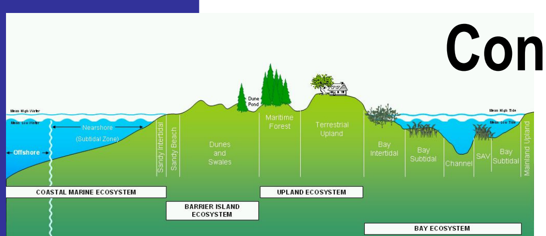
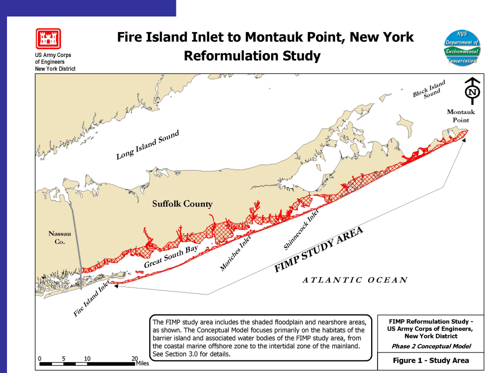
FINAL REPORT

Atlantic Coast of Long Island, Fire Island Inlet to Montauk Point, New York Reformulation Study

Work Order 29
Phase 2 Development of the Conceptual Ecosystem Model for the Fire Island Inlet to Montauk Point Study Area





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Prepared by U.S. Army Corps of Engineers

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The US Army Corps of Engineers (USACE), New York District (District) is partnering with New York State Department of Environmental Conservation (NYSDEC) to conduct a comprehensive feasibility-level reformulation of the shore protection and storm damage reduction project for 83 miles of the south shore of Long Island, New York, from Fire Island Inlet to Montauk Point (FIMP study area, Figure 1).

Commercial, residential, public and other infrastructure in the study area are subject to economic losses (or damages) during severe storms. These storms also influence indigenous natural habitats and ecosystems in the area. The principal effects are associated with extreme storm-induced tides and waves that can cause extensive flooding and erosion both within barrier island and mainland communities. Breaching and/or inundation of the barrier islands also can lead to increased flood damages, especially along the mainland communities bordering Shinnecock, Moriches and Great South Bays.

The goal of the project is to reduce risks to human life and property from coastal storms, while maintaining, and/or enhancing, and restoring ecosystem integrity and coastal biodiversity. This will require an assessment of at risk properties, present and future sea level rise, restoration and protection of important coastal landforms and processes, and important public uses of the area. The Reformulation Study will lead to a project that provides New York State and its residents with lower storm damage risks and a full range of future options for coastal zone management.

The Reformulation Study is taking an innovative approach using a science-based model for addressing coastal storm risk reduction and pre- and post-storm shoreline management along both the barrier and mainland shorelines. The District and the State of New York, in their lead project planning and cost sharing roles, are developing innovative management and restoration measures working with a wide range of stakeholders to establish comprehensive, consensus-based solutions. The final plan will recommend measures for implementation by the other federal agencies, New York State, Suffolk County and local governments through the exercise of all applicable governmental authorities to the maximum extent practical to achieve national, state and local objectives (USACE 2003).

The District is formulating a plan to evaluate an expanded scope of possible alternatives to address storm damages. The plan includes:

- identification and screening of alternatives,
- detailed design of protection by reach,
- design optimization and comparison of alternatives, and
- selection and final design of a recommended plan.

A critical step in the overall project is the development of site-specific information that will be used to evaluate each storm damage reduction alternative, no action alternative, and restoration alternative in order to identify feasible plans of protection for each reach of the study area.

The study area is divided into the following five reaches (Figure 1) based on considerations of coastal/geological characteristics, engineering, economics, environmental constraints, coastal zone management criteria, existing development, and local regulations:

- Reach 1: Fire Island Inlet to Moriches Inlet
- Reach 2: Moriches Inlet to Shinnecock Inlet
- Reach 3: Shinnecock Inlet to Southampton
- Reach 4: Southampton to Beach Hampton
- Reach 5: Beach Hampton to Montauk Point

Collection, analysis, and independent technical review of scientific data will be conducted by the USACE to improve understandings of complex and dynamic, regional hydrologic, geomorphic, and ecological factors and interrelationships while simultaneously facilitating the building and sharing of an integrated scientific knowledge base of natural and socioeconomic data.
Once defined, an Environmental Impact Statement (EIS) will be performed on the feasible plans. As part of this process, the Conceptual Model is being used as one tool that will provide input to the EIS framework, to assess the environmental significance of the proposed alternative management options in target areas of each reach. The Conceptual Model is a schematic diagram that identifies pathways between ecosystem components to focus the EIS on relevant potential impacts. All data collection and evaluation will be completed by the District, with input from various stakeholders and review panel members.

In the development of the plans, priority will be given to non-structural measures that reduce risks and provide protection to human life and property, restore and enhance coastal processes and ecosystem integrity, and are environmentally sustainable. Measures that avoid or minimize adverse environmental impacts while addressing long-term demands for public resources will be used to the extent possible.

1.1 PURPOSE

The purpose of the FIMP Conceptual Model is to represent the present scientific understanding of the project ecosystems. The Conceptual Model will also assess how the ecosystems of the study area are affected by on-going natural and anthropogenic stressors, in addition to environmental stressors relevant to the management alternatives under consideration. Since the study area is comprised of a complex mosaic of habitats and ecosystems, the FIMP Conceptual Model is actually the composite of 18 models. The models are intended to describe the relationships among the natural biotic, abiotic (physical, geological and chemical), and anthropogenic components of the South Shore ecosystem in sufficient detail to assess the ecological implications of management decisions associated with the plan.

This Phase 2 Conceptual Model study further focuses and refines draft conceptual models developed during Phase 1 at a workshop held on Long Island in June 2000 (USACE 2001) and a subsequent workshop convened at the Waterways Experiment Station. At the completion of Phase 1 all FIMP ecosystem components (ie., habitats, drivers, stressors and endpoints) were identified and defined. Phase 2 involved a systematic review all ecosystems, habitats, drivers, stressors and endpoints with the goal of developing models that could be more readily applied to the indigenous habitats and alternative management options being considered for the study area. Once the ecosystem specific model components are defined in Phase 2, site and alternative-specific information will be input into the models in Phase 3 to identify potentially significant impacts that should be assessed in more detail.

The Conceptual Model tool for this project has been adapted from a similar approach used in risk assessment of contaminated sites (USEPA 1997). However, the two models differ in that contaminants are considered only one of many stressors in the FIMP system. In addition, some of the nomenclature used in the description of model components has been changed. Project specific definitions are provided for all terms that are used in the context of the FIMP Conceptual Model.

1.2 SCOPE OF WORK

The FIMP Conceptual Model is being developed in three phases (Figure 2). As discussed above, Phase 1 largely identified and defined potential components of the Model. Phase 2 will further focus and refine the individual habitat models developed in Phase 1. In Phase 3, the next step, site and alternative specific information will be incorporated to focus the EIS effort.

The scope of the Phase 2 effort is based on existing information and the results of the Phase 1 Conceptual Models. Phase 2 work includes a comprehensive review of existing literature; development of habitat specific conceptual models; delineation of the extent of habitats and ecosystems using GIS techniques; and several interagency meetings to solicit input. This resulting report includes the following components:

- Section 3: Identify relevant ecosystem and habitat units to be included in the models;
- Section 4: Re-assess and define ecological drivers and resultant stressors;
- Section 5: Identify relevant endpoints for each ecosystem and habitat units under consideration;
- Section 6: Establish models for the major FIMP ecosystems and habitats identified that can be used in the assessment of potential project impacts; and
- Section 7: Define a path forward for alternative specific model application in Phase 3.

Key components to the Phase 2 approach are to maintain stakeholder input in the model development that was begun in Phase 1 while carefully scrutinizing natural and relevant anthropogenic characteristics of the study area. Consideration of both system specific characteristics and stakeholder input will assure all environmental concerns are addressed in the process.

2.1 STAKEHOLDER INPUT

A critical aspect of the EIS process under the National Environmental Policy Act (NEPA) is a provision to incorporate public input. Input has been solicited from numerous interested parties and agencies in the development of the Conceptual Model to facilitate public participation.

Forty-seven of the eighty-nine individuals who were invited to participate in the Phase 1 Workshop attended and provided input. Agencies and organizations that attended the Phase 1 workshop are summarized in Table 1. During the Phase 2 Conceptual Model effort an Interagency Group was established to review interim deliverables and provide input throughout the course of the effort. These agencies and organizations are also listed in Table 1. The consultant team of URS Corporation (URS), Moffatt & Nichol Engineers (MN), Allee, King, Rosen & Fleming, Environmental Consultants (AKRF) and EEA, Inc. (EEA) also participated and provided valuable technical input into the development of the Phase 2 models.

The District has assembled a Scientific Review Panel (SRP). The SRP is composed of three non-stakeholder, recognized experts who will conduct an objective independent review of the Phase 2 document. Modeling experts in the scientific field will also be utilized in this review.

Numerous meetings were convened including one specifically focused on drivers and stressors and another focused meeting on endpoint selection. Another meeting was convened to review a draft version of the document. During each meeting information was collected from participants and later reviewed for incorporation into the revised models. This active solicitation and participation of a wide cross section of technical experts with extensive experience in the study area insures that all interested parties are given an opportunity to contribute, and all relevant components of the system are appropriately addressed. While all comments were carefully considered and addressed, no model can adequately capture all of the complexities of a dynamic ocean, beach dune, and bay ecosystem. Some compromises were made in an effort to maintain functionality and utility of the models. The models are useful for describing what should be studied, but they are only conceptual in nature and not predictive. The models are intended to be inclusive of all key components of the FIMP study area ecosystems. The models facilitate interpretation of how these components are affected by the ongoing natural and anthropogenic stressors, in addition to environmental stressors relevant to management alternatives under consideration. Hence, the models attempt to be all inclusive, while addressing what is agreed by experts to be important. In the course of the meetings several concepts arose that could not be thoroughly explored and agreed upon. These concepts cannot be addressed system wide or uniformly throughout the models. They will be addressed in the context of the models as appropriate. These outstanding issues include:

- Long term impacts vs. short term impacts
- Cumulative impacts

- Natural variability
- Ecological feedback loops and cause-effect response relationships

The text of this and subsequent reports will identify aspects of the models that while technically representative, may appear to leave out critical components of the system. These components are dealt with in other areas of the model.

2.2 CONCEPTUAL MODEL

The conceptual model is a pathway diagram that graphically depicts relationships between an initial source of environmental effect or change and potential environmental components (endpoints) that may be affected. The source of the effect is the driver; the effect or impact is the stressor. For example, a Catastrophic Storm (driver) can result in Hydrological Alteration (stressor). Drivers can lead to, or result in, a number of stressors (ie., any physical, chemical, and/or biological change in the ecosystem). The model is used as an assessment tool, to delineate complete linkages or pathways between important drivers, stressors and important endpoints that should be further investigated. A driver is a natural or human activity that can lead to environmental stressor that may be experienced by an ecosystem or one of its components. An endpoint is a valued environmental attribute that has particular ecological importance and/or societal value. These concepts and definitions will be explored in depth in Sections 4.0 and 5.0, respectively. All model-specific drivers, stressor and endpoints will be presented in capital letters to indicate that they are included as components of the FIMP Conceptual Model.

