Turtle Impact Tool 2.0

The Turtle Impact Tool was created to provide conservative estimates for the impact of different scallop fishery management alternatives on loggerhead sea turtles. This tool incorporates spatially and temporally specific data for monthly turtle densities, derived from loggerhead tagging programs, and for scallop fishing effort, derived from scallop survey programs, Vessel Trip Reporting (VTR) data, and Vessel Monitoring System (VMS) data. No assumptions are made about the likelihood of scallop dredges interacting with co-occurring turtles. Impact estimates are based on estimates for the number of days that scallop vessels are fishing in each Mid-Atlantic Bight (MAB) Scallop Area Management Simulator (SAMS) area and the number of turtles that are in the same MAB SAMS area each month.

Users can change key components of scallop fishery management plans for the limited access (LA) fleet, including the open area days-at-sea (DAS) allocations, the number of trips in Mid-Atlantic Access Areas (MAAAs), and the shapefile used to defined the MAB SAMS areas and therefore the boundaries for open, closed, and rotational access areas. Values entered into the tool can be adjusted to incorporate additional fishing effort from part-time and occasional vessels by increasing the number of vessels above just those with full-time permits.

The tool offers two options for users to compare impacts from scallop fishery management alternatives. Two management alternatives can be assessed by entering model parameters directly into the graphical user interface (GUI). Tool results, including impact maps and a table showing the relative impacts of the two alternatives, are displayed on the GUI if this option is used. Users can also opt to enter data for multiple management alternatives by putting together data tables (csv files) for these alternatives. Users can download impact data tables and reports that include impact tables and maps when this option is used.

Tool components

Loggerhead sea turtle monthly density

The tool includes two sets of monthly turtle density rasters. The first is based on monthly densities derived from a geostatistical model that was developed using 2004-2016 tagging data from 271 tags deployed by six tagging programs in the western North Atlantic (**Figure 1**, Winton et. al. 2018). It also includes a set of monthly turtle density rasters derived by binning 2009-2019 tagging data collected by CFF in collaboration with the NEFSC Protected Species Branch using funding from the scallop RSA program (**Figure 2**, Patel et al. 2021).

Mid-Atlantic Bight (MAB) Scallop Area Management Simulator (SAMS) areas

The tool includes two shapefiles for the most recent MAB SAMS areas including the area (km^2) of each region: the MAB SAMS areas prior to fishing year (FY) 2022 and the new 2022 MAB SAMS areas that include a closure in the New York Bight (**Figure 3**).

Scallop biomass across the MAB

The tool includes a default scallop biomass raster based on data collected during the 2021 Coonamessett Farm Foundation (CFF) HabCam v3 survey (**Figure 3**). Users can also use their own scallop biomass rasters when running multiple-alternative comparisons.

Management designations for each SAMS area

Users can change the management designations for each SAMS area (open, closed, access area) using radio buttons on the two-alternative tab. Users upload a table with the management status for each SAMS area for each alternative when using the multiple-alternative tab (example in **Table 1**).

