What is the SASI approach?

The Magnuson Stevens Fishery Conservation and Management Act (MSA) has included provisions requiring fishery management plans (FMPs) to minimize the adverse effects of fishing on Essential Fish Habitat (EFH) since the 1996 reauthorization. As compared to previous plan-by-plan approaches to evaluating and minimizing adverse effects, which were somewhat ad hoc, major goal of the New England Fishery Management Council (NEFMC)'s EFH Omnibus Amendment 2 is to optimize the minimization of adverse effects on EFH across FMPs. Thus, the SASI approach was developed to estimate the magnitude, location, and duration of adverse effects across gears types and FMPs, and to evaluate the cumulative impacts of alternatives to minimize those effects. Specifically, because all fishing effort is converted into area swept units, regardless of whether trawl, dredge, or fixed gears are being evaluated, SASI allows for comparisons between gear types in terms of the magnitude of adverse effects they generate.

The Swept Area Seabed Impact (SASI) approach consists of five components, which are described below:

(1) Habitat map
(2) Fishing gear assessment
(3) Vulnerability Assessment
(4) SASI Model
(5) Local Indicators of Spatial Association (LISA) Analysis

The Vulnerability Assessment, SASI model, and LISA Analysis were developed by the NEFMC Habitat Plan Development Team (PDT) between fall 2007 and spring 2010. The SASI approach has been reviewed by NEFMC's Scientific and Statistical Committee (March 2009, December 2009, and August 2010) as well as an external peer review panel (February 2011).

Habitat map

The model domain extends from 3 nm offshore to the edge of the EEZ from the Maine/Canada border to the North Carolina/South Carolina border, and includes the Gulf of Maine, Georges Bank, the Mid-Atlantic Bight, and the associated slope regions. In order to estimate the vulnerability of different locations within this domain to different types of fishing activity, a habitat map was developed to serve as a foundation for the model. Two data sources were used to classify benthic sediments across this region, and two were used to classify the level of natural disturbance/water flow along the seafloor. Video survey data collected by the University of Massachusetts Dartmouth School for Marine Science and Technology, as well as data from the United States Geological Survey's usSEABED dataset, were compiled into a dominant sediment framework, mapped based on their point locations, and used to generate an unstructured grid, where cell size corresponds to spatial sampling density. Each of the unstructured grids was classified as low or high natural disturbance, by spatially joining the grid with estimates of benthic boundary shear stress derived from the Finite Volume Coastal Ocean Model, (FVCOM). Where the SASI sediment grid was outside the spatial footprint of the FVCOM model, depth was used instead. Combining these two elements, dominant substrate and depth, each location is the SASI domain is characterized as being dominated by mud, sand, granule-pebble, cobble, or boulder substrates, and as either high or low energy.

Fishing gear assessment

Regional patterns of fishing activity were evaluated using fishery-dependent data, and six major gear types were selected for analysis, based on two criteria: they were considered to be bottom-tending gears, whether mobile or fixed, and they were used with reasonable frequency in federal waters. These gears include bottom trawl, scallop dredge, hydraulic clam dredge, sink gillnet, demersal longline, and trap (combining lobster and red crab). The model document describes the characteristics and use of each of these gears.

Vulnerability Assessment

The Vulnerability Assessment serves as both a comprehensive gear effects literature review and as a framework for generating susceptibility and recovery parameters for the SASI model. Vulnerability was decomposed into susceptibility and recovery. Different suites of structural seabed features (e.g. sponges, biogenic burrows, bedforms, etc.) were inferred to each of the ten possible combinations of substrate (mud, sand, granule-pebble, cobble or boulder) and energy (high or low) that might occur throughout the model domain. Susceptibility refers to the percentage of a particular structural habitat feature removed or damaged by a single pass of a given type of fishing gear, and recovery refers to the number of years required for the feature to return to its pre-impact state. Susceptibility and recovery scores were assigned individually for each combination of feature and gear type, based on literature review and professional judgment. The scores in these tables were then used as parameters in the model.

SASI model

The SASI model itself is a geo-referenced analytical tool that estimates the adverse effects (Z) of fishing on the seabed structures described above. It works by combining fishing effort data, seabed substrate and energy data, and gear-specific habitat susceptibility and recovery parameters in a spatial framework. Fishing effort estimates were calculated for each of ten bottom tending gear types, including four types of trawls (fish, squid, shrimp, and raised footrope subtypes), three types of dredges (day boat and trip scallop, and hydraulic clam), and the three types of fixed gears listed previously.

Fishing effort data as area swept and SASI model outputs (spatially explicit vulnerability and annual estimates of adverse impacts, by gear type) are provided at a 100 km^2 grid resolution. Both fishing effort inputs and model outputs are given in km^2 units. Model runs were completed for hypothetical, even distributions of fishing effort (simulated runs, output referred to as vulnerability, or Z_∞); and realized, historical distributions of fishing effort (realized runs, output referred to as $Z_{realized}$). Because the recovery parameters are modeled using a decay function, Z_∞ and $Z_{realized}$ are stock variables, providing estimates that include residual adverse effects from past years as well as current year effects.

LISA geostatistical analysis

To translate the map of highly vulnerable structural habitats emerging from the vulnerability/Z_∞ analysis into smaller-scale areas more amenable to area-based fishery management regulations, clustering of the Z_∞ outputs was examined using Local Indicators of Spatial Association (LISA) techniques. The LISA approach considers each 100 km^2 grid cell individually, comparing the vulnerability of it and its neighbors to the distribution of vulnerability (Z_∞) values throughout the entire domain. The grids that are identified as high vulnerability and lie within high vulnerability neighborhoods were used as a starting point for the development of spatially-specific habitat management alternatives.