The conceptual model diagrams include many possible pathways or linkages that may be of interest in a defined ‘system’. The ‘system’ can be as small as an individual site, or as large and complex as an ecosystem. In the context of the FIMP project, implementation of alternatives (storm damage reduction and restoration alternatives) in specific reaches of the study area have the potential to result in impacts to the ecosystem as a whole, even in areas where the specific project application is not directly applied. These impacts will be assessed in the models at a conceptual level for each habitat and further addressed in the final EIS document for the FIMP Reformulation Project. Landscape effects, or effects to multiple habitats from the same stressor can occur where habitats are closely interrelated, or biota use several different habitats to complete their life cycles. Potential impacts of the alternative can also be compounded by on-going natural activities or drivers and stressors that are unrelated to the project. The final (Phase 3) individual models for the proposed alternatives will define many potential pathways to insure that potential impacts are identified and being addressed in project management decisions. While every effort was made to make the models comprehensive, no model can include all possible pathways or linkages, and there is no insurance that all potential impacts will be identified. However, based on consensus, the models describe relevant pathways to be included in the EIS.

The conceptual models for the FIMP study area habitats have been developed in the two phases described below. In Phase 3, alternative or reach specific models will be developed as input to the EIS for the project. The conceptual models will be used to guide the EIS’ evaluation of potentially significant impacts.

2.3 PHASE 1 MODELS

The development of the Phase 1 models is detailed in the report produced subsequent to the workshops held on Long Island and at the Waterways Experiment Station (WES, USACE 2001). The purpose of the Phase 1 effort was to comprehensively and systematically identify all ecosystems, habitats, drivers, stressors and endpoints that could have any relevance to the FIMP study area and storm damage reduction project. Beginning with the identification of six subregions, an idealized transect of habitats was formulated that defined all possible habitats from the open ocean, across the barrier island, through the backbay areas, and onto the mainland upland. This comprehensive set of habitats formed the basis for identification of a comprehensive list of reasonable habitat units that were incorporated into the final Phase 1 models.

In addition to the habitats, the Phase 1 effort included a delineation of all possible drivers based on known natural or human activities that could lead to environmental stress in a system such as the FIMP study area. Participants in the workshop effort were encouraged to identify every possible driver based on their technical expertise. As a result, the initial list included five natural drivers, and 21 anthropogenic drivers that were considered by the workshop participants to be comprehensive and somewhat redundant. The list was further scrutinized to eliminate redundancy, resulting in a final list of four natural and eight anthropogenic drivers that would be included in the Phase 1 models.

All potentially relevant stressors were defined as part of the Phase 1 effort. Workshop participants separated stressors into physical, chemical and biological changes to which the ecosystem responds or changes. The process resulted in the identification of 20 physical stressors, four chemical stressors, and three biological stressors. These stressors represented a focus for the development of the Phase 1 models. Once the Phase 1 driver and stressor lists were finalized, workshop participants assigned qualitative weights (low, low/medium, medium, medium/high, high) to the individual driver/stressor associations. The strength of these associations helped identify the most likely impacted ecosystem components for each of the four ecosystems of concern (Coastal Marine, Ocean Beach and Dune, Bay, and Barrier Island Upland) and their associated habitats. Habitat level stressor/effects matrices and conceptual models were then developed for each of the habitats identified.

2.4 PHASE 2 MODELS

The results of the Phase 1 effort formed the basis for the development of the Phase 2 conceptual models for the FIMP study area. The purpose of the Phase 2 effort was to refine and focus the Phase 1 work in a systematic review all ecosystems, habitats, drivers, stressors, and endpoints with the goal of developing models that could be more readily applied to the indigenous habitats and alternative management options being considered for the reaches of the study area. As with Phase 1, a critical component of Phase 2 was consideration of input received from project stakeholders. The comprehensive Phase 1 habitat list was revisited to develop a representative list of habitats that occur within the study area.

Similarly, the comprehensive lists of drivers and stressors identified in Phase 1 were reviewed to identify and recommend modification to refine and focus the driver/stressor relationships to support the EIS process. The refinement resulted in the final incorporation of three Natural and six Anthropogenic Drivers into the Phase 2 Conceptual Model. Twenty stressors were selected and incorporated into the model representing changes in physical, hydrological, water quality, biological and human aspects of the ecosystems. The four ecosystems identified in Phase 1, Coastal Marine, Ocean Beach and Dune, Bay, and Barrier Island Upland, were retained for inclusion in the Phase 2 Conceptual Model, but in some cases, the habitats within each of the respective ecosystems were redefined, resulting in a total of 14 habitat models within 4 ecosystems.

The details of the Phase 2 approach are provided in the following section.

The purpose of the FIMP Reformulation Study is to identify, evaluate, and recommend long-term solutions for hurricane and storm damage reduction for homes and businesses within the floodplain along the southern ocean and bay shorelines of Suffolk County, New York. The FIMP study area spans the 83-mile barrier island chain from Fire Island Inlet to Montauk Point (Figure 1). While the study area extends as far landward as Sunrise and Montauk Highway in some locations, the area of interest for the purposes of the conceptual model extends from the intertidal zone of the mainland, southward, to the coastal marine offshore zone. It includes the following four ecosystems and associated habitats that will be discussed below:

- Coastal Marine
- Ocean Beach and Dune
- Bay
- Barrier Island Upland

3.1 FIMP HABITATS

As discussed in Section 2 above, all possible habitats present within the FIMP study area were defined as part of the Phase 1 effort, resulting in the identification of a total of four ecosystems and numerous habitats. In defining the relevant habitats to be modeled in Phase 2 of the FIMP study, existing available habitat data and nomenclature from other studies and agencies were reviewed so that the final list would be consistent, to the extent possible, with existing convention. The following information sources were consulted in the development of a complete habitat list to be incorporated into the Phase 2 conceptual models for the FIMP study area.

- Phase 1 Conceptual Model
- NYSDEC Significant Habitat and Wetlands Maps
- Conceptual Model Covertype Mapping
- FIMP Environmental Impact Statement Outline (pre-draft)

Definitions of habitats from each of these sources were based on existing (biological) habitat definitions, as well as existing Federal and State definitions. In the event that definitions and/or habitat types were inconsistent between different sources consulted, efforts were taken to combine the habitats to facilitate the assessment process. Thus, some of the habitat definitions from these sources were either re-defined and/or combined for inclusion in Phase 2. The habitat definition also had to be relevant to the FIMP study area. Habitats and their definitions from the Phase 1 Conceptual Model (USACE 2000) are provided below.

The four Phase 1 Conceptual Model "Idealized List", Ecosystems of Concern and their respective habitats are:

- Coastal Marine Ecosystem - Marine Offshore, Marine Nearshore, Ocean Sandy Intertidal, Ocean Rocky Intertidal
- Ocean Beach and Dune Ecosystem - Ocean Sandy Beach, Ocean Rocky Beach, Dunes, Swales, Maritime Forests, Salt Marshes, Bay Intertidal

- Bay Ecosystem - Bay Subtidal, Sand Shoals, Bare Sand, Mud Flats, Back Barrier Marshes, Marsh Islands, Inlets
- Barrier Island Upland Ecosystem – Terrestrial Upland, Upland Forest, Coastal Ponds, Tidal Creeks, and Deltas and Dredged Material Islands

The Draft EIS considered system-wide as well as localized issues by defining five distinct environmental habitats: Offshore Zone, Atlantic Shore (Nearshore, Beach and Inlets), Ocean Beach and Dune, Back Bay, and Barrier Island Uplands. The following additional plant resources were also considered in the draft EIS:

- Freshwater Wetland Plants
- Maritime Grasslands
- Maritime Shrubland and Heathland
- Maritime Forest
- Successional Woodlands (Ornamentals/Cultivars)

3.2 FINAL HABITATS

From the approach described above, it is apparent that the supporting information for habitat definition underwent extensive scrutiny and comprehensive review in the course of model development. In some cases, multiple habitats had to be combined, separated, or renamed to satisfy an existing regulation, or region-specific characteristic of the study area. For example, Bay Subtidal Habitat and SAV Habitat are listed as separate habitats despite the fact that SAV occurs in the subtidal zone. As another example, Salt Marsh and Bay Intertidal are also distinct categories. These decisions were made to facilitate potential future permitting issues, since the habitats are considered separate in state regulation. In all cases, every attempt was made to incorporate all natural environmental and regulatory issues in the identification of final habitats for the model.

The review and compilation of existing relevant habitat definitions resulted in the identification of a total of four ecosystems and 14 habitats that were retained for inclusion in the conceptual models for the FIMP study area. The list of ecosystems and habitats is provided in Table 2. A typical transect that includes all FIMP ecosystems and habitats is provided in Figure 3 and described in the following paragraphs.

3.2.1 Coastal Marine Ecosystem

The Coastal Marine Ecosystem extends offshore from a depth of 30 m, to the mean high water (MHW) line on the ocean side of the island. The associated coastline is exposed to wind and waves. This ecosystem is particularly critical to the project since storms approach the barrier islands from this area, and many of the storm damage reduction alternatives will be focused here. The final list of habitats in the Coastal Marine Ecosystem is as follows:

- Marine Offshore
- Marine Nearshore

- Sandy Intertidal

The Coastal Marine Ecosystem includes Marine Offshore, Marine Nearshore, Sandy Intertidal and Rocky Intertidal habitats described in the Phase 1 Model. The Rocky Intertidal habitat, included in the Phase 1 Model was eliminated from further assessment because this habitat type is not common along the FIMP study area except for areas along the far Eastern mainland shoreline, and as existing structural groins and jetties.

3.2.2 Ocean Beach and Dune Ecosystem

By definition, for the purposes of the Conceptual Model, the Ocean Beach and Dune Ecosystem extends from the MHW line on the ocean side to the boundary of the primary Dune and Swale habitat with the Terrestrial Upland. The final list of habitats in the Ocean Beach and Dune Ecosystem is as follows:

- Sandy Beach
- Dunes and Swales

While the Ocean Beach and Dune Ecosystem includes Ocean Sandy Intertidal, Ocean Rocky Intertidal, Sandy Beach, Rocky Beach, Dunes, and Swales, only two categories of habitats have been retained for inclusion in the conceptual model for this ecosystem. The habitats Sandy Beach and Dunes and Swales will be included in the conceptual model. The remainder of the habitats are included in more ecologically appropriate ecosystems or eliminated from the modeling effort. Intertidal Sandy Ocean habitat is included under Coastal Marine Ecosystem; Intertidal Sandy Bay and Salt Marsh are included in Bay Ecosystems; and Barrier Island Upland and Maritime Forest are included in Barrier Island Upland Ecosystems. The only remaining habitat, Rocky Substratum has been eliminated since it is not common in the FIMP study area.

