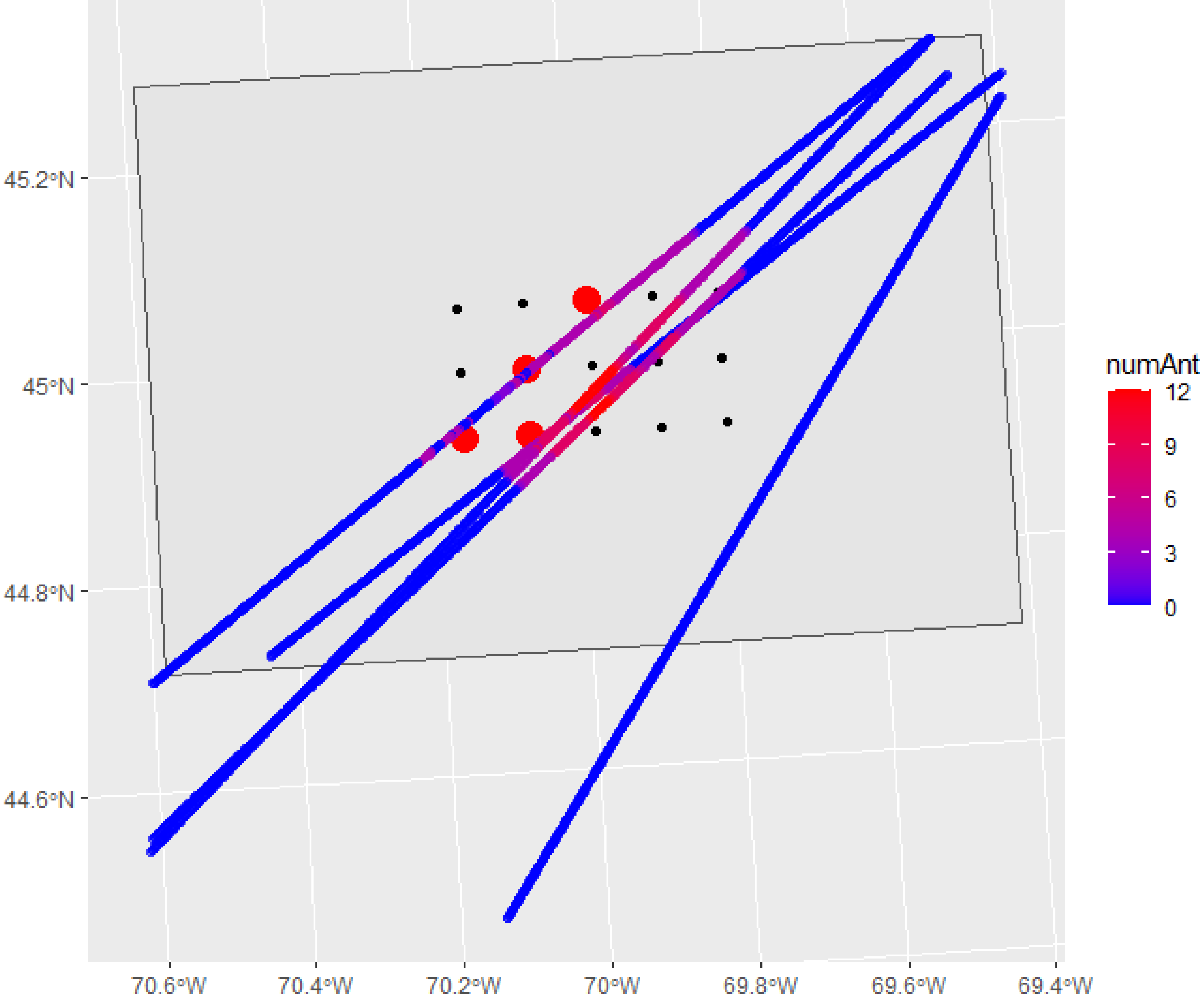
How effective are offshore receivers for answering key questions for marine species?

- This likely depends on the:
  - Goals of the study
    - Are you interested in estimating occupancy in an area or habitat use? These goals require very different scales of information
      - Single antenna v. multi-antennae detections
  - Study design
    - How many receivers are used and in what spatial configuration?
    - Transmitter configuration
  - Study species
    - How do species move through the environment?
    - What height to they typically fly?
    - Do they spend a lot of time resting on the water?


45.2°N
45°N
44.8°N
44.6°N
70.6°W
70.4°W
70.2°W
70°W
69.8°W
69.6°W
69.4°W



Average Flight Height = 100 m



Detection Threshold = -68.1 dbm

Discussion

- Are there other kinds of questions you are interested in answering with automated telemetry?
- How effective is automated telemetry in answering these questions relative to other kinds of methods?
- What other aspects of study design should we consider?