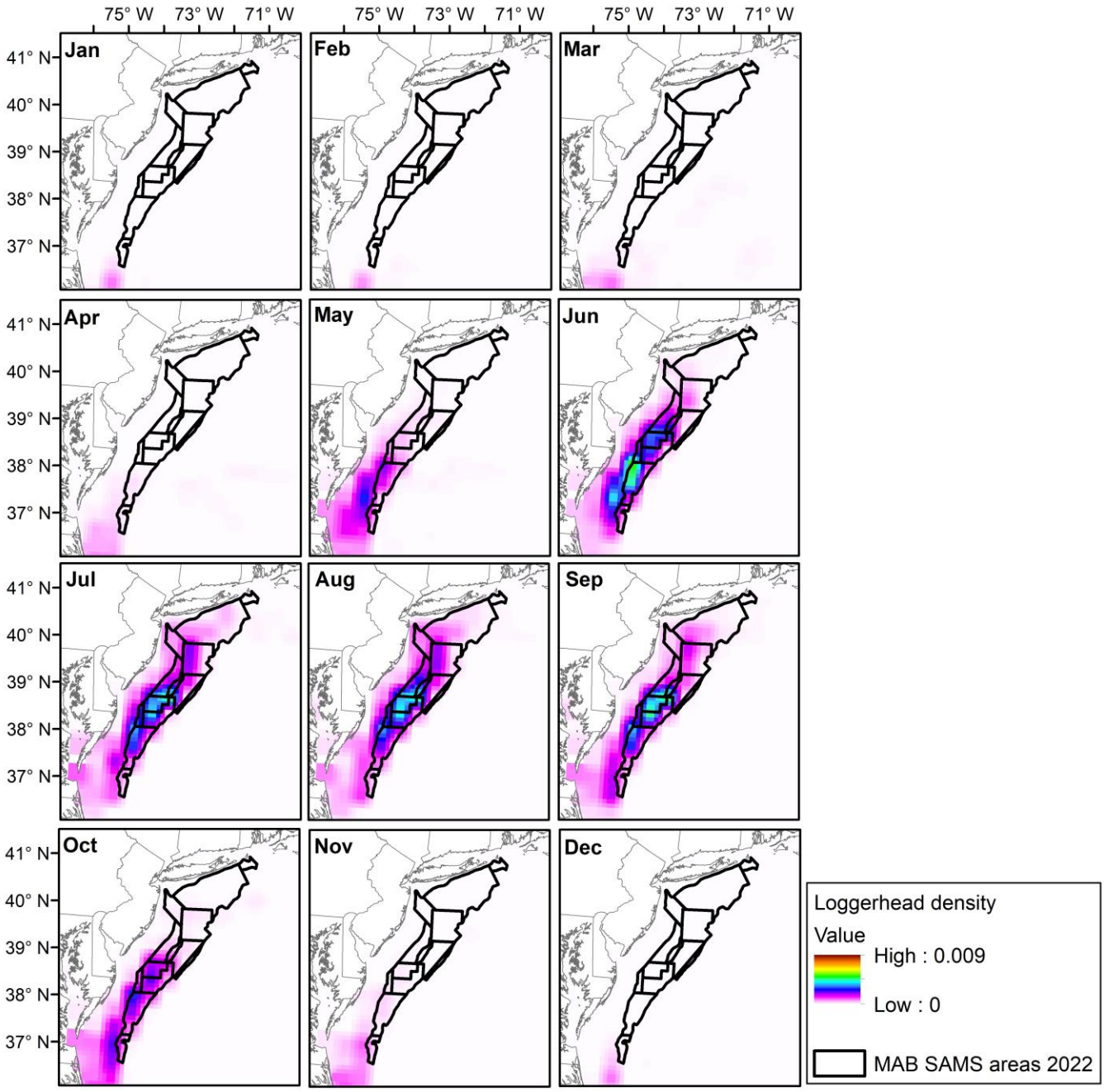


Figure 1. Monthly normalized turtle density maps based on the Winton et. al. 2018 model.

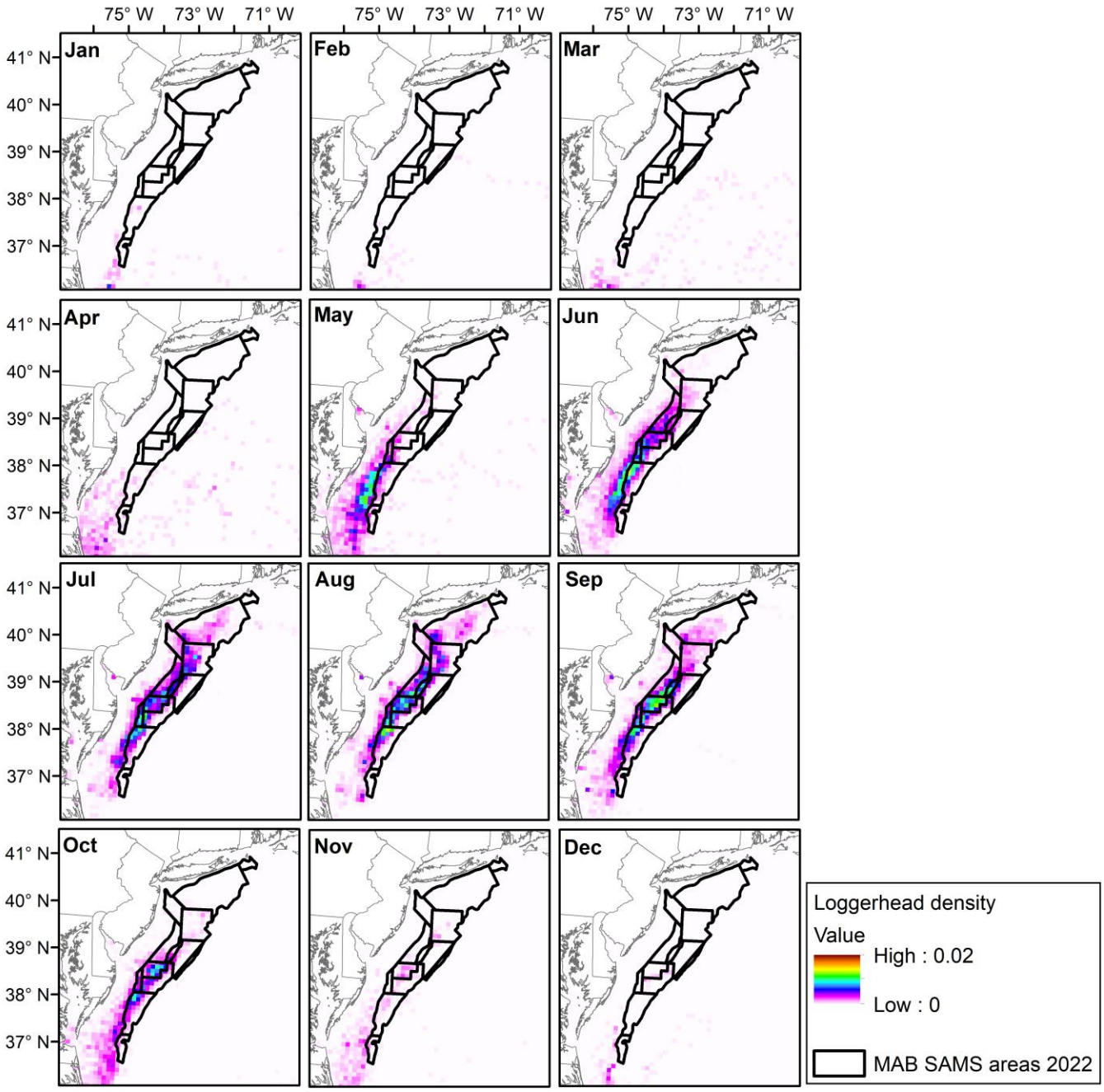


Figure 2. Monthly normalized turtle density maps based on tagging data from 2009-2019.

Relationships between scallop biomass/density and fishing effort

Estimated scallop biomass and yearly effort data by SAMS area for 2015 – 2022 were used to derive best-fitting linear relationships between scallop biomass or density and fishing effort for open and access areas. Effort has a linear relationship with scallop biomass in open areas and with scallop density in access areas.