3.2.3 Bay Ecosystem

The Bay Ecosystem model is the most complex and includes the most interrelated habitats. It is comprised of a complex mosaic of habitats including Bay Intertidal, Bay Subtidal, Sand Shoals and Bare Sand, Mud Flats, Back Barrier Marshes, Fringing Marshes and Marsh Islands, Dredged Material Islands, Inlets, and SAV. These habitats were carefully evaluated, and wherever possible, very similar habitat types were compiled into one habitat type.

The final list of habitats in the Bay Ecosystem is as follows:

- Bay Intertidal
- Sand Shoals, Bare Sand, Mud Flats
- Salt Marsh (Intertidal and High Marsh)
- Bay Subtidal
- Submerged Aquatic Vegetation (SAV)
- Inlets

In the process of combining related or similar habitats, Intertidal Bay combined Sand Shoal/Bare Sand and Mud Flats, Back Barrier Marsh and Marsh Islands, Sandy Intertidal Bay and Dredge

Material Disposal Islands habitat into one habitat for model assessment. No separate models were developed for Back Barrier Marsh and Marsh Islands, and Dredge Material Disposal Islands. These habitat types will be addressed in Phase 3 as separate models, or as part of the existing Upland models if warranted.

3.2.4 Barrier Island Upland Ecosystem

While the Barrier Island Upland Ecosystem includes Terrestrial Upland, Maritime Forest, Freshwater Wetland, and Coastal Ponds, Maritime Grasslands, Woodlands, Heathlands, Pine Barrens, and Coastal Forests only the most common and representative non-aquatic habitats present in the FIMP study area were retained for inclusion in the Conceptual Model to focus the models on habitats actually present within the FIMP study area. If additional habitat models are warranted, they will be developed as part of Phase 3. The final list of habitats in the Barrier Island Upland Ecosystem is as follows:

- Terrestrial Upland
- Maritime Forest
- Bayside Beach

Since selected habitats and some species overlap with the Bay or Coastal Marine Ecosystems the final habitats included for the model were limited. Additional habitat models may be developed in Phase 3 and included if warranted. That is, if a selected reach includes any of these habitats and it becomes relevant to the Phase 3 assessment, a new habitat model will be developed (e.g., freshwater wetlands, and coastal ponds).

By definition, the Barrier Island Upland Ecosystem contains and refers to the Barrier Island only. While the project area encompasses areas of “Terrestrial” upland on the mainland of Long Island, the model does not cover this area. Phase 3 will include these additional upland areas, if relevant.

3.3 PHASE 2 MODEL INPUT

The four ecosystems and 14 habitats summarized in Table 2 and discussed above are the basis for the development of the relevant conceptual models for the FIMP study area. Habitat models developed for each of these units will form the basic building blocks for the alternatives. These are the specific models that will be developed in Phase 3 and will direct the assessment to appropriate and relevant endpoints to be discussed in Section 5.0

4.1 DEFINITION

A driver is any natural or human activity that can lead to or result in an environmental stressor; i.e., any physical, chemical, and/or biological change experienced by an ecosystem. The US Environmental Protection Agency's (EPA's) definition restricts stressors to only those physical, chemical, or biological entities that can induce an adverse response (USEPA 1997). Thus EPA's definition restricts drivers and stressors to adverse impacts. The Cape Cod Monitoring Program (CCMP) uses the term "Agents of Change" defined as mechanisms such as natural processes and events, or human activities (Roman and Barrett 1999). Agents of change operate within the normal range of variability and acceptable limits. When they are outside this range they are "sources of stress" defined as the associated impacts of human activities that diminish the quality or integrity of the ecosystem. However, because the goal of the conceptual model process is to assist in the preparation of an EIS, it is appropriate to consider both positive and negative changes. One driver can lead to multiple stressors, and these stressors can potentially have both adverse and positive impacts.

4.2 IDENTIFICATION OF DRIVERS AND STRESSORS

An initial list of drivers and stressors was defined in the Phase 1 Model and forms the basis of drivers and stressors developed in Phase 2. The original list was systematically reviewed in an effort to focus the Phase 2 Conceptual Model development, and facilitate its practical application to the FIMP EIS. As part of the process, initial drivers and stressors were reviewed for consistency with the definition provided in the draft Conceptual Models for Coastal Long Island Ecosystems (USACE 2000); EPA Risk Assessment Guidance (EPA 1994, 1995, & 1997); and the Cape Cod Monitoring Program (Roman and Barrett 1999).

As with other model components, supporting information generated from stakeholder input, project objectives and regional knowledge for identification of appropriate and sufficient drivers underwent extensive scrutiny and comprehensive review in the course of model development. In some cases, related drivers were combined under one specific driver type. In other cases, what seemed to be related drivers were covered under multiple separate drivers. For example, drivers that could be considered consumption of resources, such as commercial fin fishing and sand mining, are covered under separate drivers of Agriculture/Aquaculture and Construction-Dredging, respectively. All decisions were made to facilitate model development while maintaining realistic potential pathways among drivers, stressors and endpoints.

Based on this review, and comments received from the Interagency Committee, 9 drivers and 20 stressors were defined for use in the Phase 2 Model. The list of final drivers retained is divided into Natural and Anthropogenic sources as follows:

NATURAL DRIVERS

- Catastrophic Storms
- Climate Change
- Sea Level Rise

ANTHROPOGENIC DRIVERS

- Development
- Agriculture/Aquaculture
- Recreation/Land Use
- Construction-Hard
- Construction-Soft
- Construction-Dredging

Definitions of the Phase 1 drivers are provided in the Phase 1 document. The definitions of the final Phase 2 drivers are provided in Appendix A.

The list of final stressors is divided into six categories as follows:

HYDROLOGICAL STRESSORS

- Changes in Overwash Regime
- Flooding
- Hydrological Alteration
- Change in Wave Dynamics
- Circulation Changes

WATER QUALITY STRESSORS

- Changes in Salinity
- Changes in Nutrient Concentrations
- Contaminants
- Changes in Sedimentation
- Turbidity
- Reduced Dissolved Oxygen
- Changes in Water Temperature

PHYSICAL STRESSORS

- Breach Formation
- Habitat Alteration

BIOLOGICAL STRESSORS

- Species Displacement
- Algal Blooms

HUMAN STRESSORS

- Human Presence

OTHER STRESSORS

- Salt Deposition
- Groundwater Regime
- Changes in Fire Regime

Definitions of the Phase 1 stressors are provided in the Phase 1 document. The definitions of the final Phase 2 stressors are provided in Appendix A. For the purposes of the model, the list of stressors were grouped into realistic categories based generally on mode of action. The categories were developed in an effort to manage and organize the numerous stressors that would be addressed. It is acknowledged that some stressors could be assigned to several categories. In the Phase 3 effort drivers and stressors may be revisited if necessary, to reconsider more complex issues such as those related to sedimentation, that could be considered either drivers or stressors, or that should be separated out into multiple stressor categories.

Finally, as a result of Phase 2 review meetings, the drivers and stressors relating to sedimentation will receive additional consideration in the Phase 3 efforts. As currently modeled, ecosystem stress attributed to sedimentation is addressed in all of the Physical Stressors, Hydrological Stressors and several of the Water Quality Stressors (ie., Changes in Sedimentation and Turbidity). Both of the Physical Stressors (Breach Formation and Habitat Alteration) include a component of sediment movement. Since water is a medium in sediment transport, any of the Hydrological Stressors may also include changes in sedimentation patterns. Similarly, if warranted, a geologic scale may also be incorporated to better assess large-scale sedimentation patterns over time.

4.3 HABITAT RESPONSES

The selection of specific components of the respective habitats included in the model is critical to environmental impact assessment. Potential environmental impacts can create habitat responses that result in changes to components such as community composition, species interactions, biodiversity, and/or physical, chemical and biological attributes of an area.

An important consideration of the habitat models is the conceptual understanding that the response of the habitat to a stressor may result in an impact to biota that utilize the habitat. The stressor does not typically act directly on the biota. The details and boundaries of potential habitat responses are dynamic, complex and beyond the scope of the FIMP model development but require some explanation.

A variety of habitat responses may occur specific to a biological component of the model if the physical, chemical and biological attributes of the area and the interrelationships between these attributes and biota within the habitat are affected. For example, Changes in Sedimentation may fill in certain areas of the bay rendering them unsuitable for certain types of fish requiring deeper water. While the sedimentation may not directly affect the fish, the habitat response creates a new set of features that are no longer suitable.

In some circumstances, a habitat response can also trigger a secondary response if a habitat process, species, population, or physical attribute is altered to the extent that the habitat no longer provides a required service (eg., breeding, feeding, nursery area). The alteration may also result in new or additional services to another component of the ecosystem.

Threatened or endangered species are dealt with slightly differently in the models. Under the Federal Endangered Species Act <u>individuals</u> of a species are managed and protected. For example, in the Inlet Model (see Section 6.3), Transitional Amphibians and Reptiles were selected as endpoints because the specific endpoints in this case are Kemps-Ridley, Loggerhead, and Hawksbill turtles, all of which are Threatened and Endangered Species even though the inlet is not the only habitat utilized by the turtles.

All of these effects will be identified and assessed using the reach specific and alternative specific models in Phase 3.

4.4 PHASE 2 MODEL INPUT

Habitat specific relevant drivers were identified for each ecosystem to be modeled. While each driver can lead to numerous stressors that may result in finite, local, short-term impacts, some drivers are responsible for inducing broader, long-term impacts. It is these drivers, and the more important stressors that they generate, that are more likely to result in measurable or detectable changes that are the focus for the Phase 2 model input for drivers and stressors. Table 3 provides a summary of the relevant drivers and stressors that will be incorporated in each of the habitat models.

As part of the Phase 1 effort, workshop participants reviewed the agreed upon list of environmental stressors and developed a matrix of stressor-driver relationships. The relationships between each driver and stressor were qualitatively weighted in terms of importance. As part of the Phase 2 effort, the Interagency Work Group was asked for their general opinions regarding the strength of the re-organized driver-stressor relationships focusing on new drivers and/or stressors that were added to the list. Information from the Phase 1 and Phase 2 reviews was compiled to define the stressors most likely to influence the respective habitats. Hence, the relevant stressors identified in the Phase 1 Model were further scrutinized to establish those most likely to influence the habitat or ecosystem in a measurable way. These stressors are summarized in Table 4 and form the set of data to be used as input into the Phase 2 models for each respective habitat.

5.1 DEFINITION

An ecological endpoint describes a valued environmental attribute that has particular ecological importance (e.g., keystone species, threatened and endangered species), and/or societal relevance and value (e.g., commercially important species). The selection of ecological endpoints should:

- be ecosystem or habitat specific;
- be sensitive to the drivers or stressors being assessed for plan development (if known);
- incorporate specific environmental goals; and
- be amenable to measurement or prediction.