Online Study Design Tool for Offshore Automated Radio Telemetry Stations

Andrew Gilbert

Stakeholder Workshop

January 13, 2021

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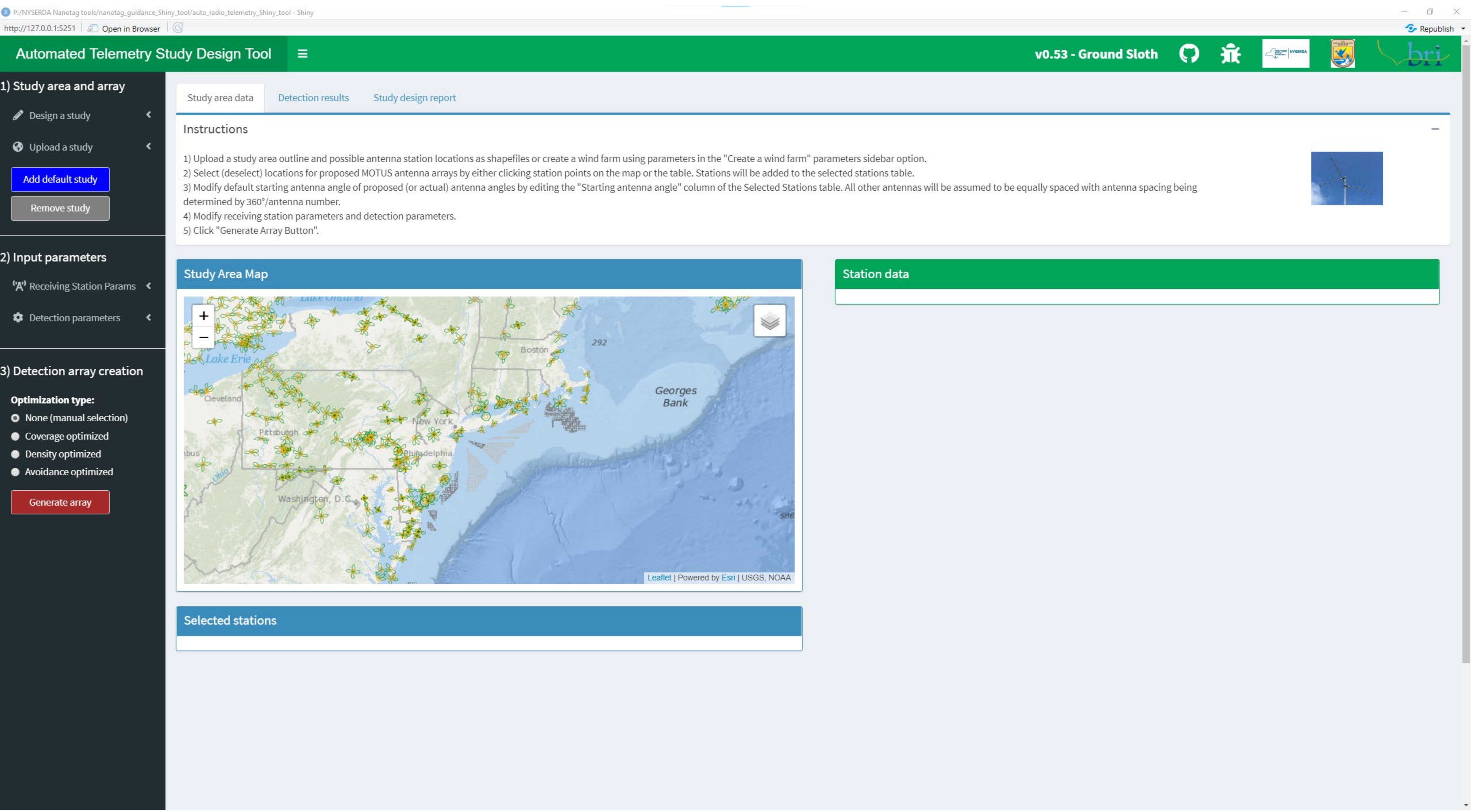
P:/NYSERDA Nanotag tools/nanotag_guidance_Shiny_tool/auto_radio_telemetry_Shiny_tool - Shiny
http://127.0.0.1:5251
Open in Browser
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Automated Telemetry Study Design Tool
v0.53 - Ground Sloth
1) Study area and array
Design a study
Upload a study
Add default study
Remove study
2) Input parameters
Receiving Station Params
Detection parameters
3) Detection array creation
Optimization type:
None (manual selection)
Coverage optimized
Density optimized
Avoidance optimized
Generate array
Study area data
Detection results
Study design report
Instructions
1) Upload a study area outline and possible antenna station locations as shapefiles or create a wind farm using parameters in the "Create a wind farm" parameters sidebar option.
2) Select (deselect) locations for proposed MOTUS antenna arrays by either clicking station points on the map or the table. Stations will be added to the selected stations table.
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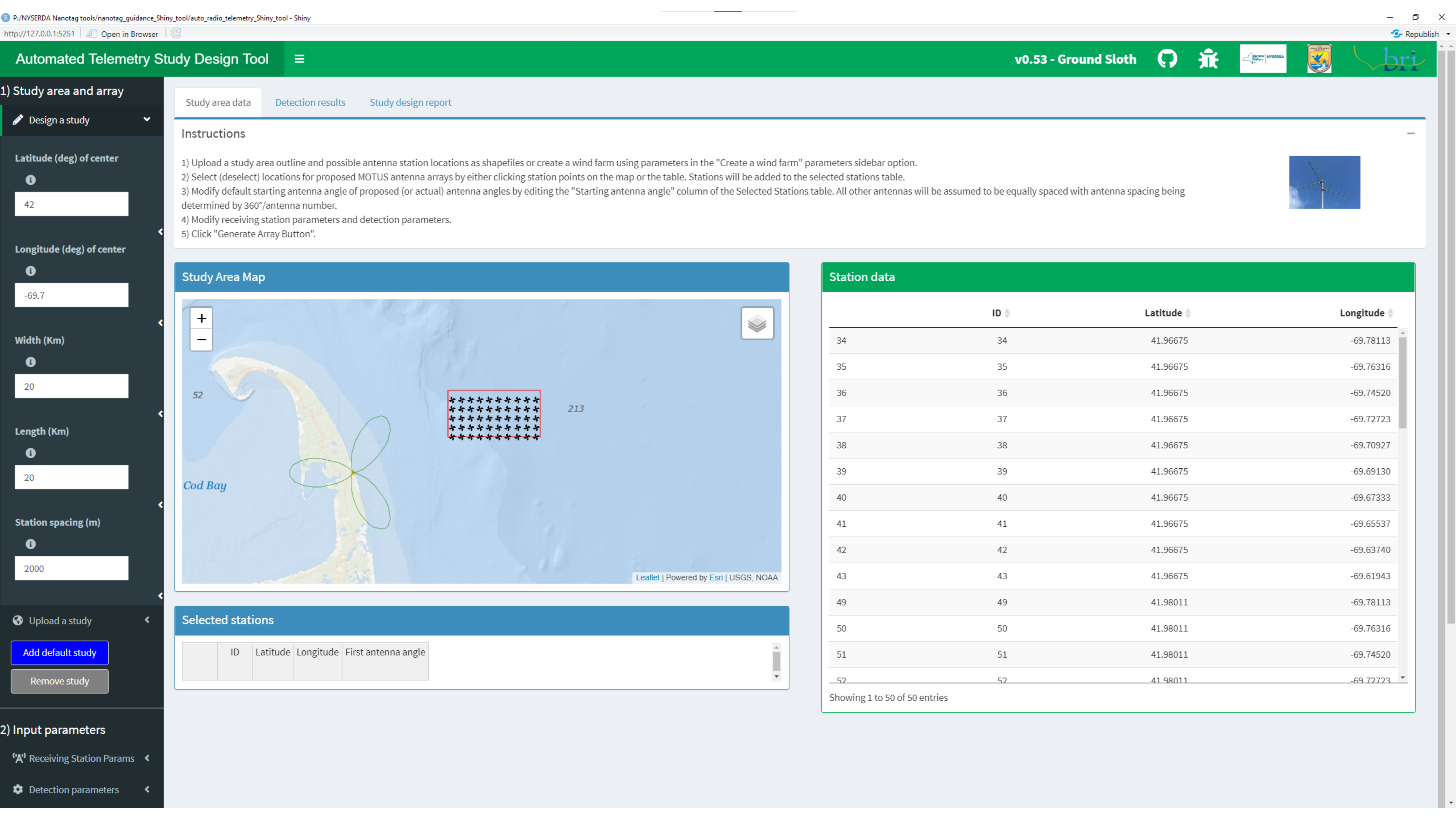