Estimated proportional fishing effort by month

The tool includes a default table of proportional fishing effort by month for MAB open and access areas based on VTR and VMS data from FY 2018 through FY2021 (**Table 2**). Users can upload their own tables of proportional fishing effort by month when running multiple-alternative comparisons.

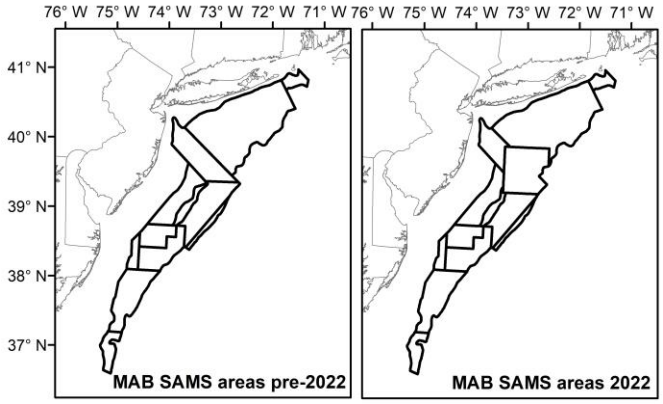


Figure 3. Mid-Atlantic Bight SAMS areas included in the tool.

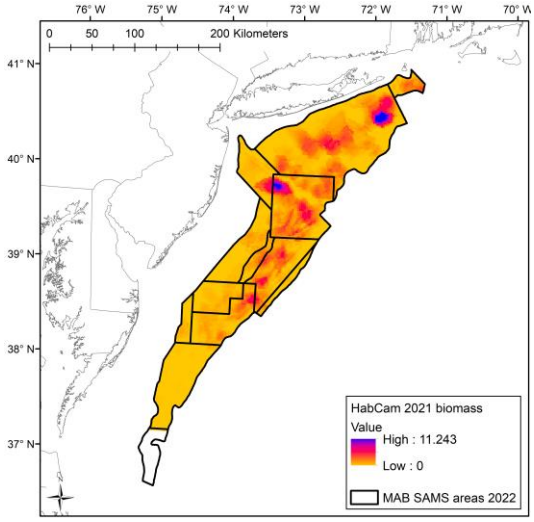


Figure 4. Default scallop biomass raster included in the tool.

The R Shiny app

The Turtle Impact Tool runs as an R Shiny app. The app includes two options for running the tool (separate tabs). The option labeled "Simple Two Alternatives" uses the default scallop biomass raster and all of the inputs are entered on the GUI. Tool outputs, including maps and a table of impact ratios, are displayed on the GUI only. The option labeled "Multiple Alternatives" allows users to supply their own scallop biomass raster, or use the default scallop biomass raster, and enter information for multiple alternatives by uploading csv files. Impact estimates for all of the Alternatives are displayed on the GUI, and users can download this table and/or a report that includes the displayed table, impact maps for each alternative, and details about the inputs used for that analysis. can download this table and/or a report that includes the displayed table, impact maps for each alternative, and details about the inputs used for that analysis.

Simple Two Alternatives

User inputs: To run the tool using this option, users input the following parameters for two management alternatives (**Figures 5 and 6**):

1) The MAB SAMS areas to be used. The default selection is the SAMS areas before 2022.

2) The management designations for each SAMS area. The default selections are the designations that were in place during FY2020 and FY2021.

3) The number of full-time equivalent scallop vessels. The default value of 330 is based on the number of full-time limited access vessels plus half of the part-time limited access vessels over the last 10 years (Table 35 in NEFMC 2022).

4) The loggerhead sea turtle population size. The default value of 48,700 turtles is based on the most recent estimates for the Mid-Atlantic loggerhead population (Table 9 in NEFSC 2011), rounded to the nearest 100.

5) The number of open area DAS.

Figure 5. The Turtle Impact Tool User Interface. This shows the appearance of the "Simple Two Alternatives" tab of the GUI after the tool runs.

6) The percentage of open area effort in MAB. The tool provides a default value of 55%, which is an estimate based on VTR and VMS data, rounded to the nearest 5%. (see Appendix A for more details)

7) The number of trips in MAAAs.

8) The length of MAAA trips in DAS – the tool provides a default of 8 days, which is an estimate based on VTR reports for 15,000 to 18,000-lb trip lengths in MAAAs from FY2016 through FY2021.

Tool outputs: The tool outputs the following information (**Figure 6**):

1) A table with impact ratios for each month and the full year.

2) Total turtle impact maps for each alternative with matching scales for easy comparisons.