Selection of comprehensive and appropriate endpoints for the conceptual model is critical to ensure that all potential impacts can be sufficiently assessed in the EIS. All of the endpoints are biological in nature; they refer to biological components of the habitat or system. Physical and chemical aspects of the system are included in the model as drivers and stressors (See Section 4.0). While it is likely not possible to predict the response of each endpoint on a 'micro-scale', they do form an adequate basis for the level of assessment that will be performed in the EIS for the project.

EPA guidance (1997) distinguishes between assessment endpoints and measurement endpoints. An assessment endpoint is the explicit expression of the environmental characteristic that is to be protected. Measurement endpoints are measurable ecological characteristics that are related to the valued characteristic chosen as the assessment endpoint. For example, protection of the benthic macroinvertebrate community is considered an assessment endpoint; site specific benthic community data is the measurement endpoint. However, measurement and assessment endpoints are most typically associated with risk assessment models and, as such, are used less explicitly in this conceptual model. The following paragraphs describe endpoints in more detail, along with the process used in the development of endpoints for the FIMP Conceptual Model.

5.1.1 Assessment Endpoints

Since the assessment endpoint expresses the environmental characteristic to be protected, it must provide a detailed description of that particular component of the ecosystem and be relevant or directly related to the assessment issues.

Ecological assessment endpoints should identify valued environmental attributes upon which management decisions are made. For example, if the plan alternative for a specific reach includes construction of a seawall, and survey data demonstrate that protected species utilize the area where the seawall would be constructed, the management decision would be to consider a more environmentally sound alternative. Examples of valued environmental attributes with ecological importance include keystone species and ecologically important processes that help sustain the ecosystem. Examples from the FIMP study area include functioning as a food base (e.g., benthic macroinvertebrates), providing habitat (e.g., salt marsh vegetation), or promoting production of critical resources (e.g., nutrients). Environmental attributes selected using these criteria should have a direct influence on these ecological characteristics. Understanding ecosystem components is essential in selecting endpoints in order to capture potential community or ecosystem level "cascade of adverse effects (EPA 1995)" that could result from the loss of these attributes.

The selection of assessment endpoints often depends upon how society or the public at large views specific species. In some cases, some resources of ecological relevance are not considered valuable because society considers them a pest or are indifferent to them. An example used by EPA is midges, a group of insects considered to be pests, but that can also represent the base of a food web that supports a valued sport fishery. In this case the fishery would be the assessment endpoint and midge density would be the ecological component to measure, or measurement endpoint.

FIMP relevant endpoints with societal value and/or that meet a policy goal include loss of an endangered species or its habitat (e.g., Piping Plover), reproductive potential of a species important for commerce or recreation (e.g., Summer and Winter Flounder), attributes that support food sources or flood control (e.g., Dunes), wetlands (e.g., Salt Marsh), and rare habitats or ecosystems (e.g., Maritime Forest). To ensure that the assessment is comprehensive, endpoints for the conceptual model were selected from the following major trophic levels: vegetation, invertebrates, fish, amphibians and reptiles, birds and mammals.

5.1.2 Measurement Endpoints

An endpoint can only be relevant if it displays a measurable or predictable characteristic of an ecological component (e.g., protection of benthic community richness) that results from exposure to a stressor (e.g., Changes in Sedimentation). As discussed above, appropriately chosen assessment endpoints define the ecological value in sufficient detail to identify the measures needed to answer specific questions or to test specific hypotheses (EPA 1997). Once assessment endpoints are defined and agreed upon by the stakeholders, testable hypotheses and measurement endpoints can be developed to serve as a basis for impact assessment. For the FIMP study area, measurement endpoint data come from existing literature (e.g., historical surf clam data) and additional data collected as part of the project (e.g., supplemental surf clam surveys).

Measurement endpoints should be relevant to an assessment endpoint in that they correlate with or can be used to infer or predict changes in the assessment endpoint. Ideally, they are readily measurable biological effects such as mortality, reproduction, growth, or density.

In selecting measurement endpoints, the species and life stage, population, or community chosen should be those most susceptible to the stressor for the assessment endpoint in question. The life history, habitat, and behavioral characteristics should also be considered. For the FIMP study area, an extensive amount of existing data has been reviewed to identify suitable measurement endpoint data. Where data gaps were identified, new data were collected to serve as measurement endpoints for the sensitive environmental attributes or assessment endpoints that are to be protected in the FIMP study area. An extensive list of existing information was summarized and abstracted in Appendix E of the Phase 1 report (USAERDC 2001). Data gap analyses were performed to identify additional information needs for the project. General categories of additional data collected as part of the project include:

- Borrow area, backbay and intertidal benthic macroinvertebrate surveys
- Borrow area and backbay finfish surveys

- Demersal finfish, shellfish, squid and macroinvertebrate studies of off shore borrow areas
- Aerial photographic analysis and vegetative mapping
- Analysis of historic vegetative zonation
- Temporal changes in terrestrial, wetland, and SAV due to overwash and breach events
- Hard clam growth rates investigations
- Beach insect and invertebrate surveys
- Shorebird and terrestrial bird surveys
- Cultural buildings surveys
- Piping Plover Habitat Suitability Index investigations
- Shorebird Habitat Evaluation Procedures (HEP) Analysis
- Creel surveys
- SAV surveys
- Surf clam surveys
- Surface water quality monitoring
- Sediment grain-size distribution of borrow and potential placement areas
- Hydrological data collection and modeling
- Cover type mapping

Many of these studies have included multi-season and multi-year, comprehensive sampling events. The USACE restoration framework and vision statement (USACE 2003) in addition to the draft EIS and outlines (USACE 1977 and 2001) have also provided useful information. The reader is referred to Appendix E of the Phase 1 report for a more complete list of references.

5.2 FINAL ENDPOINTS

A stated purpose of the Conceptual Model is to develop a scientific understanding of the ecosystems involved and how they are affected by both environmental stressors relevant to the management alternatives under consideration, as well as other natural and anthropogenic stressors. Principle issues of concern to be incorporated in the model are the storm-induced extreme tides and waves that can cause extensive flooding and erosion on the barrier island and associated mainland communities.

Assessment endpoints must allow for evaluation of the significance of potential ecological impacts related to shore protection and storm damage reduction, but should also be manageable in number to reduce redundancy, focus monitoring resources, and provide maximum clarity regarding ecological condition. Additionally, if there is a change in the ecosystem of importance, it should be reflected in the change of at least one or more of the selected ecological endpoints, and, conversely, a change in an endpoint would be considered to be ecologically important.

The identification of final endpoints for the FIMP conceptual models was based on a review and categorization by habitat of the original endpoints identified in the Phase 1 model. The Phase 1 endpoints were identified by technical experts who participated in the workshop (See Section 1.0), based on their technical expertise regarding specific ecosystem components. Most of the original 105 ecological endpoints were consistent with EPA's general definition of endpoints in that they identify valued environmental attributes that have particular ecological importance, societal value, and/or meet a policy goal. However, many of the listed endpoints failed to define the ecological value in sufficient detail to be considered assessment endpoints. Thus, all of the listed endpoints were rewritten to meet the criteria of assessment endpoint.

Several of the 105 ecological endpoints originally identified in Phase 1 could not be used as assessment endpoints, a few examples include:

- Distribution and composition of terrestrial invertebrate community (ticks, mosquitoes, and green flies)
- Abundance and distribution of *Phragmites*
- Invasive species
- Recreational use
- Aesthetics

The first three of these listed endpoints have non-indigenous, nuisance, pest, and/or invasive species as receptors and do not meet the EPA guidance definition of assessment endpoints. In fact, 'non-indigenous/nuisance species' has been included under the Species Displacement stressor in the Biological Stressors category (Appendix A). However, since some of these receptors may have ecological importance, they have been incorporated into the measurement endpoints for related assessment endpoints (Table 5).

The listed endpoints of 'recreational use' and 'aesthetics' are human concepts, not ecological endpoints. Recreational use is now included as the driver Recreation/Land Use (see Section 4.0 and Appendix A). Aesthetics has been eliminated from the Conceptual Model. Impact on recreational use and aesthetics will be addressed in the EIS under Human Environment. Changes in recreational use and aesthetic values will also be addressed in the assessment of benefits used to compare plans and to justify project selection. Finally, the "Wildlife Population" endpoint described in the Phase 1 model was too broad a grouping to be amenable to prediction. In addition, it is not defined in sufficient detail to identify measures needed to answer specific questions. Instead separate assessment endpoints were described for discrete biological components including vegetation, invertebrates, finfish, amphibians and reptiles, birds, and mammals.

Once the original list of endpoints was revised, a master list of all endpoints was compiled by significance of the assessment endpoint. This list also included specific commercially and recreationally important species (Table 6) and endangered or threatened species (Table 7). An anomaly that should be pointed out is the Diamondback Terrapin. While the terrapin was delisted in 2001, it was felt that there is sufficient societal interest in this species to include it in this protected category (6 NYCRR Section 3.1).

The master list of endpoints was compiled for each organismal group of vegetation, invertebrates, finfish, reptiles and amphibians, birds, marine mammals, terrestrial mammals, and insects for each habitat under each ecosystem. In this way habitat specific lists of endpoints were developed that identified the significance of each endpoint within the habitat.

The assessment endpoints for each of the groups are as follows:

- Protection of vegetation communities
- Protection of aquatic benthic invertebrate communities
- Protection of fish populations and communities
- Protection of amphibian and reptile populations and communities
- Protection of bird populations and communities
- Protection of marine mammals populations and communities
- Protection of terrestrial mammals populations and communities
- Protection of of terrestrial insect communities

In addition, two assessment endpoints are identified for unique or otherwise sensitive components of the FIMP study area, and are treated with a far more stringent regard under the Phase 2 model:

- Protection of all individuals listed as endangered or threatened or "species of special concern"
- Protection of the Maritime Forest

These proposed assessment endpoints reflect the goal of avoiding or minimizing critical adverse potential impacts associated with implementation of shore protection and storm damage reduction alternatives. Important receptors are identified for each assessment endpoint. These receptors were selected to represent important populations, communities, guilds, and/or processes that have ecological importance, societal value, and/or meet a policy goal. A list of these endpoints by habitat is provided in Table 5.

5.3 PHASE 2 MODEL INPUT

The endpoint review process resulted in the reduction and combination of 105 ecological endpoints to the focused set of endpoints that will be carried through the Phase 2 Conceptual Model. Depiction within the model represents a two-step process. First, potential effects of the project on a specific habitat are based on organismal groupings (e.g., vegetation, invertebrates, finfish), and these groups are further sub-divided into the three endpoint categories of:

- Aquatic
- Transitional
- Terrestrial

Aquatic Endpoints refer exclusively to biota that utilize the marine environment for all or a portion of their lives and include Vegetation, Invertebrates, Finfish, Birds and Marine Mammals. The aquatic habitat models that include these endpoints include Coastal Marine Offshore, Coastal Marine Nearshore, Coastal Marine Sandy Intertidal, Bay Intertidal, Sand Shoals, Bare Sand and Mud Flats, Salt Marsh, Bay Subtidal, SAV, and Inlets.