5) Click "Generate Array Button".
Study Area Map
Lake Erie
Cleveland
Boston
292
Georges
Bank
New York
Pittsburgh
Philadelphia
Washington, D.C.
Leaflet | Powered by Esri | USGS, NOAA
Station data
Selected stations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Automated Telemetry Study Design Tool
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1) Study area and array
Design a study
Latitude (deg) of center
42
Longitude (deg) of center
-69.7
Width (Km)
20
Length (Km)
20
Station spacing (m)
2000
Upload a study
Add default study
Remove study
2) Input parameters
Receiving Station Params
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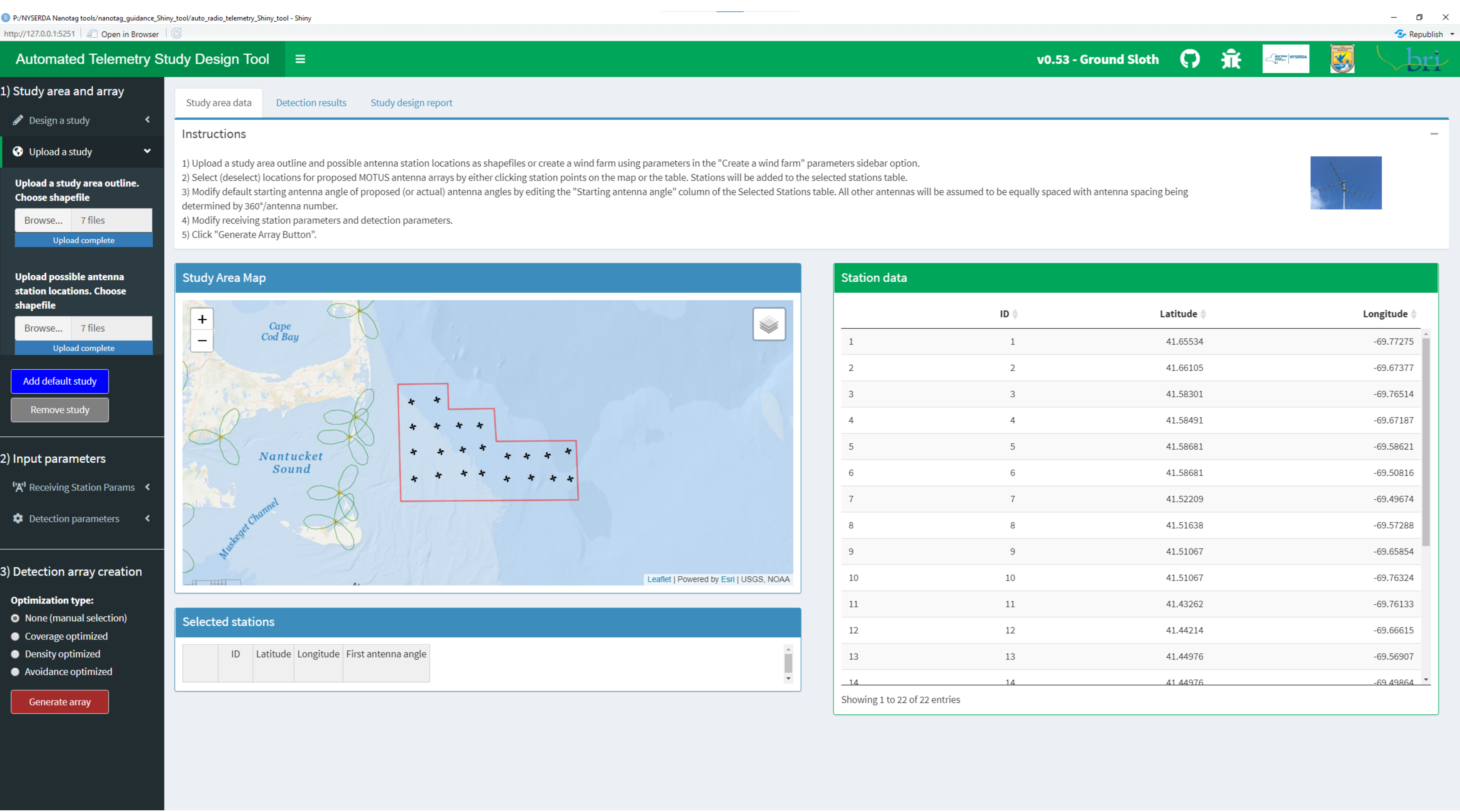
Study Area Map
52
213
Cod Bay
Leaflet | Powered by Esri | USGS, NOAA
Selected stations
ID Latitude Longitude First antenna angle
Station data
ID Latitude Longitude
34 34 41.96675 -69.78113
35 35 41.96675 -69.76316
36 36 41.96675 -69.74520
37 37 41.96675 -69.72723
38 38 41.96675 -69.70927
39 39 41.96675 -69.69130
40 40 41.96675 -69.67333
41 41 41.96675 -69.65537
42 42 41.96675 -69.63740
43 43 41.96675 -69.61943
49 49 41.98011 -69.78113
50 50 41.98011 -69.76316
51 51 41.98011 -69.74520