SASI and EFH designations

Because of the spatial overlaps in EFH designations, and due to the general nature of the EFH designations, EFH was considered holistically by the PDT for the purpose of estimating adverse effects. In addition, although the EFH designations include information such as preferred water temperature, and the entire water column may be designated EFH depending on the species and lifestage, the SASI adverse effects evaluation focuses on the seabed, in particular on various structural features of interest. This is because seabed structures were assumed to be the most heavily impacted by fishing operations. Obviously, non-fishing stressors on habitat might have significant effects on water quality, especially in near-shore environments, but because the Council has a direct ability to control fishing operations, and a mandate to minimize the impacts of fishing operations on habitat, SASI focuses on fishing impacts on seabed structures.

How is SASI being used?

For the Omnibus EFH Amendment, the SASI approach is being used both to develop alternatives, and to analyze alternatives. The flowchart below diagrams the data inputs, processes, outputs, and applications/benefits associated with the SASI approach. Note that some outputs are inputs to other processes.

Some SASI outputs fulfill the basic EFH requirements of the MSA, i.e. to make a determination as to whether the effects of fishing on habitat are adverse (susceptibility and recovery parameters), and to describe the magnitude of those effects and the need for further action ($Z_{realized}$ outputs). Others (Z_{∞} outputs, vulnerable habitat clusters) were used to guide the Council as it develops and analyzes appropriate measures to minimize adverse effects.

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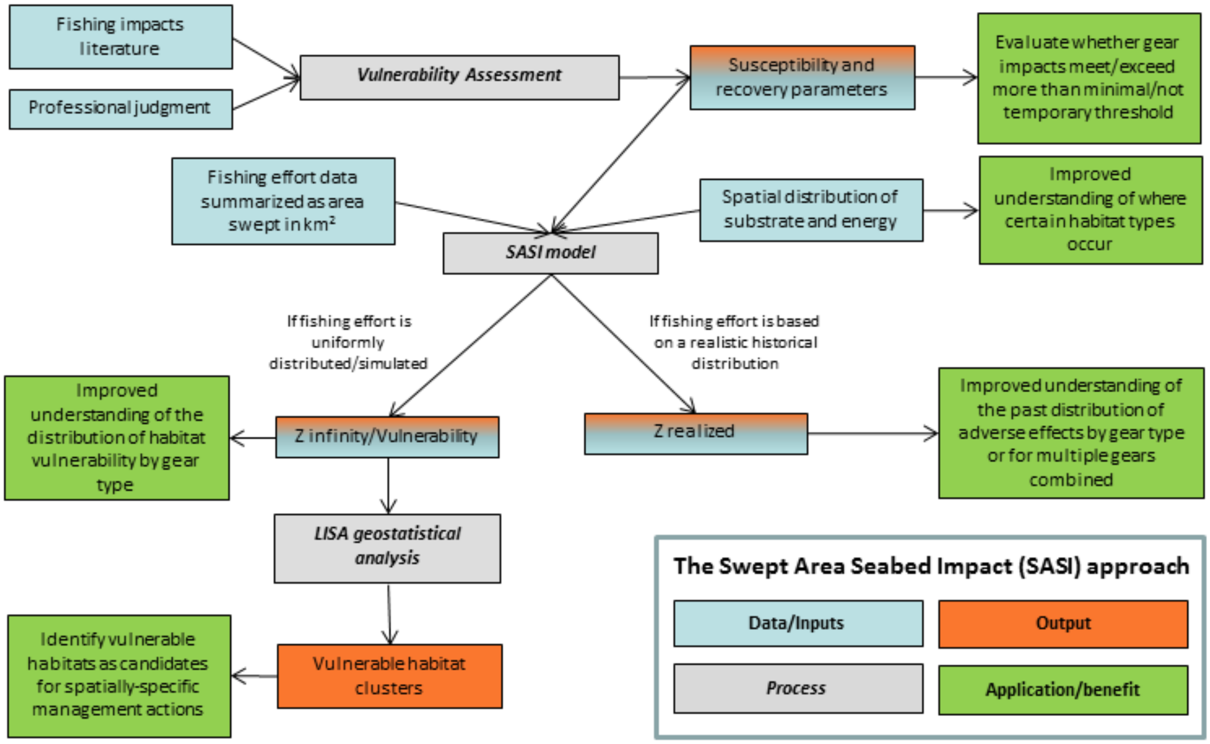
For more information about the SASI approach or Omnibus EFH Amendment 2, visit the habitat section of www.nefmc.org, or contact: Michelle Bachman, mbachman@nefmc.org, (978) 465-0492 x 120.


Fishing impacts literature
Professional judgment
Vulnerability Assessment
Susceptibility and recovery parameters
Evaluate whether gear impacts meet/exceed more than minimal/not temporary threshold
Fishing effort data summarized as area swept in km²
Spatial distribution of substrate and energy
Improved understanding of where certain habitat types occur
SASI model
If fishing effort is uniformly distributed/simulated
If fishing effort is based on a realistic historical distribution
Improved understanding of the distribution of habitat vulnerability by gear type
Z infinity/Vulnerability
Z realized
Improved understanding of the past distribution of adverse effects by gear type or for multiple gears combined
LISA geostatistical analysis
Identify vulnerable habitats as candidates for spatially-specific management actions
Vulnerable habitat clusters
The Swept Area Seabed Impact (SASI) approach
Data/Inputs
Output
Process
Application/benefit