Transitional Endpoints include Vegetation, Amphibians and Reptiles, and Birds that require both aquatic and terrestrial habitats for portions of their life cycles or to satisfy needs of reproduction, feeding or resting. The habitats associated with transitional endpoints include all 14 listed habitats except SAV.

Terrestrial Endpoints include Vegetation, Birds, Terrestrial Mammals and Insects, and Amphibians and Reptiles. The habitats associated with terrestrial endpoints include Sandy Beach, Dunes and Swales, Terrestrial Uplands, Bayside Beach and Maritime Forest.

The conceptual model provides a framework for description of relationships between drivers, stressors, and endpoints so that all potential relevant impacts associated with project implementation can be accounted for in the assessment process. Many drivers and their associated stressors can occur and are occurring with or without project implementation, while others such as "construction-dredging" only occur during a project action involving dredging. Changes induced by stressors can be measured in the endpoints selected for the habitat. All selected drivers, stressors and endpoint categories were compiled into a model template that would provide the basis for creation of the habitat specific models. The Phase 2 model template is shown in Figure 4.

Habitat specific models are provided for each of the four ecosystems in the following sections. In each section, individual habitat models in the order moving from offshore to the barrier island, bay and barrier island upland are presented. The ecosystem model (Coastal Marine, Ocean Beach and Dune, Bay or Barrier Island Upland) is presented last in each ecosystem subsection, incorporating all of the drivers, stressors and endpoints for all habitats in that specific ecosystem.

6.1 COASTAL MARINE ECOSYSTEM

Habitats included within the Coastal Marine Ecosystem are Marine Offshore, Marine Nearshore, and Sandy Intertidal habitats. The areal extent of this ecosystem extends from the mean high tide line on the ocean side of the barrier island, to 30m in depth offshore (Figure 3).

6.1.1 Coastal Marine Offshore

The furthest offshore marine habitat included in the model is Marine Offshore (Figure 5). The Marine Offshore habitat is that oceanic area from 10 to 30 m in depth. This habitat was considered to be relatively homogeneous throughout the whole southern Long Island coastline from Rockaway Inlet, through Fire Island National Seashore. For the purposes of this investigation, the habitat is divided into pelagic and benthic zones. The benthic zone consists primarily of a sandy substrate within the FIMP study area. While the drivers and stressors are the same for both the benthic and pelagic zone, the ecological endpoints are quite different. Project alternatives such as Beach Restoration would likely be included in this model since potential borrow areas are located in this habitat.

Drivers and Stressors. Construction – Dredging is the driver resulting in the most stressors (6) in the Coastal Marine Offshore habitat. As concluded in Phase 1 and Phase 2, the operation of dredging is the driver of primary concern because it will result in the largest number of impacts and could be a component of the beach restoration alternative. While dredging is generally associated with localized impacts, relationships among species and habitats could create impacts over a wider area. For example, while dredging affects benthic communities in the dredged area, these invertebrates provide prey for wider ranging biota such as birds and finfish, thus impacts to the benthos could have effects on components of adjacent habitats and ecosystems. The remaining drivers associated with the Marine Offshore habitat are Catastrophic Storms, Agriculture/Aquaculture, and Recreation/Land Use. These drivers are independent of project implementation, and will occur regardless of the FIMP project (i.e. are presently ongoing and will continue with or without project implementation) but must be considered in model development to facilitate assessment of potential cumulative impacts to the Marine Offshore habitat.

Endpoints. With the exception of Sea Turtles, which are considered a transitional endpoint, all endpoints associated with the Marine Offshore habitat fall under the Aquatic Endpoint grouping. Of these, Invertebrates, Amphibians and Reptiles, Finfish, and Marine Mammals can be subjected to a variety of habitat responses. Specific endpoints that utilize the Marine Offshore habitat are listed in Table 5. For purposes of discussion, the Marine Offshore area is divided into the pelagic and benthic zones. In general, the risks to pelagic endpoints are deemed to be low compared to medium to high impacts to benthic endpoints unless dredge management is implemented.

Specific endpoints of the benthic zone include both infaunal and epifaunal Invertebrates and Benthic Finfish. Polychaetes are an important benthic infaunal component; epifaunal forms include Amphipods, Echinoderms, and Surf Clams. Benthic finfish of concern include both Summer and Winter Flounder. These species, along with Bluefish and Striped Bass, are commercially and recreationally important pelagic species. The pelagic zone is dominated by migratory and highly mobile species of fish including the following bottom fish: Hake, Scup, Butterfish, Sand Lance, and Windowpane. The pelagic zone also provides habitat for Marine Mammals, all of which are threatened and/or endangered. In addition, endangered and threatened Kemps-Ridley, Hawksbill, and Loggerhead sea turtles are present in this habitat and are included in the model. These species spend an appreciable amount of time on the bottom and thus are potentially vulnerable to dredging activities. An additional concern is capture during hydraulic dredging.

While numerous fish species use the Coastal Marine Offshore habitat, many are migratory, have a wide home range, or are highly mobile. These species are less likely to be affected by habitat alteration that may occur as a result of either Natural or Anthropogenic Drivers.

6.1.2 Coastal Marine Nearshore

Moving landward from the Marine Offshore Habitat (Figure 3), the next habitat is the Marine Nearshore. Figure 6 is the conceptual model for the Coastal Marine Nearshore habitat. The habitat is defined as the area between mean low water (MLW) to 10m in depth. This model will likely be included in many of the project alternatives since they involve elements in or adjacent to the Marine Nearshore habitat.

Drivers and Stresssors. The inclusion of all nine drivers in the Marine Nearshore Habitat model suggests that this area is highly vulnerable to ongoing natural and anthropogenic effects, and is susceptible to effects of project implementation. Since all three Natural Drivers are also associated with these stressors, potential effects to the Marine Nearshore habitat would occur with or without project implementation.

Because this habitat is located in shallow depths and close to the shoreline, the anthropogenic drivers of Construction-Hard, Construction-Soft and Construction-Dredging result in the largest number of stressors. Of the selected stressors, Habitat Alteration, Changes in Sedimentation, and increased Turbidity may contribute to overall Species Displacement. These stressors were further exacerbated by Hydrological Alteration and Human Presence, two additional stressors that are included in the model. Impacts from construction drivers on the Nearshore habitat can be managed through strategic environmental planning and timing of operations.

The remaining Anthropogenic Drivers selected for the Marine Nearshore model are Development, Agriculture/Aquaculture and Recreation/Land Use. These drivers currently influence the study area and will continue with or without the project. Development on the mainland is most closely associated with the far eastern barrier island in areas such as Dune Road along Shinnecock and Moriches Bays where structures are located in close proximity to beach and dune areas. In addition, development continues along the Fire Island National Park and barrier island communities. Over the years this area has been heavily developed and stressors such as Habitat Alteration, Species Displacement and Human Presence are ongoing. The growing human presence on this fragile barrier island has yielded an increase in recreation such as boating, personal water craft use, fishing, and other activities.

Endpoints. All endpoints associated with the Marine Nearshore habitat fall under either the Aquatic or Transitional Endpoint groupings. Habitat responses can affect Invertebrates, Amphibians and Reptiles, Finfish, Birds, and Marine Mammals that utilize this habitat. Similar to the Marine Offshore habitat, the Nearshore habitat is divided into pelagic and benthic zones. The predominant pelagic fish populations of concern include Silversides, Anchovies, Bluefish, and Striped Bass. Marine Mammals, especially seals on the eastern end of the study area are a concern and included in the model. The Nearshore habitat is also important to birds such as Cormorants, Osprey, Terns, Mergansers, and Sea Ducks, which are all included in the Nearshore model.

The benthic community of the nearshore environment includes all of the Aquatic Invertebrate Endpoints, several of which are commercially and recreationally important. While this area is similar to the Marine Offshore benthic habitat community, the Marine Nearshore community differs with its absence of the sand dollar. Benthic fish species found in this area are the Winter and Summer Flounder, which are also commercially and recreationally important.

Since the Marine Nearshore Habitat is transitional from the deeper offshore waters to the shallow, Sandy Intertidal zone, it includes endpoints that are common to both of these areas. Hence, potential impacts can also be the same and may overlap.

6.1.3 Coastal Marine Sandy Intertidal

The Sandy Intertidal habitat extends from the boundary of the Marine Nearshore at MLW to MHW(Figure 3). Owing to tidal influence, the presence of a pelagic zone alternates between high and low tide. The Sandy Intertidal habitat is the closest landward habitat within the Coastal Marine ecosystem. Since many of the alternatives under consideration include features that would be built in this or adjacent habitats, many models will include a Sandy Intertidal component to ensure that potential impacts are assessed. Figure 7 is the conceptual model for the Coastal Marine Sandy Intertidal habitat.

Drivers and Stresssors. As with the Marine Nearshore habitat, the inclusion of all nine drivers in the Marine Sandy Intertidal habitat model suggests that this area is also highly vulnerable to both on-going drivers and associated stressors and potential effects of project implementation.

Due to the orientation of this habitat on the coastal boundary of the barrier island, Catastrophic Storms are the driver selected with the highest number of associated stressors (11). Additional Natural Drivers of Climate Change and Sea Level Rise may also cause associated stressors due to upland proximity and shallow depth, respectively.

Of the list of Anthropogenic Drivers Construction-Hard, Construction-Soft, and Construction-Dredging result in the largest number of stressors as was noted in the Marine Nearshore habitat. Many of the associated stressors remain the same as those found in the Marine Nearshore model, with the addition of those stressors compounded by the proximity to the shore. The Physical Stressor Breach Formation is an additional stressor in this zone because construction activities this close to shore can have a greater impact to the barrier island upland. It is important to note, that while both Construction-Hard, and Construction-Soft resulted in the same number of associated stressors (10), they do not create the same impact severity. Construction-Hard is likely to result in greater and longer term effects due to the invasiveness of the construction material and techniques. As an example of Construction-Hard, bulkhead construction will likely have more far-reaching and long term impacts to the Sandy Intertidal habitat than a Construction-Soft element such as beach replenishment. Consequently, all associated stressors that may result from these drivers are typically greater with Construction-Hard than with Construction-Soft. For example, bulkhead construction will create greater Habitat Alteration to Sandy Intertidal and contiguous habitats compared to potential effects associated with beach replenishment.

The remaining Anthropogenic Drivers selected for the Marine Sandy Intertidal model are the same as those for the Marine Nearshore but could potentially have a wider geographic range of impact to the project area. Drivers are currently influencing the study area for many of the communities along the Fire Island Barrier Island that are heavily developed such as Dunewood, with development into the Sandy Intertidal habitat. Effects of this development on the Sandy Intertidal habitat will continue with or without the project. Finally, Recreation/Land Use is also relevant to this habitat model and consequently results in ongoing stressors to the system. The predominant recreation in this area is beach use and associated stressors such as Human Presence.

Endpoints. All endpoints associated with the Marine Sandy Intertidal habitat fall under either the Aquatic or Transitional Endpoint groupings. Habitat responses can affect Invertebrates, Finfish, and Birds that utilize the Sandy Intertidal habitat. The area is typically highly turbid with very high wave energy. The naturally highly stressed intertidal zone is characterized by fewer endpoints adapted to survive in this habitat.