Showing 1 to 50 of 50 entries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http://127.0.0.1:5251
Open in Browser
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Automated Telemetry Study Design Tool
v0.53 - Ground Sloth
1) Study area and array
Design a study
Upload a study
Upload a study area outline. Choose shapefile
Browse...
7 files
Upload complete
Upload possible antenna station locations. Choose shapefile
Browse...
7 files
Upload complete
Add default study
Remove study
2) Input parameters
Receiving Station Params
Detection parameters
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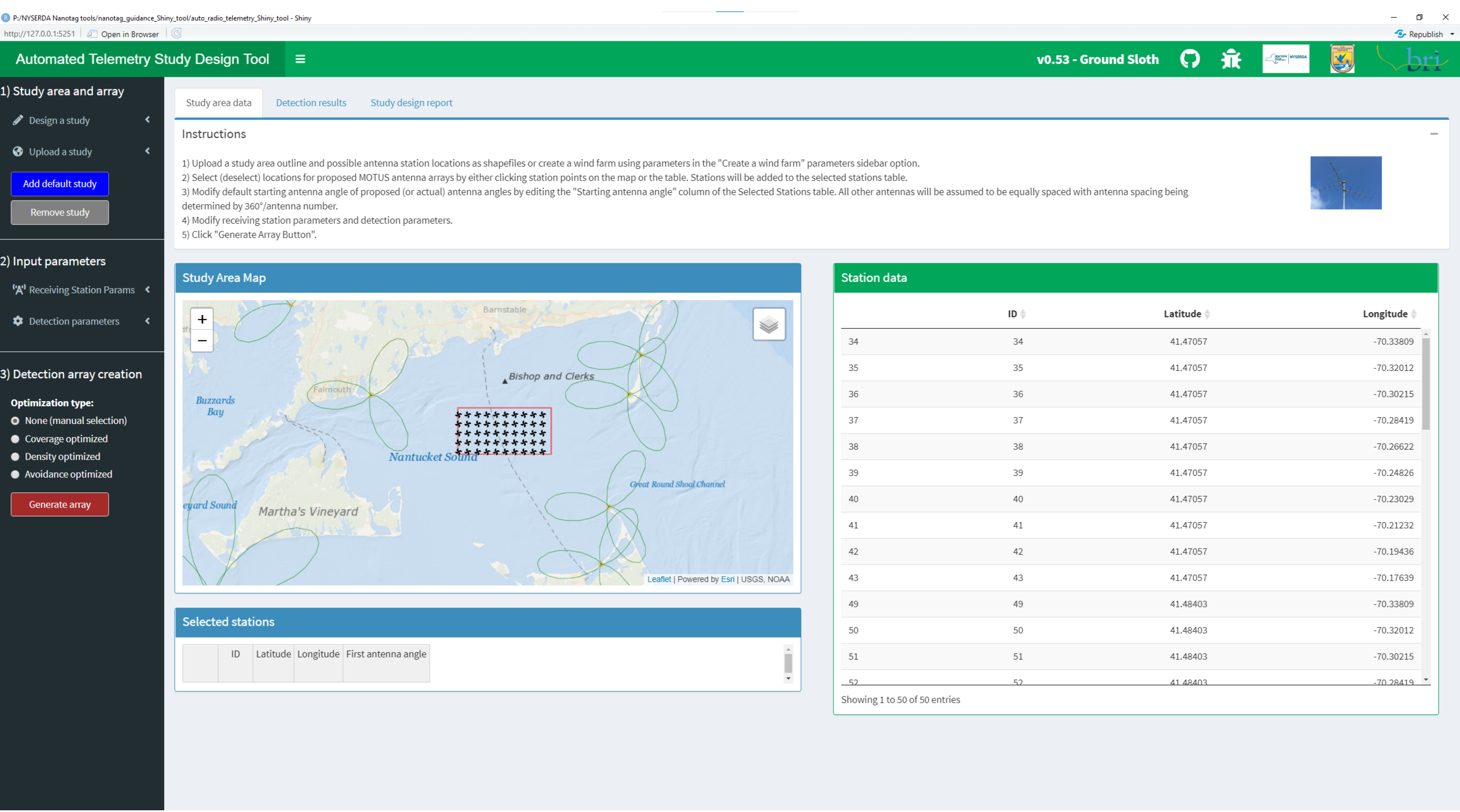
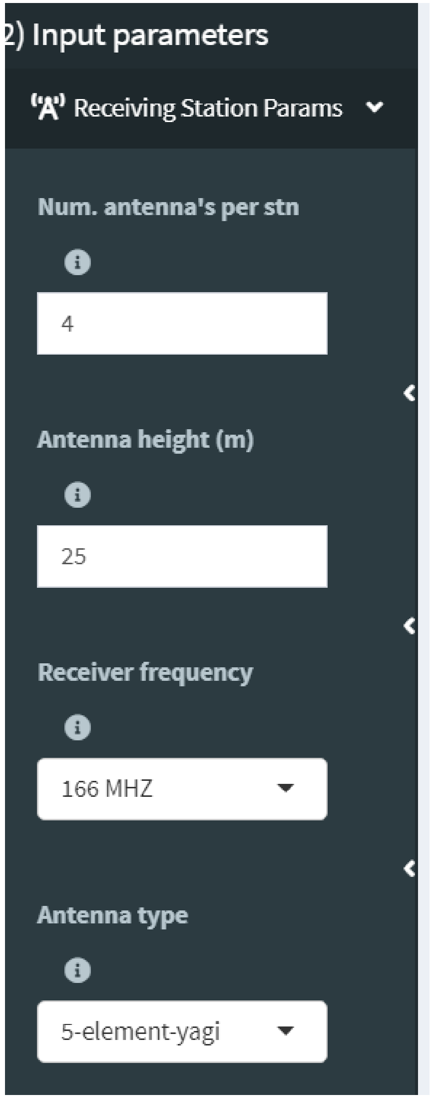
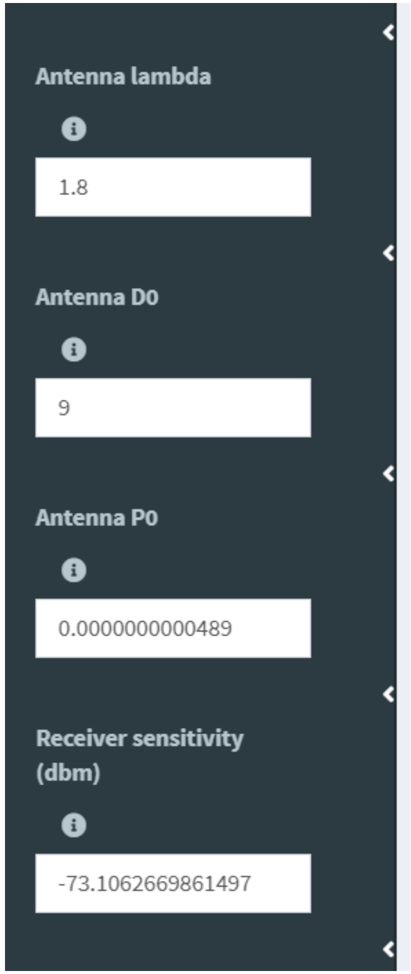
Study Area Map
Cape Cod Bay
Nantucket Sound
Muskeget Channel
Leaflet | Powered by Esri | USGS, NOAA
Selected stations
ID
Latitude
Longitude
First antenna angle
Station data
ID
Latitude
Longitude
1 1 41.65534 -69.77275
2 2 41.66105 -69.67377
3 3 41.58301 -69.76514
4 4 41.58491 -69.67187
5 5 41.58681 -69.58621
6 6 41.58681 -69.50816
7 7 41.52209 -69.49674
8 8 41.51638 -69.57288
9 9 41.51067 -69.65854
10 10 41.51067 -69.76324
11 11 41.43262 -69.76133
12 12 41.44214 -69.66615
13 13 41.44976 -69.56907
14 14 41.44976 -69.49864
Showing 1 to 22 of 22 entries