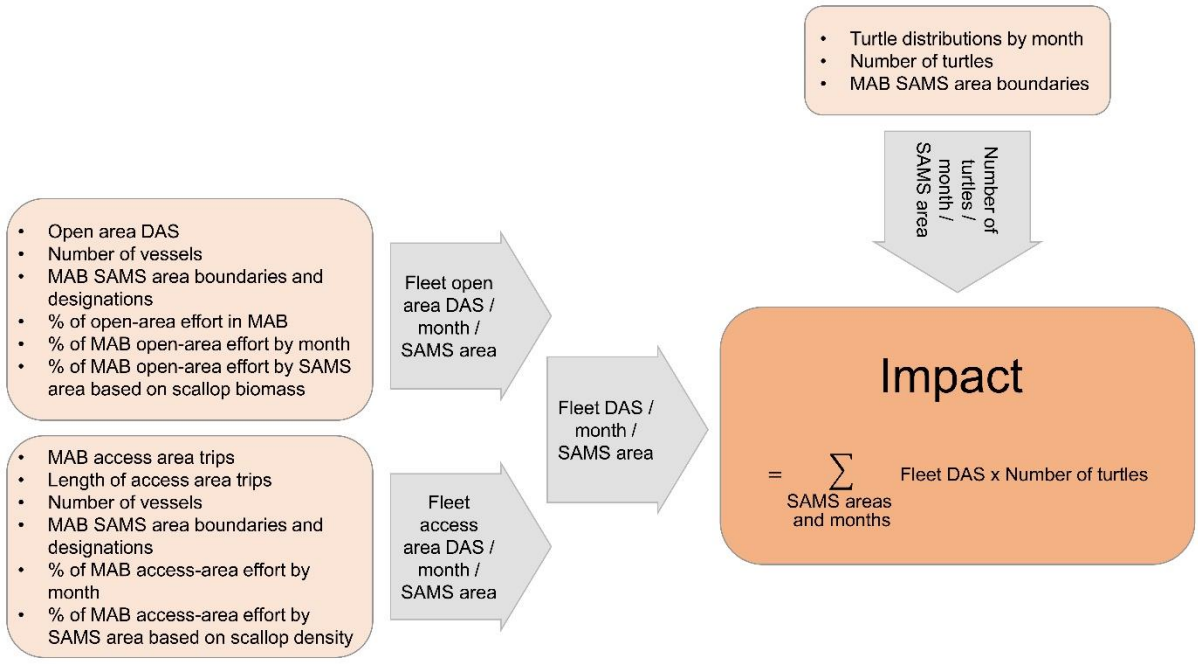


Figure 6. Flow chart showing tool components

Multiple Alternatives

User inputs: To run the tool using this option, users upload the following files with input parameters for multiple alternatives The recommended maximum number = 10 to avoid long run times if more are included. The files that need to be uploaded include the following (**Figure 7**):

1) A raster that defines the spatial distribution and abundance of scallop biomass in the MAB. This can be the included default raster HabCam2021GAMOKresiduals.tif or a raster supplied by the user.

2) A table (csv file) with the alternative management parameters. The required column headings are shown in **Table 1**. The same table is also included as an example in the package folder (Alternative management parameters 4 EXAMPLE.csv).

3) A table (csv file) with the alternative MAB SAMS area designations. The required first column is shown in **Table 3**. The same table is also included as an example in the package folder (Alternative SAMS area designations 4 EXAMPLE.csv).

4) A table (csv file) with proportional fishing effort by month for MAB open and access areas. The required first column and column headings are shown in **Table 2**. Note that only one table can be included per run. The same table is also included as as the default table in the package folder (Effort by month split DEFAULT.csv).

Tool outputs: The tool outputs the following information (**Figure 7**):

1) A table with impacts for each month and the full year for each alternative.

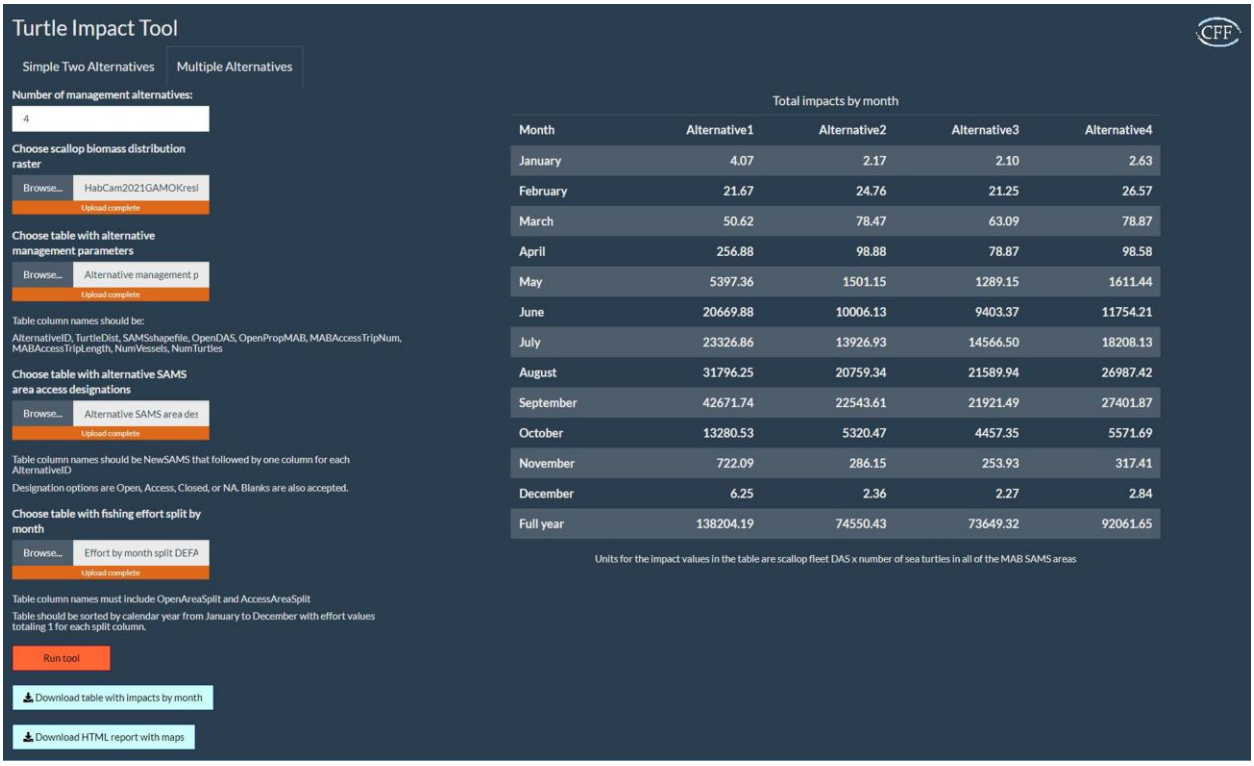


Figure 7. The Turtle Impact Tool User Interface. This shows the appearance of the "Multiple Alternatives" tab of the GUI after the tool runs using the included example and default files.