The intermittent marine intertidal pelagic zone is characterized by a relatively low diversity of fish, consisting principally of Atlantic Silversides, Kingfish, and Juvenile Bluefish. Similarly, because of the alternate inundation and drying of this zone, the benthic community tends to have a lower species richness, with dominant taxa including the polychaete *Scolelepis*, the bivalve *Donax*, and the mole crab *Emerita*. The Sandy Intertidal habitat is particularly important to birds including numerous shorebirds such as Sandpipers, Terns, and Gulls that utilize this habitat for forage. This zone can be particularly sensitive since it provides habitat to endangered and threatened bird species such as the Piping Plover, Osprey, Common Tern, and Least Terns (Table 5). All of these endpoints are included in the Sandy Intertidal model.

6.1.4 Coastal Marine Ecosystem Model

The Coastal Marine Ecosystem is particularly important to the FIMP assessment in that most alternatives will address or potentially involve some aspect of the ecosystem. Some of the alternatives (e.g., beach nourishment) will occur in or adjacent to the intertidal or subtidal zones.

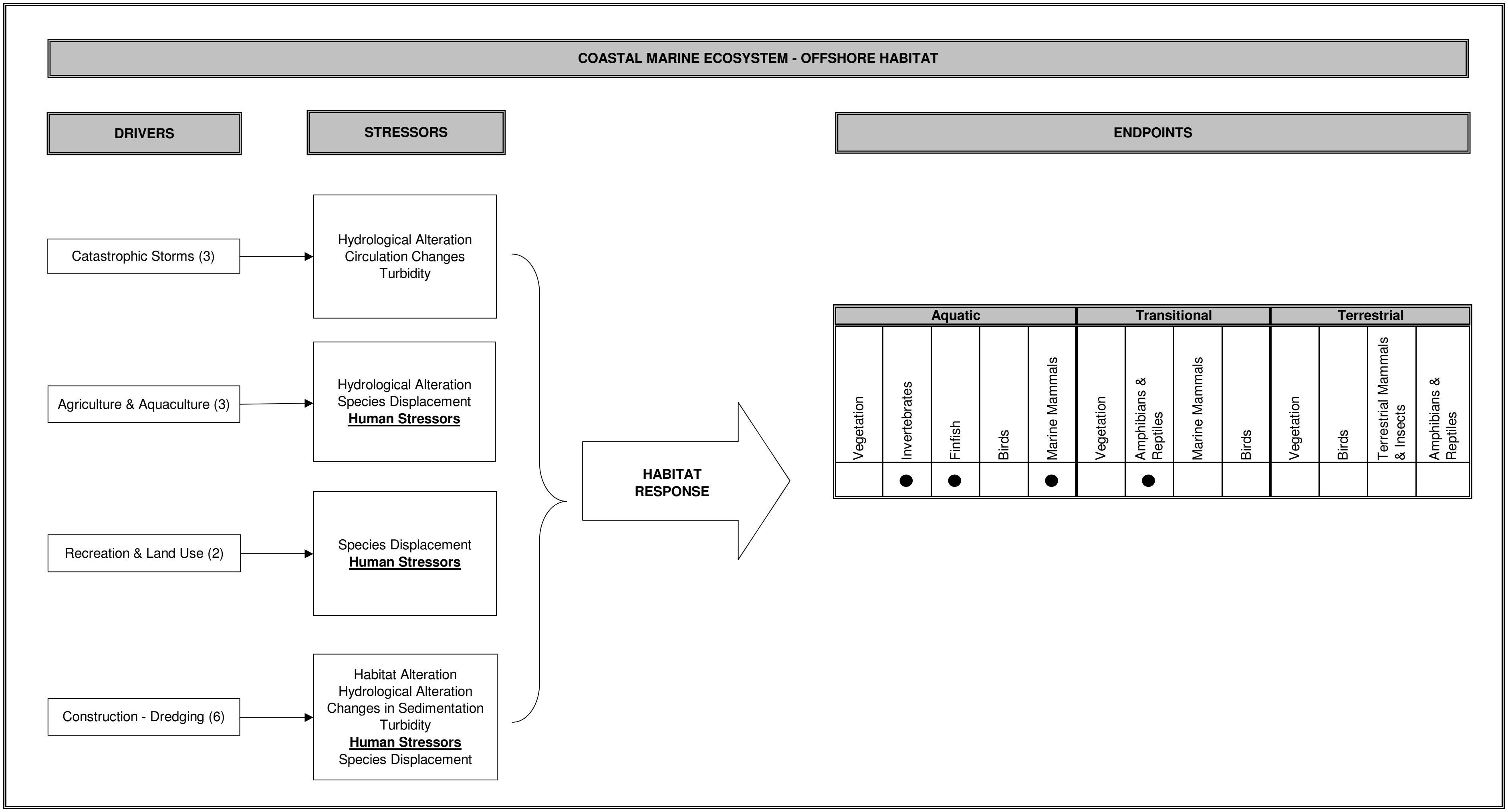
Impacts to either of these zones can also be linked to adjacent zones or habitats resulting in landscape level effects. For example, beach nourishment may temporarily eliminate benthos in the intertidal zone. This localized effect can have broader impacts to birds or finfish that may rely on the benthos for prey.

Critical drivers and stressors of the Coastal Marine Ecosystem are defined based on those identified in the Phase 1 model, and modified in Phase 2 as described in Section 4.0. The ecosystem model is presented in Figure 8 and includes and summarizes all of the drivers and stressors associated with the three habitats that are part of this ecosystem.

Critical drivers may include natural phenomena such as Catastrophic Storms, Climate Change, and associated Sea Level Rise, along with Anthropogenic Drivers of Development, Agriculture and Aquaculture, Recreation/Land Use, and Construction. Catastrophic Storms (11) and Construction Hard (10), Soft (10), and Dredging (8) are responsible for the greatest number of stressors. Physical, Hydrological, Water Quality, Biological, and Human Stressors are all relevant to this ecosystem.

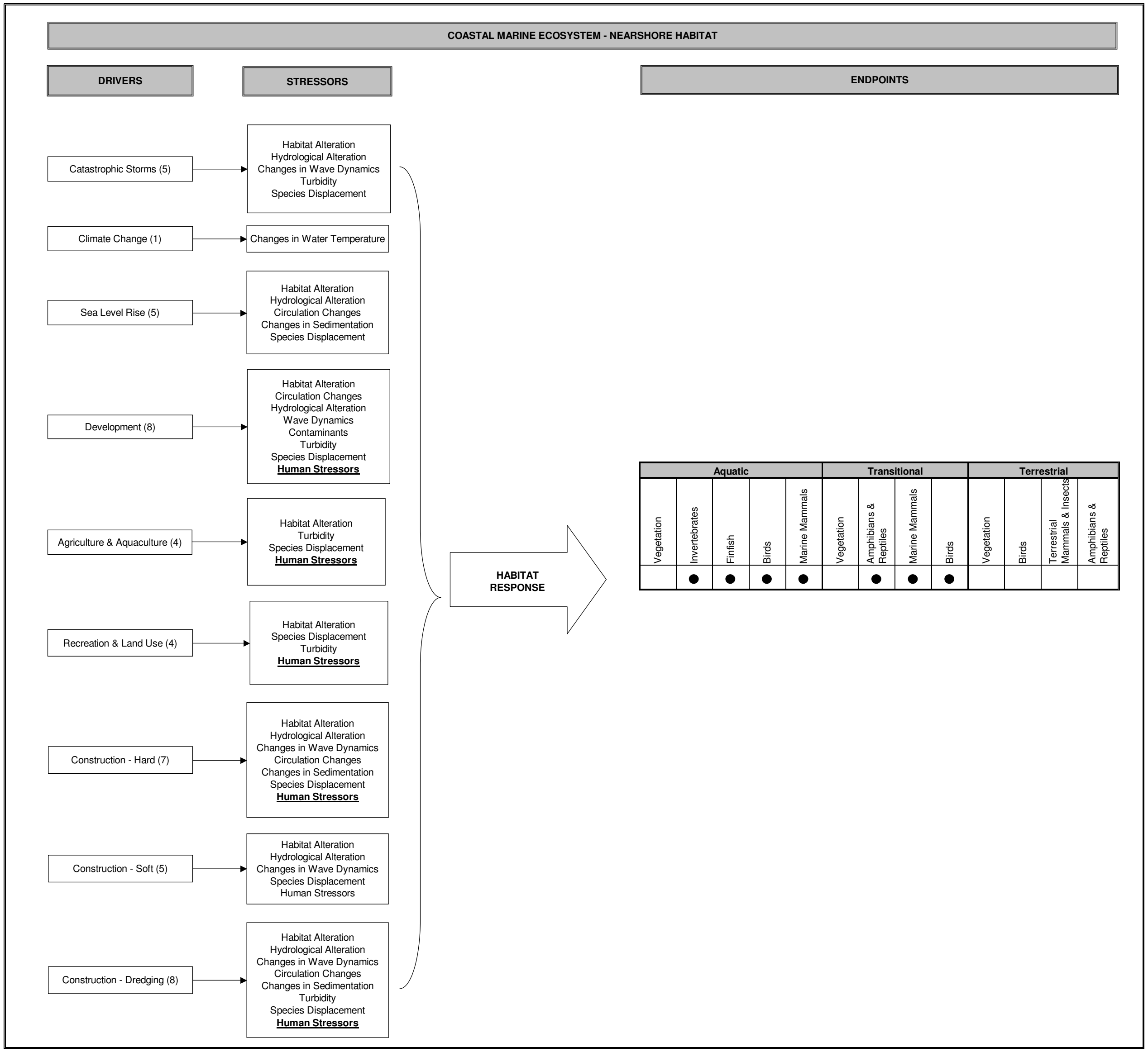
The Coastal Marine Ecosystem is critical to Invertebrate, Finfish, Bird, Marine Mammal, and Amphibian and Reptile organismal groupings. Of particular concern are potential impacts to endangered and threatened Birds, Mammals, and Amphibians and Reptiles, and commercially and recreationally important finfish species that use the ecosystem for habitat for all or part of their lives.