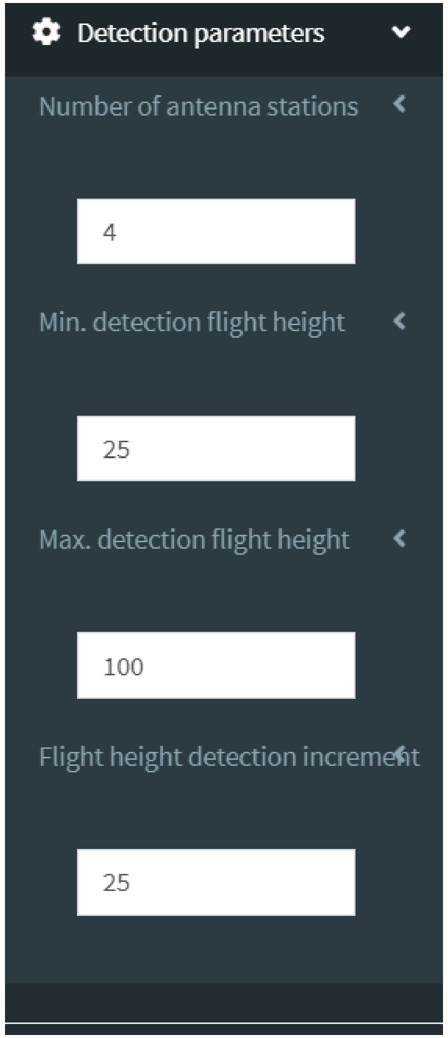


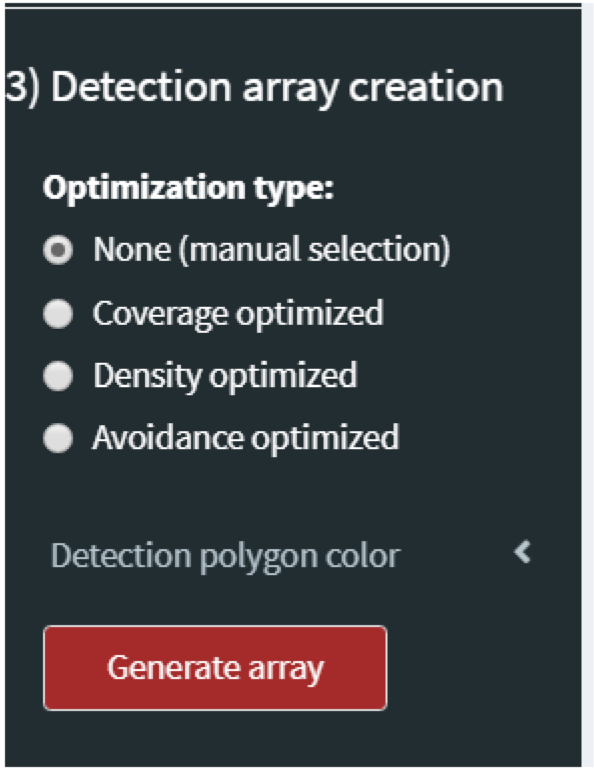
	ID	Latitude	Longitude
34	34	41.47057	-70.33809
35	35	41.47057	-70.32012
36	36	41.47057	-70.30215
37	37	41.47057	-70.28419
38	38	41.47057	-70.26622
39	39	41.47057	-70.24826
40	40	41.47057	-70.23029
41	41	41.47057	-70.21232
42	42	41.47057	-70.19436
43	43	41.47057	-70.17639
49	49	41.48403	-70.33809
50	50	41.48403	-70.32012
51	51	41.48403	-70.30215
52	52	41.48403	-70.28419