Tool downloads: The tool lets users download the following products:

1) The table with impacts for each month and the full year for each alternative that is displayed when analysis is completed (as a csv file).

2) A report (html format) that includes the above table, total impact maps for all alternatives, and all user inputs (name of the scallop biomass raster and copies of the three uploaded tables). An example of the report is included at the end of the guide.

Literature cited

New England Fishery Management Council (NEFMC). 2022. Framework Adjustment 34 to the Scallop Fishery Management Plan. https://s3.amazonaws.com/nefmc.org/220310-Framework-34-Final-Submission.pdf.

Northeast Fisheries Science Center (NEFSC). 2011. Preliminary summer 2010 regional abundance estimate of loggerhead turtles (*Caretta caretta*) in Northwestern Atlantic Ocean continental shelf waters. https://repository.library.noaa.gov/view/noaa/3879.

Patel SH, Winton MV, Hatch JM, Haas HL, Saba VS, Fay G, Smolowitz RJ. 2021. Projected shifts in loggerhead sea turtle thermal habitat in the Northwest Atlantic Ocean due to climate change. Scientific Reports 11: 8850.

Winton MV, Fay G, Haas HL, Arendt M, Barco S, James MC, Sasso C, Smolowitz R. 2018. Estimating the distribution and relative density of satellite-tagged loggerhead sea turtles using geostatistical mixed effects models. Marine Ecology Progress Series 586: 217-32.

Table 1: Example of table with alternative management parameters.

AlternativeID	TurtleDist	SAMSshapefile	OpenDAS	OpenPropMAB	MABAccessTripNum	MABAccessTripLength	NumVessels	NumTurtles
A1	Model	MABSAMSold	24	0.55	1	8	330	48700
A2	Model	MABSAMS	24	0.55	0	0	330	48700
A3	Model	MABSAMSold	24	0.55	0	0	330	48700
A4	Model	MABSAMSold	30	0.55	0	0	330	48700

Table 2: Default table for proportional fishing effort by month for MAB open and access areas. Note that the sum of values in the columns "OpenAreaSplit" and "AccessAreaSplit) are each equal to one.

Month	MonthName	OpenAreaSplit	AccessAreaSplit
1	Jan	0.04	0.04
2	Feb	0.06	0.02
3	Mar	0.13	0.03
4	Apr	0.1	0.15
5	May	0.09	0.19
6	Jun	0.09	0.09
7	Jul	0.07	0.05
8	Aug	0.1	0.06
9	Sep	0.12	0.11
10	Oct	0.08	0.1
11	Nov	0.07	0.09
12	Dec	0.04	0.07

Table 3: Example of table with alternative MAB SAMS area designations for the three alternatives shown in Table 1.

NewSAMS	A1	A2	A3	A4
BI	Open	Open	Open	Open
LI	Open	Open	Open	Open
Nearshore-N	Open	Open	Open	Open
Nearshore-S	Open	Open	Open	Open
NYB	Open	Open	Open	Open
NYB-West	Open	Open	Open	Open
NYB-East	Open	Open	Open	Open
NYB-Closure	NA	Closed	NA	NA
HCS	Access	Open	Open	Open
ET-Open	Access	Open	Open	Open
ET-Flex	Access	Open	Open	Open
DMV	Open	Open	Open	Open
VIR	Open	Open	Open	Open