Figure 5
Coastal Marine Ecosystem - Offshore Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



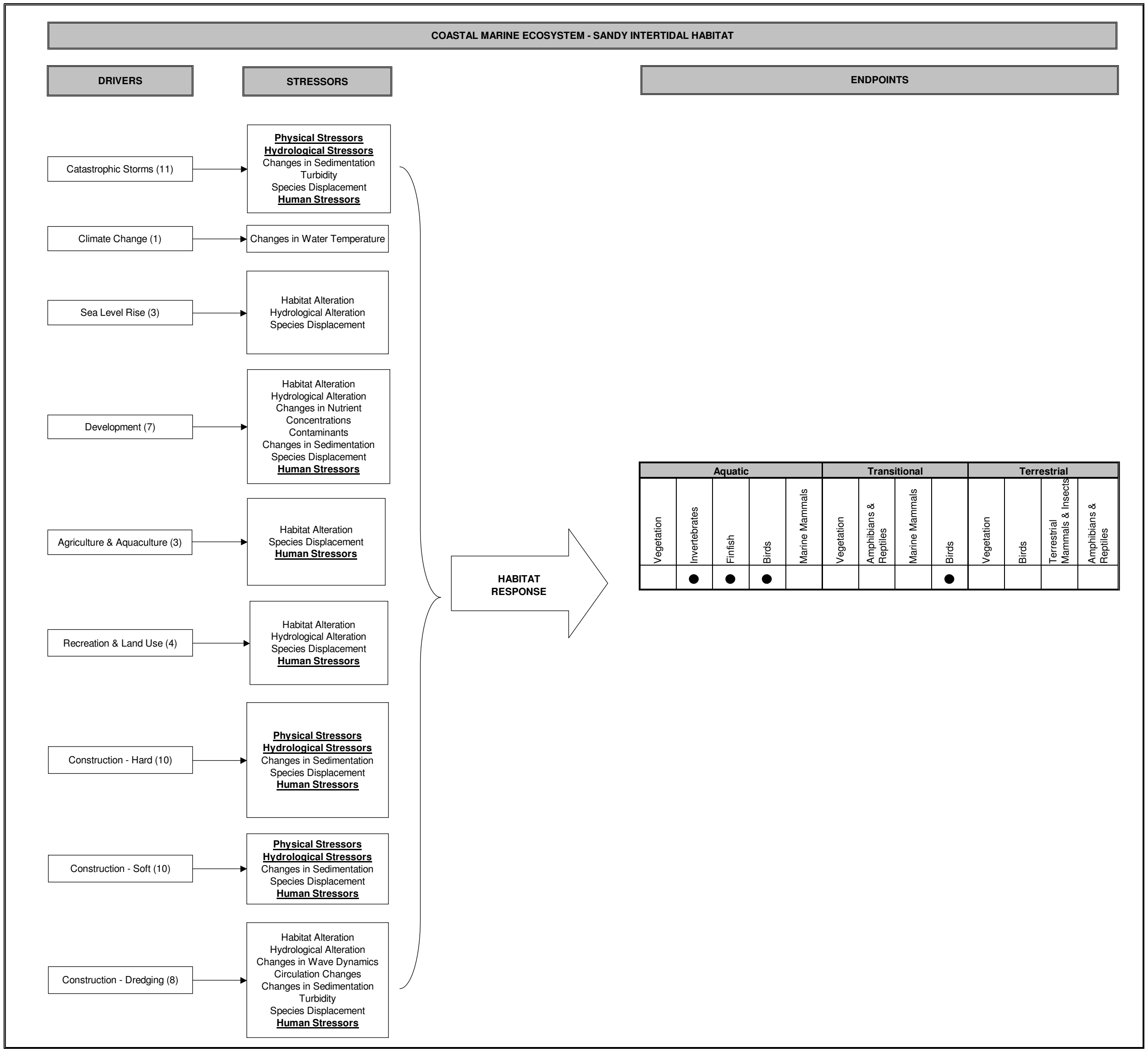
Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 6
Coastal Marine Ecosystem - Nearshore Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



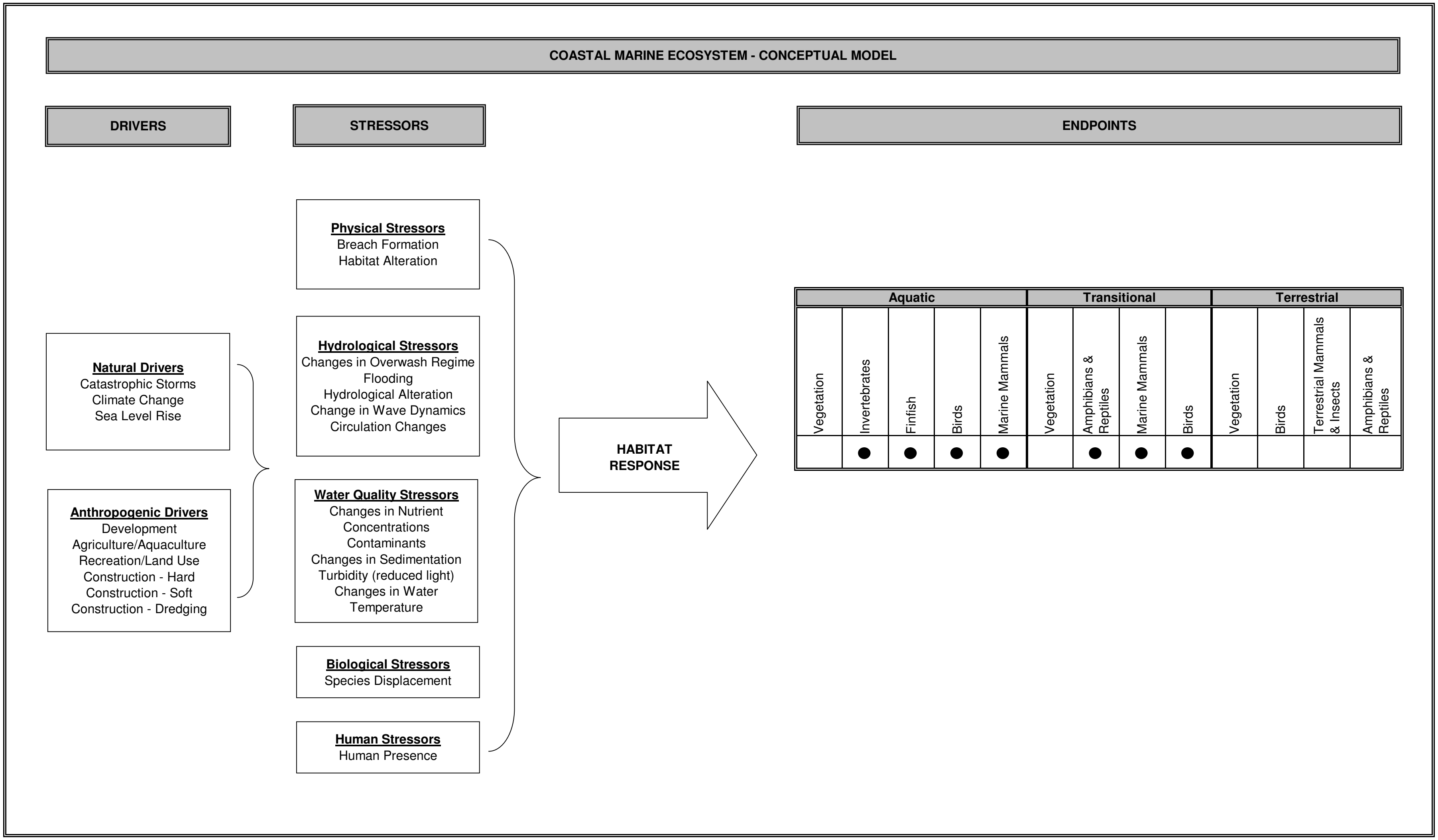
Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 7
Coastal Marine Ecosystem - Sandy Intertidal Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 8
Coastal Marine Ecosystem - Conceptual Model
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



Aquatic					Transitional				Terrestrial			
Vegetation	Invertebrates	Finfish	Birds	Marine Mammals	Vegetation	Amphibians & Reptiles	Marine Mammals	Birds	Vegetation	Birds	Terrestrial Mammals & Insects	Amphibians & Reptiles
	●	●	●	●		●	●	●				

6.2 OCEAN BEACH AND DUNE ECOSYSTEM

The Ocean Beach and Dune ecosystem includes habitats of Sandy Beach and Dunes and Swales. The real extent of this ecosystem extends from the MHW line on the ocean side to the landward extent of the primary dune and swale.

6.2.1 Sandy Beach

This habitat type extends from the MHW line, or upper bound of the Sandy Intertidal habitat, to the line of vegetation (boundary between the Sandy Beach and the toe of the Dune in areas with no vegetation) considered the lower limit of the Dune and Swale habitat, discussed below. The Sandy Beach habitat typically extends from MHW to the toe of the primary dune, and is composed of a sandy substrate. While these habitats are typically sparsely vegetated, they are an important nesting and/or resting area for some shorebirds.

Drivers and Stressors. Of the six drivers that may affect the Sandy Beach habitat, Construction-Hard (10) results in the most stressors with Catastrophic Storms (9) similarly important. Construction-Hard activities associated with human action and potential alternatives associated with the project have the greatest potential for impacts to the Sandy Beach habitat. Stressors associated with the Construction-Hard driver include all of the Physical and Hydrological stressors potentially associated with the project that were identified for the model, in addition to Changes in Sedimentation, Species Displacement, and Human Presence. Many of these stressors may occur in certain portions of the study area such as Moriches and Shinecock Bays, where Development and Human Presence is already extensive.

Catastrophic Storms can also result in substantial impacts to the Sandy Beach habitat through Physical and Hydrological Stressors, Changes in Sedimentation, and Species Displacement. All of these potential effects would occur in the absence of project implementation. An objective of the project is to minimize or eliminate these potential effects of storm damage.

The stressor Changes in Overwash Regime can also be important in altering the nature of the Sandy Beach habitat. Effects on birds can occur through loss of nesting habitat, but the process of overwash can also create new foraging areas. Overwash can create new ephemeral pools while destroying old ones. It can also destroy existing plant community habitat, and re-establish earlier stages.

Endpoints. All endpoints associated with the Sandy Beach habitat fall under the transitional and Terrestrial Endpoint groupings. Habitat responses can potentially impact Transitional Endpoints of Vegetation and Birds. Habitat responses such as reduction in the width of the Sandy Beach, could affect Terrestrial Endpoints of Terrestrial Mammals and Insects.

Specific endpoints that utilize the Sandy Beach habitat are listed in Table 5. While the Sandy Beach does not provide habitat space to the diversity of biota compared to other habitats within the study area, it does provide habitat for threatened and/or endangered birds such as the Least and Common Terns and Piping Plover, and vegetation such as the Sea Beach Amaranth. Potential impacts to Sandy Beach habitat would be of particular concern in areas where these endpoints occur.

6.2.2 Dunes and Swales

The Dunes and Swales habitat is located from the landward edge of the Sandy Beach, to the landward limit of the primary dune and swale. Freshwater ponds, wetlands, shrubby or forested vegetation communities may occur in between dunes and swales. Figure 10 is the conceptual model for the Dunes and Swales habitat.

Drivers and Stresssors. With the exception of the driver Construction-Dredging, the inclusion of the remaining eight drivers in the Dunes and Swales habitat model suggests that this area could be highly vulnerable to effects of project implementation. Anthropogenic drivers have the potential to result in the greatest impacts to this habitat. All three natural drivers are also present with or without project implementation.

Construction-Hard (12) and Construction-Soft (10) impacts have the potential to result in the largest number of stressors. Construction can be associated with physical changes caused by vehicular and pedestrian movement if permitted in this sensitive habitat. Construction impacts on the Dunes and Swales habitat can be managed through strategic planning and timing of operations and environmentally sound construction practices.