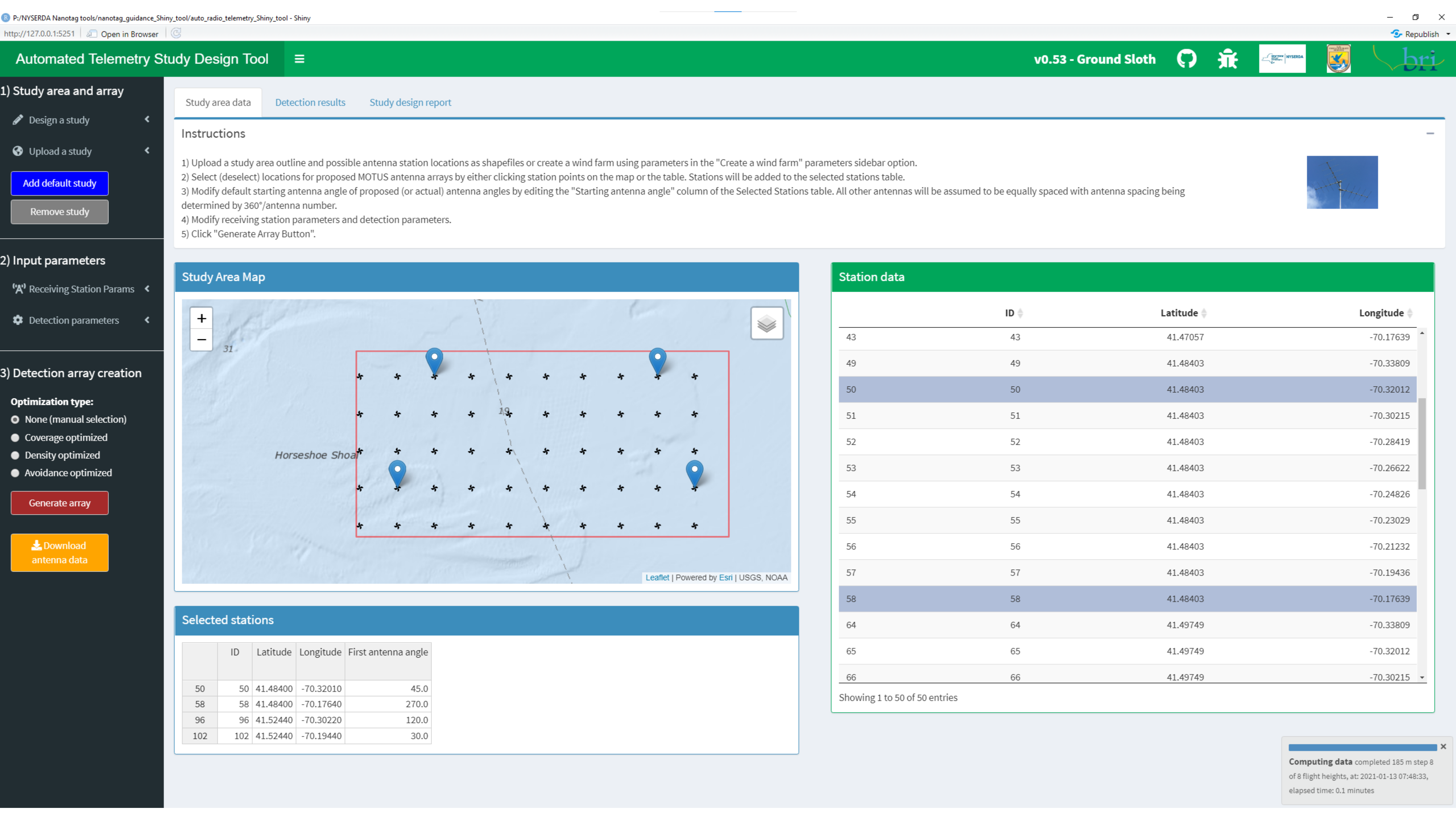
Input parameters







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Coverage optimized
Density optimized
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Generate array
Download antenna data
Study area data
Detection results
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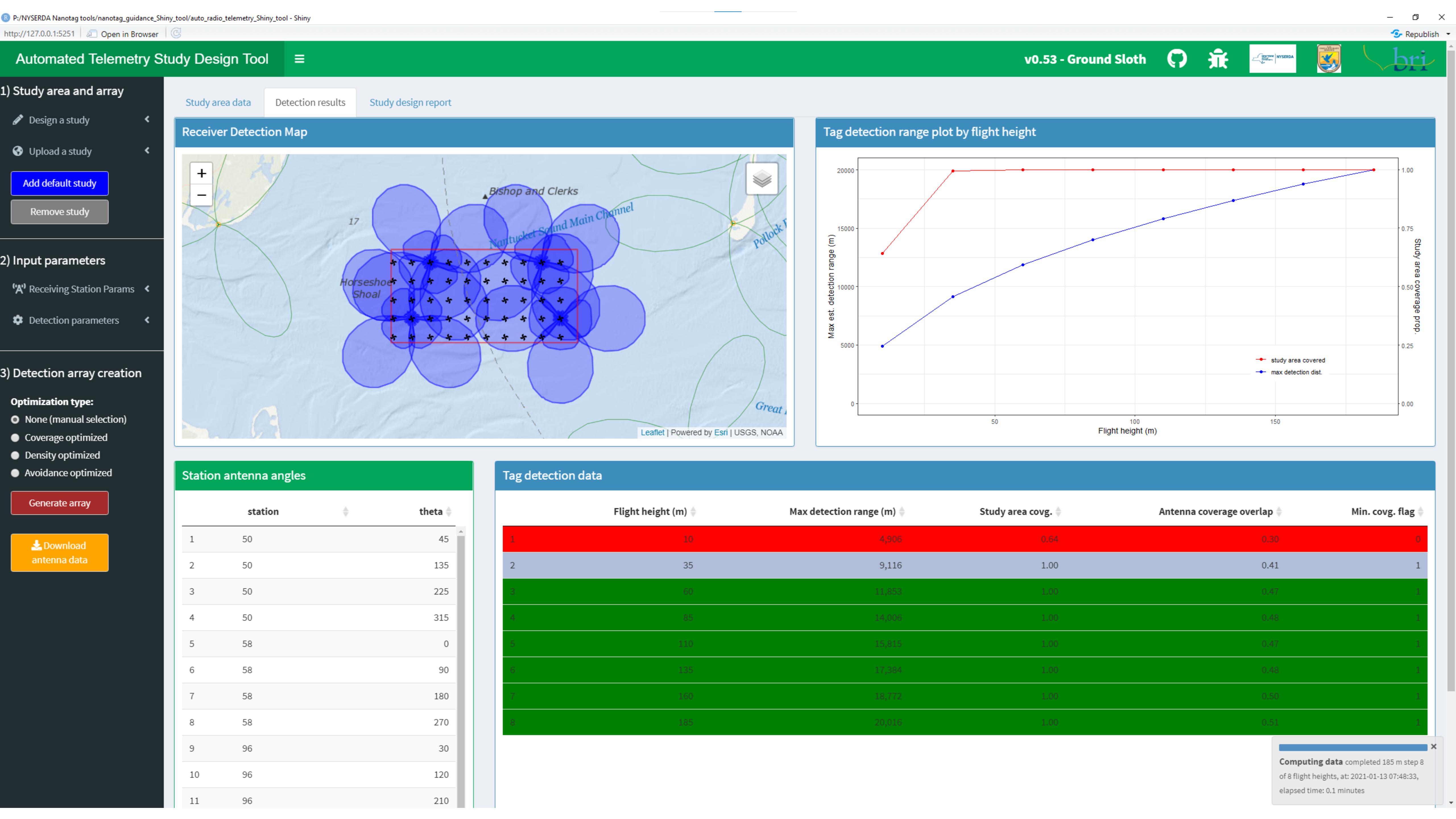
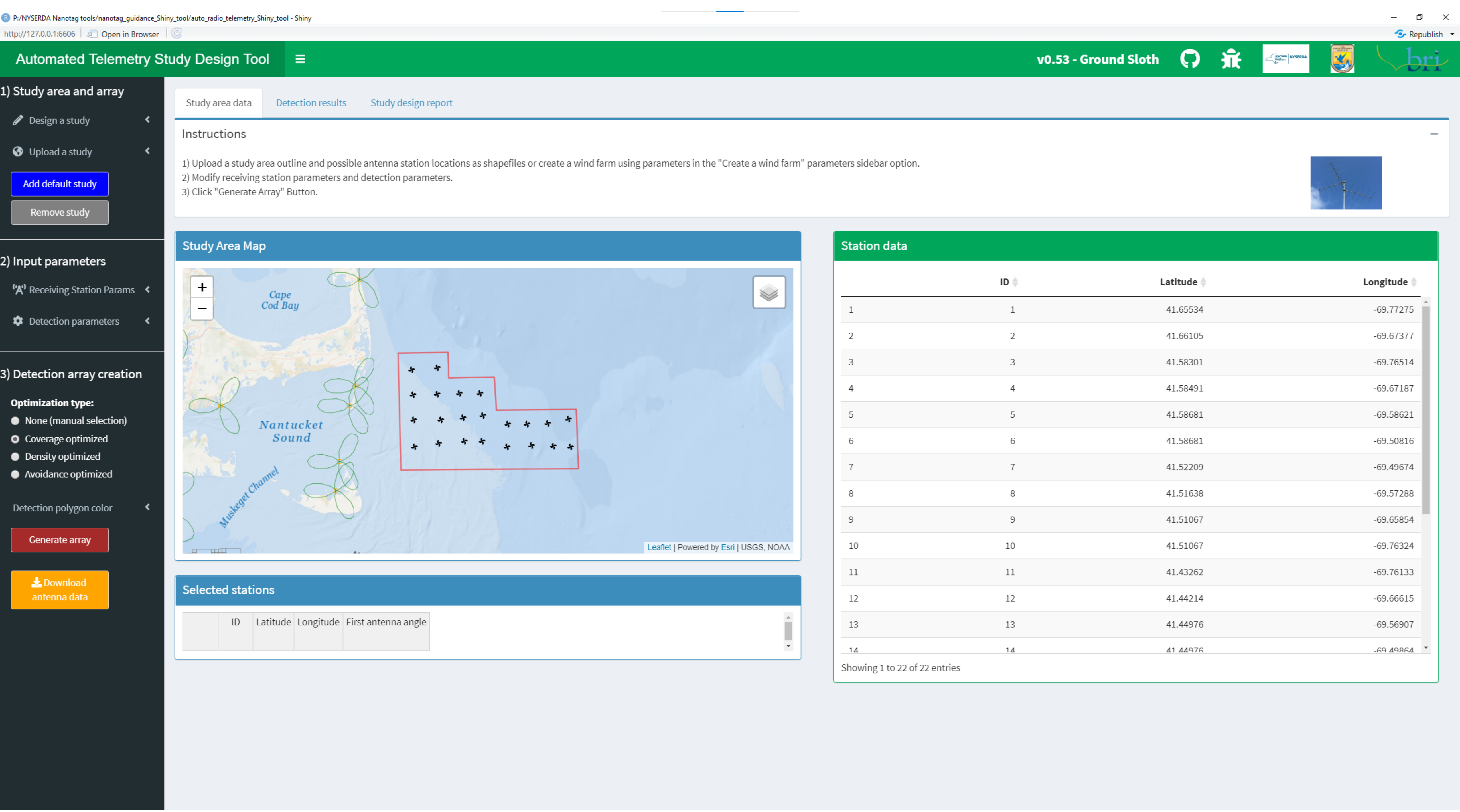
5) Click "Generate Array Button".
Study Area Map
31
Horseshoe Shoal
Leaflet | Powered by Esri | USGS, NOAA
Station data
ID Latitude Longitude
43 43 41.47057 -70.17639
49 49 41.48403 -70.33809
50 50 41.48403 -70.32012
51 51 41.48403 -70.30215
52 52 41.48403 -70.28419
53 53 41.48403 -70.26622
54 54 41.48403 -70.24826
55 55 41.48403 -70.23029
56 56 41.48403 -70.21232
57 57 41.48403 -70.19436
58 58 41.48403 -70.17639
64 64 41.49749 -70.33809
65 65 41.49749 -70.32012
66 66 41.49749 -70.30215
Showing 1 to 50 of 50 entries
Selected stations
ID Latitude Longitude First antenna angle
50 50 41.48400 -70.32010 45.0
58 58 41.48400 -70.17640 270.0
96 96 41.52440 -70.30220 120.0
102 102 41.52440 -70.19440 30.0
Computing data completed 185 m step 8 of 8 flight heights, at: 2021-01-13 07:48:33, elapsed time: 0.1 minutes