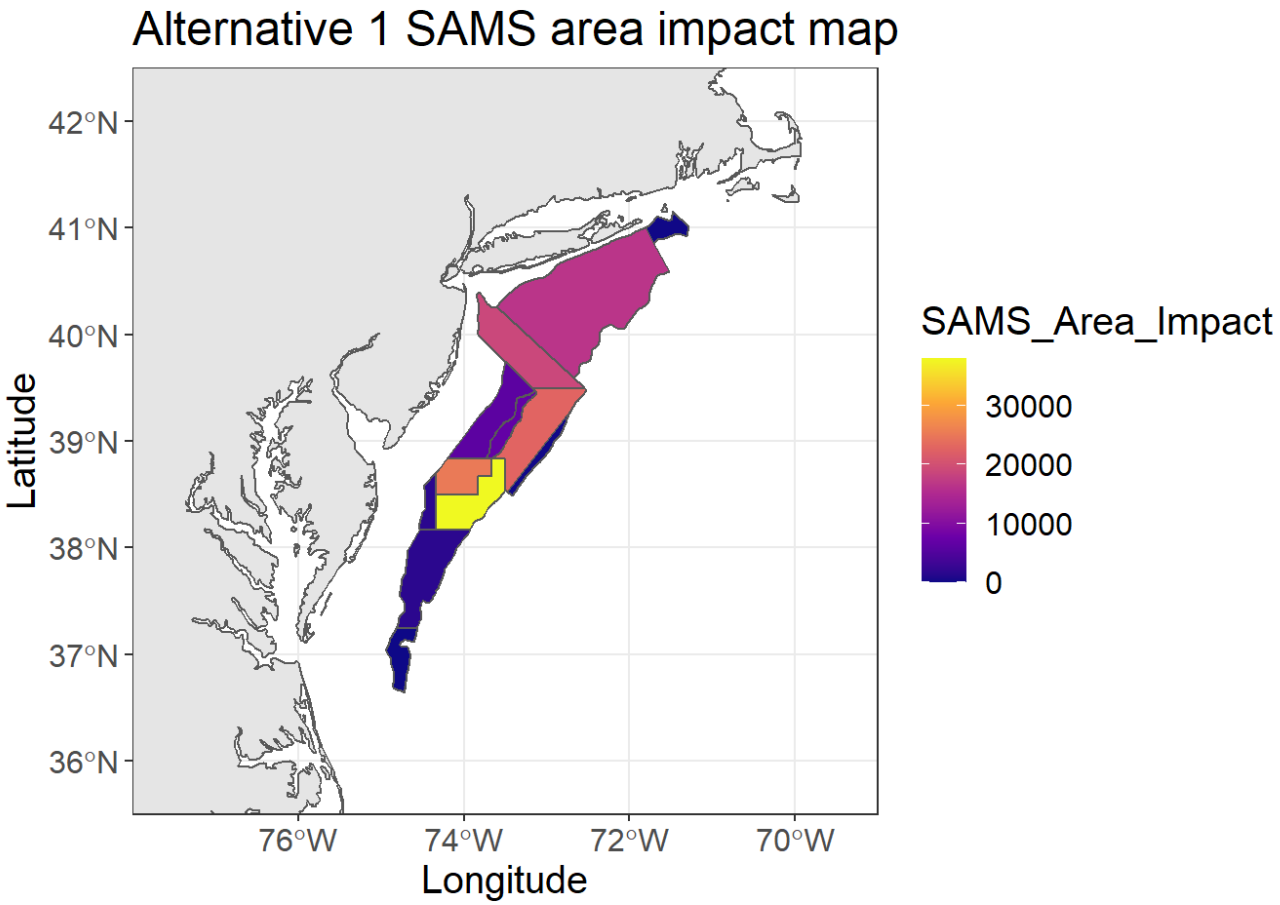
Turtle Impact Tool output

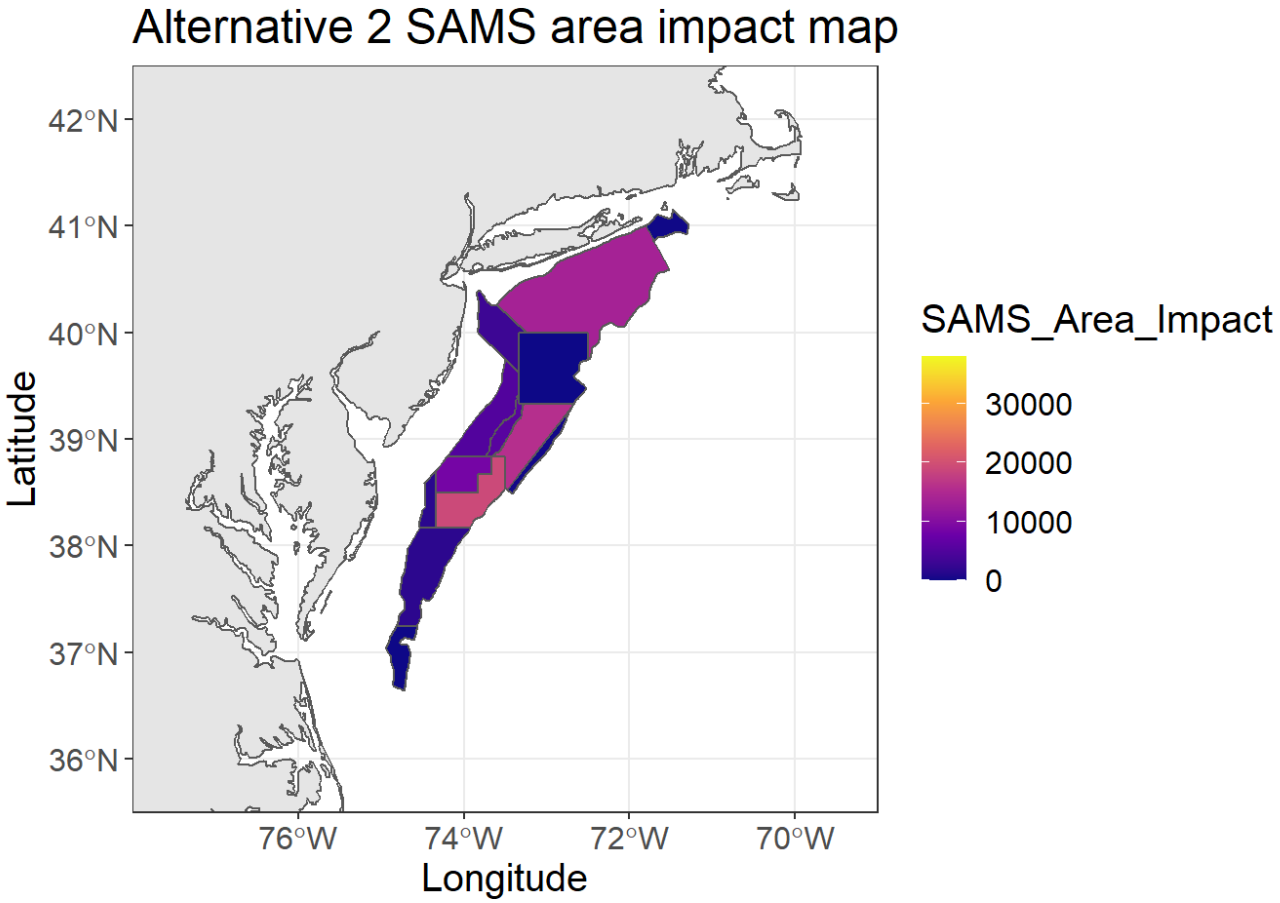
2023-07-19

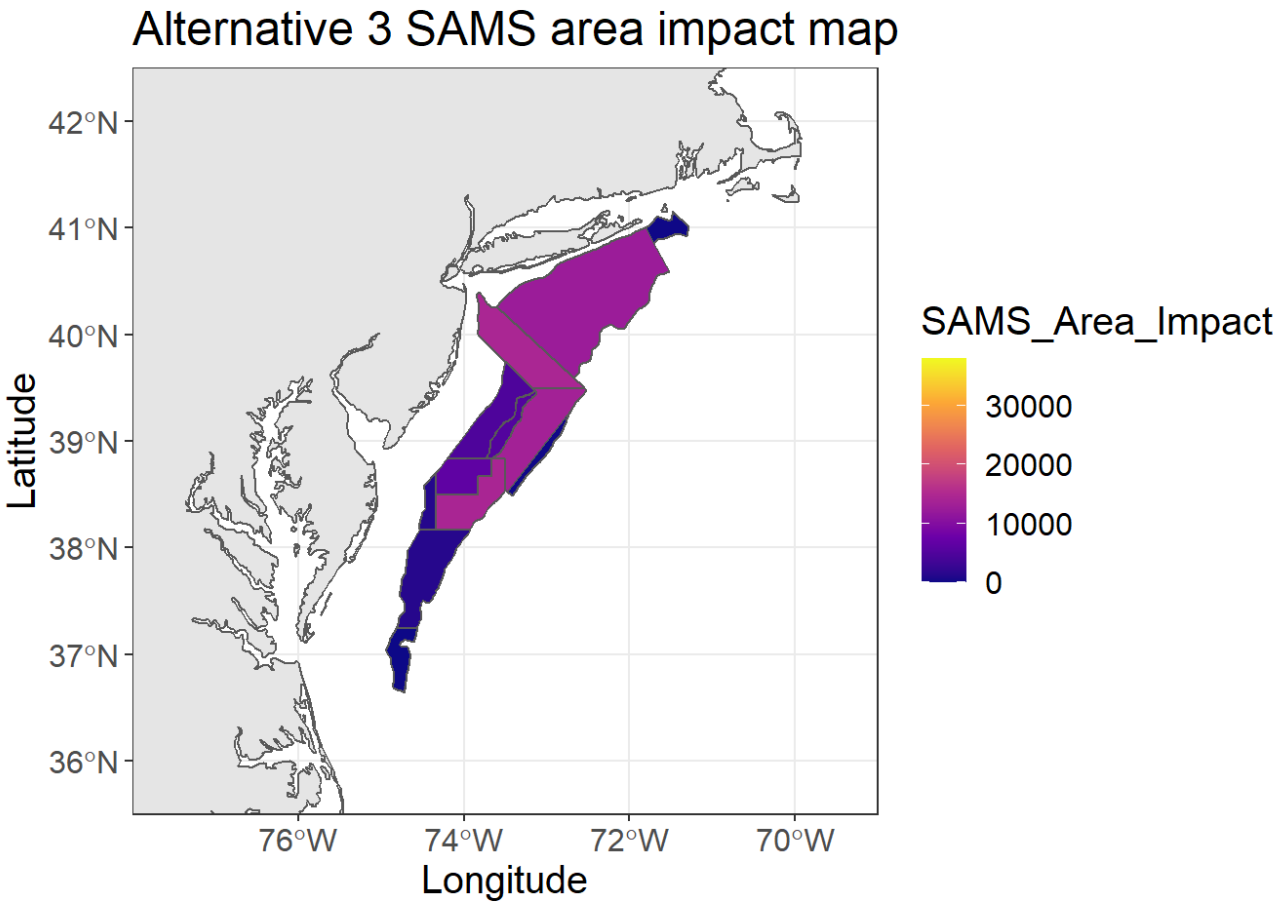
Output

Monthly and total impacts for alternatives

Month	Alternative1	Alternative2	Alternative3	Alternative4
January	4.069	2.175	2.102	2.627
February	21.667	24.760	21.255	26.568
March	50.618	78.467	63.095	78.869
April	256.876	98.880	78.866	98.582
May	5397.358	1501.155	1289.155	1611.443
June	20669.881	10006.126	9403.371	11754.214
July	23326.859	13926.934	14566.502	18208.128
August	31796.249	20759.343	21589.935	26987.419
September	42671.743	22543.610	21921.494	27401.867
October	13280.531	5320.471	4457.350	5571.687
November	722.091	286.150	253.926	317.408
December	6.247	2.361	2.271	2.839
Full year	138204.189	74550.432	73649.322	92061.651


Alternative 1 SAMS area impact map
42°N
41°N
40°N
39°N
38°N
37°N
36°N
Latitude
76°W
74°W
72°W
70°W
Longitude
SAMS_Area_Impact
30000
20000
10000
0


Alternative 2 SAMS area impact map
42°N
41°N
40°N
39°N
38°N
37°N
36°N
Latitude
76°W
74°W
72°W
70°W
Longitude
SAMS_Area_Impact
30000
20000
10000
0