	station	theta
1	50	45
2	50	135
3	50	225
4	50	315
5	58	0
6	58	90
7	58	180
8	58	270
9	96	30
10	96	120
11	96	210

	Flight height (m)	Max detection range (m)	Study area covg.	Antenna coverage overlap	Min. covg. flag
1	10	4,906	0.64	0.30	0
2	35	9,116	1.00	0.41	1
3	60	11,853	1.00	0.47	1
4	85	14,006	1.00	0.48	1
5	110	15,815	1.00	0.47	1
6	135	17,384	1.00	0.48	1
7	160	18,772	1.00	0.50	1
8	185	20,016	1.00	0.51	1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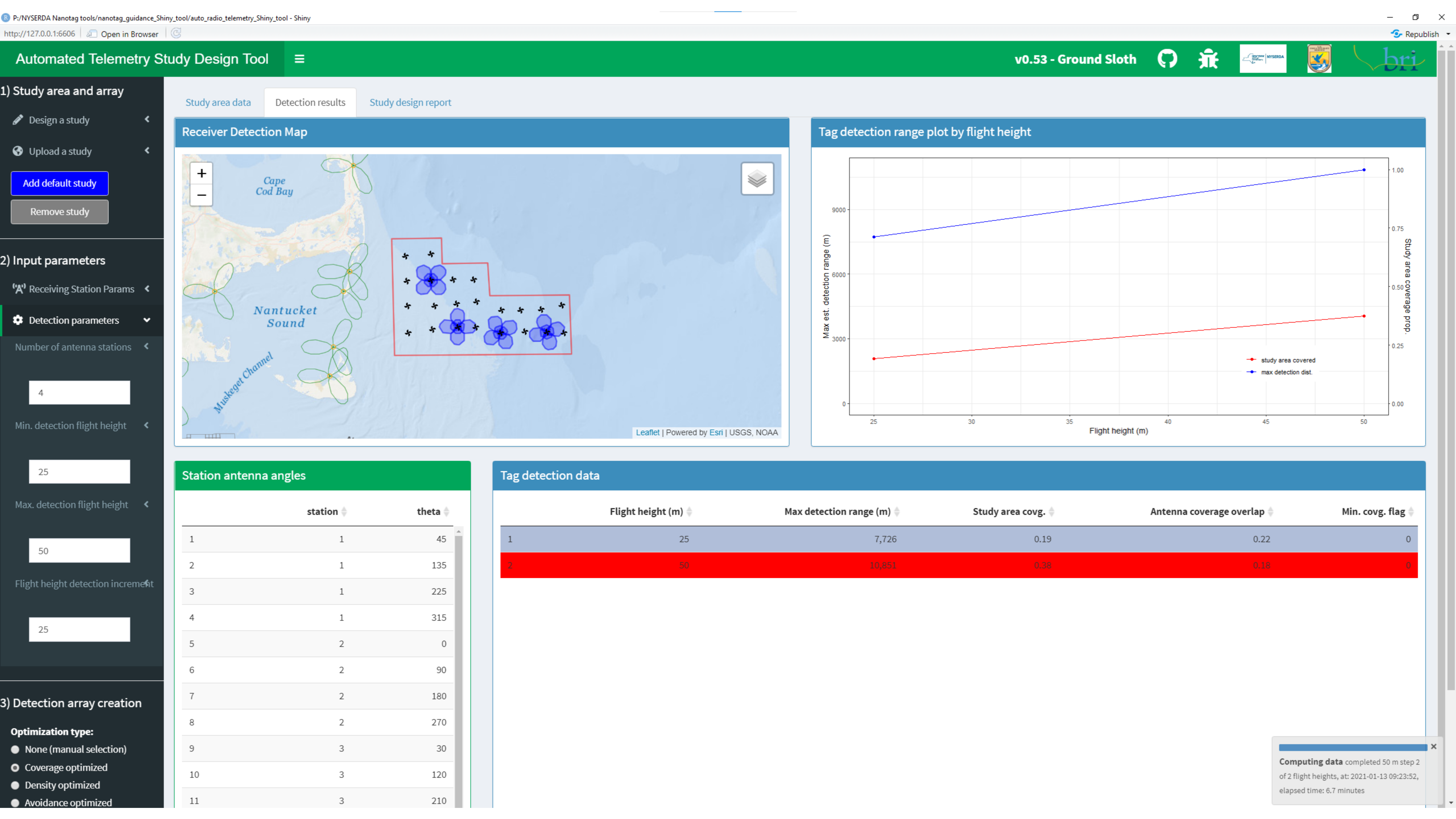
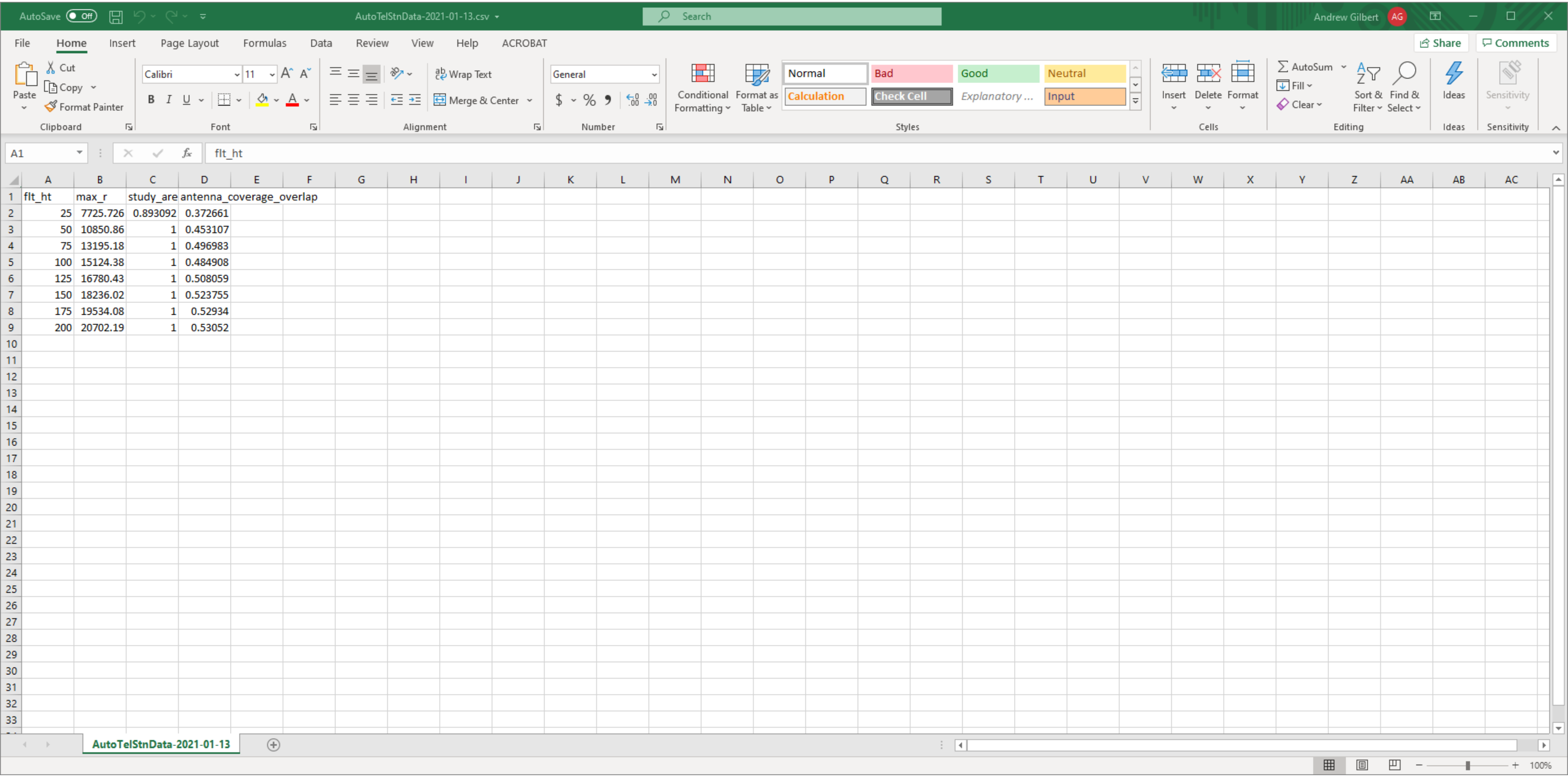
1) Study area and array
Design a study
Upload a study
Add default study
Remove study
2) Input parameters
Receiving Station Params
Detection parameters
3) Detection array creation
Optimization type:
None (manual selection)
Coverage optimized
Density optimized
Avoidance optimized
Detection polygon color
Generate array
Download antenna data
Study area data
Detection results
Study design report
Instructions
1) Upload a study area outline and possible antenna station locations as shapefiles or create a wind farm using parameters in the "Create a wind farm" parameters sidebar option.
2) Modify receiving station parameters and detection parameters.
3) Click "Generate Array" Button.
Study Area Map
Cape Cod Bay
Nantucket Sound
Muskeget Channel
Leaflet | Powered by Esri | USGS, NOAA
Selected stations
ID
Latitude
Longitude
First antenna angle
Station data
ID
Latitude
Longitude
1 1 41.65534 -69.77275
2 2 41.66105 -69.67377
3 3 41.58301 -69.76514
4 4 41.58491 -69.67187
5 5 41.58681 -69.58621
6 6 41.58681 -69.50816
7 7 41.52209 -69.49674
8 8 41.51638 -69.57288
9 9 41.51067 -69.65854
10 10 41.51067 -69.76324
11 11 41.43262 -69.76133
12 12 41.44214 -69.66615
13 13 41.44976 -69.56907
Showing 1 to 22 of 22 entries


P:/NYSERDA Nanotag tools/nanotag_guidance_Shiny_tool/auto_radio_telemetry_Shiny_tool - Shiny
http://127.0.0.1:6606
Open in Browser
Republish
Automated Telemetry Study Design Tool
v0.53 - Ground Sloth
1) Study area and array
Design a study
Upload a study
Add default study
Remove study
2) Input parameters
Receiving Station Params
Detection parameters
Number of antenna stations
4
Min. detection flight height
25
Max. detection flight height
50
Flight height detection increment
25
3) Detection array creation
Optimization type:
None (manual selection)
Coverage optimized
Density optimized
Avoidance optimized
Study area data
Detection results
Study design report
Receiver Detection Map
Cape Cod Bay
Nantucket Sound
Muskeget Channel
Leaflet | Powered by Esri | USGS, NOAA
Tag detection range plot by flight height
Max est. detection range (m)
Study area coverage prop.
Flight height (m)
study area covered
max detection dist.
Station antenna angles
station theta
1 1 45
2 1 135
3 1 225
4 1 315
5 2 0
6 2 90
7 2 180
8 2 270
9 3 30
10 3 120
11 3 210
Tag detection data
Flight height (m) Max detection range (m) Study area covg. Antenna coverage overlap Min. covg. flag
1 25 7,726 0.19 0.22 0
2 50 10,851 0.38 0.18 0
Computing data completed 50 m step 2 of 2 flight heights, at: 2021-01-13 09:23:52, elapsed time: 6.7 minutes



AutoTelStnData-2021-01-13.csv

flt_ht	max_r	study_are	antenna_coverage_overlap
25	7725.726	0.893092	0.372661
50	10850.86	1	0.453107
75	13195.18	1	0.496983
100	15124.38	1	0.484908
125	16780.43	1	0.508059
150	18236.02	1	0.523755
175	19534.08	1	0.52934
200	20702.19	1	0.53052

P:/NYSERDA Nanotag tools/nanotag_guidance_Shiny_tool/auto_radio_telemetry_Shiny_tool - Shiny

http://127.0.0.1:6606 Open in Browser Republish

Automated Telemetry Study Design Tool

v0.53 - Ground Sloth

1) Study area and array

Design a study

Upload a study

Add default study

Remove study

2) Input parameters

Receiving Station Params

Detection parameters

3) Detection array creation

Optimization type:

- None (manual selection)
- Coverage optimized
- Density optimized
- Avoidance optimized

Detection polygon color

Generate array

Download antenna data

Study area data | Detection results | Study design report

Report

Here you will find the an assessment of the suitability of the station arrays to detect target species.

Discussion

- What would you like for inputs?
- What would you like for outputs?
- Layout changes?
- Needs for the report tab?
- Study designs that are not captured here that could be implemented in tool?
- Would you like to be a beta tester?
  - If so email me (Andrew Gilbert, Andrew.Gilbert@briloon.org) and/or Kate Williams (Kate.Williams@briloon.org) to be added to the working group to provide further info and be sent the link to the app