Alternative 3 SAMS area impact map
42°N
41°N
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38°N
37°N
36°N
Latitude
76°W
74°W
72°W
70°W
Longitude
SAMS_Area_Impact
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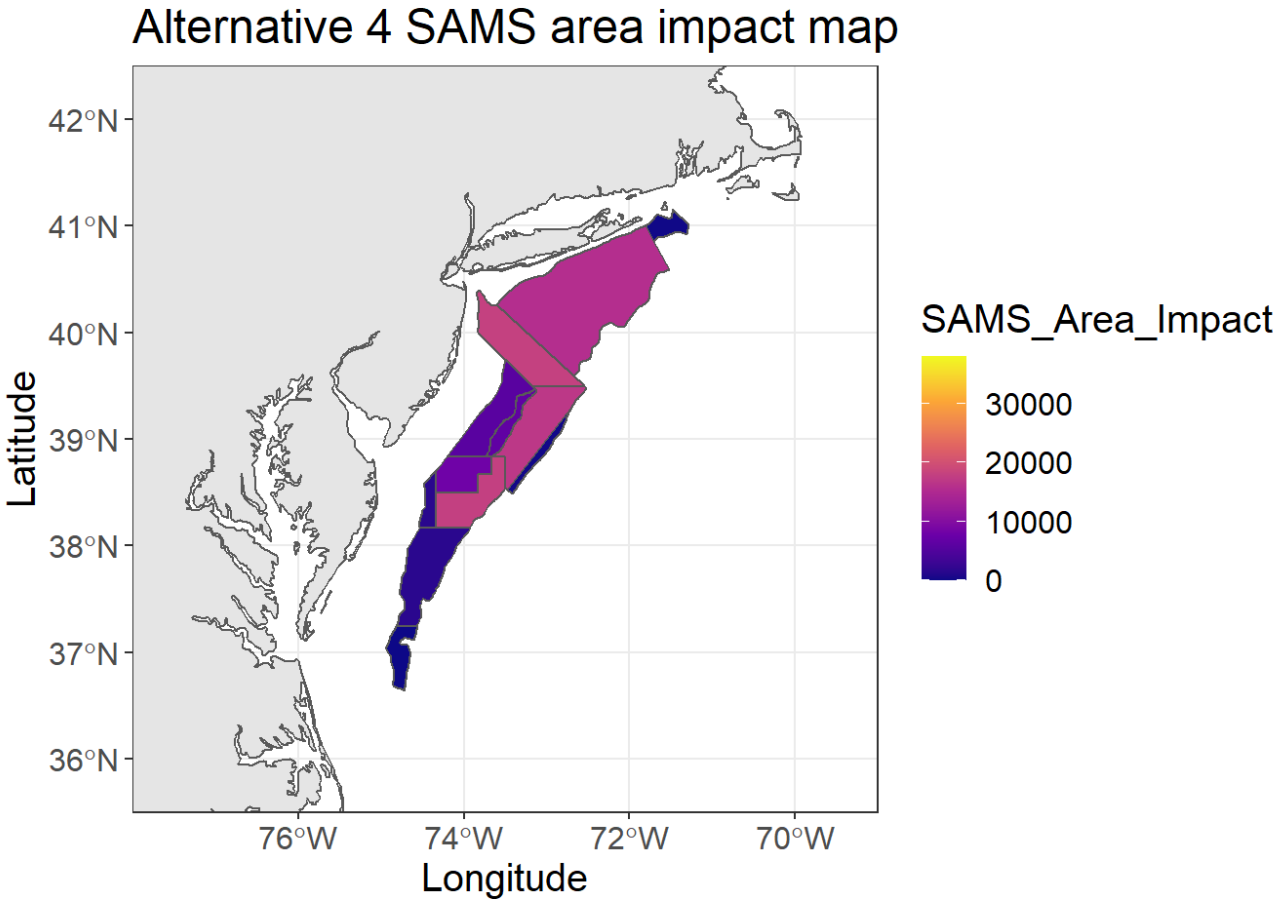
Alternative 4 SAMS area impact map
42°N
41°N
40°N
39°N
38°N
37°N
36°N
Latitude
76°W
74°W
72°W
70°W
Longitude
SAMS_Area_Impact
30000
20000
10000
0

Input data

Scallop biomass raster = HabCam2021GAMOKresiduals.tif

Alternative management parameters

AlternativeID	TurtleDist	SAMSshapefile	OpenDAS	OpenPropMAB	MABAccessTripNum	MABAccessTripLength	NumVessels	NumTurtles
A1	Model	MABSAMSold	24	0.55	1	8	330	48700
A2	Model	MABSAMS	24	0.55	0	0	330	48700
A3	Model	MABSAMSold	24	0.55	0	0	330	48700
A4	Model	MABSAMSold	30	0.55	0	0	330	48700

Alternative SAMS area access designations

NewSAMS	A1	A2	A3	A4
BI	Open	Open	Open	Open
LI	Open	Open	Open	Open
Nearshore-N	Open	Open	Open	Open
Nearshore-S	Open	Open	Open	Open
NYB	Open	Open	Open	Open
NYB-West	Open	Open	Open	Open
NYB-East	Open	Open	Open	Open
NYB-Closure	NA	Closed	NA	NA
HCS	Access	Open	Open	Open
ET-Open	Access	Open	Open	Open
ET-Flex	Access	Open	Open	Open
DMV	Open	Open	Open	Open
VIR	Open	Open	Open	Open

Monthly fishing effort splits

Month	MonthName	OpenAreaSplit	AccessAreaSplit
1	Jan	0.04	0.04
2	Feb	0.06	0.02
3	Mar	0.13	0.03
4	Apr	0.10	0.15
5	May	0.09	0.19
6	Jun	0.09	0.09
7	Jul	0.07	0.05
8	Aug	0.10	0.06
9	Sep	0.12	0.11
10	Oct	0.08	0.10
11	Nov	0.07	0.09
12	Dec	0.04	0.07