The remaining Anthropogenic Drivers selected for the Dunes and Swales model are Development, Agriculture/Aquaculture, and Recreation/Land Use. As with the Natural Drivers, potential stressors associated with these Anthropogenic Drivers will continue with or without the project.

The Dunes and Swales habitat has the greatest vulnerability to Habitat Alteration because of its physical sensitivity. This stressor was identified for each of the selected drivers. Habitat Alteration can result in impacts to both the human and natural environments. Changes to the dune structure can result in greater potential storm damage to properties, and also result in elimination of grasses that act to stabilize the dunes and provide habitat for biota.

Endpoints. All endpoints associated with the Dunes and Swales habitat are in either the Transitional or Terrestrial Endpoint groupings. Habitat responses have the potential to affect all Transitional Endpoints and the Terrestrial Endpoint of Vegetation. Direct mortality of plants mostly affects shallow-rooted annual plants like the Sea Beach Amaranth, found commonly near the seaward toe of a dune in this area. Habitat responses such as compaction, reduction in size or elimination of the dune can affect the remaining Terrestrial Endpoints of Birds, Mammals and Insects, and Amphibians and Reptiles.

Specific endpoints that utilize the Dunes and Swales habitat are listed in Table 5. The Dunes and Swales habitat is of particular ecological importance since it provides habitat for threatened and/or endangered birds such as the Piping Plover and Short-Eared Owl, and vegetation such as the Sea Beach Amaranth. Additionally, under the Amphibians and Reptiles category, the Diamondback Terrapin, although not a listed threatened or endangered species, has received notable local attention. Please note, while the terrapin was delisted in 2001, it is being retained on the conceptual model list of threatened and endangered species owing to its sensitivity and societal interest (6 NYCRR, Section 3.1). Potential impacts to Dune and Swale habitat would be of particular concern in areas where these endpoints occur.

6.2.3 Ocean Beach and Dune Ecosystem Model

For the purposes of the conceptual model the Ocean Beach and Dune Ecosystem refers only to the habitats of the Sandy Beach and Dunes and Swales, extending from the MHW line to the line of the primary dune and swale habitat.

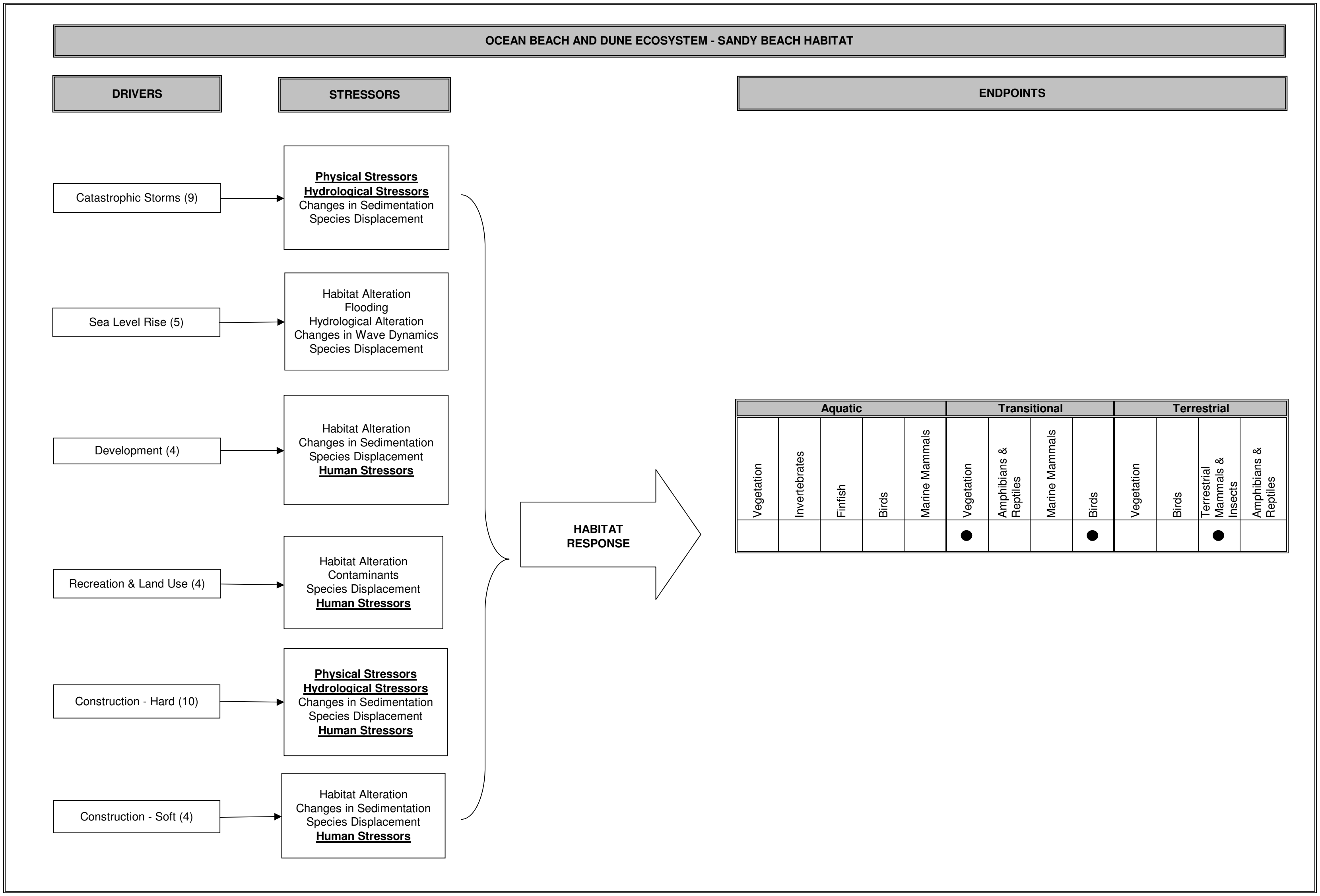
Compared to the Marine and Bay ecosystem models, the Ocean Beach and Dune Ecosystem model is fairly simple.

Critical drivers and stressors of the Ocean Beach and Dune Ecosystem are defined based on those identified in the Phase 1 model, and modified in Phase 2 as described in Section 4.0. The ecosystem model is presented in Figure 11 and includes and summarizes all of the drivers and stressors associated with the two habitats that are considered part of this ecosystem for the purposes of this investigation.

Critical drivers may include all of the natural phenomena such as Catastrophic Storms, Climate Change and associated Sea Level Rise, along with all Anthropogenic Drivers except Construction-Dredging. Construction Hard (12) and Soft (10) are responsible for the greatest number of stressors. Physical, Hydrological, Water Quality, Biological, Human, and Other Stressors are all relevant to this ecosystem.

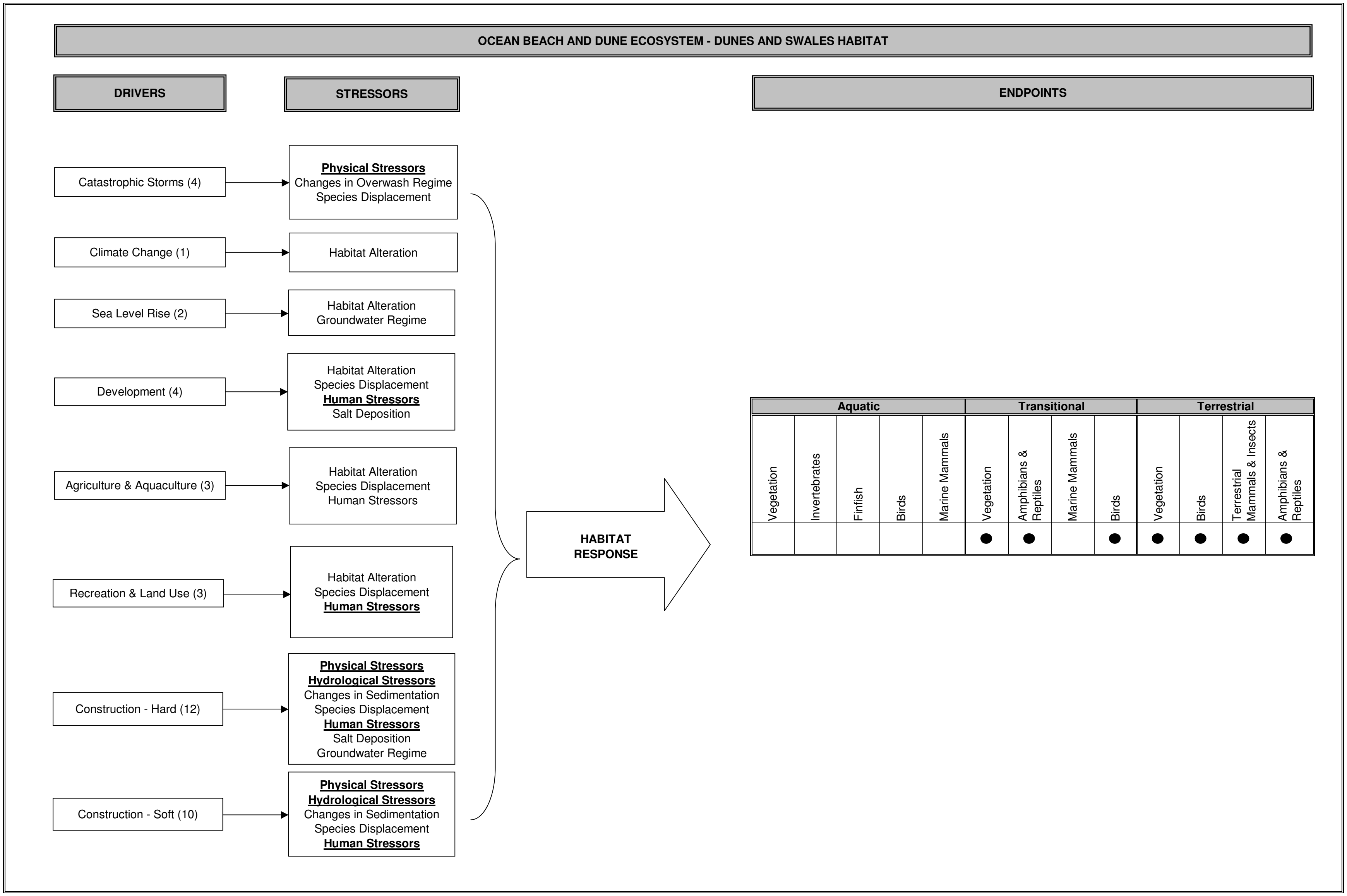
The Ocean Beach and Dune Ecosystem is critical to Vegetation, Amphibians and Reptiles, Birds, and Terrestrial Mammals and Insects organismal groupings. Of particular concern are potential impacts to endangered and threatened vegetation, birds, invertebrates and amphibians and reptiles that use the ecosystem for habitat for all of part of their lives.

Figure 9
Ocean Beach and Dune Ecosystem - Sandy Beach Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



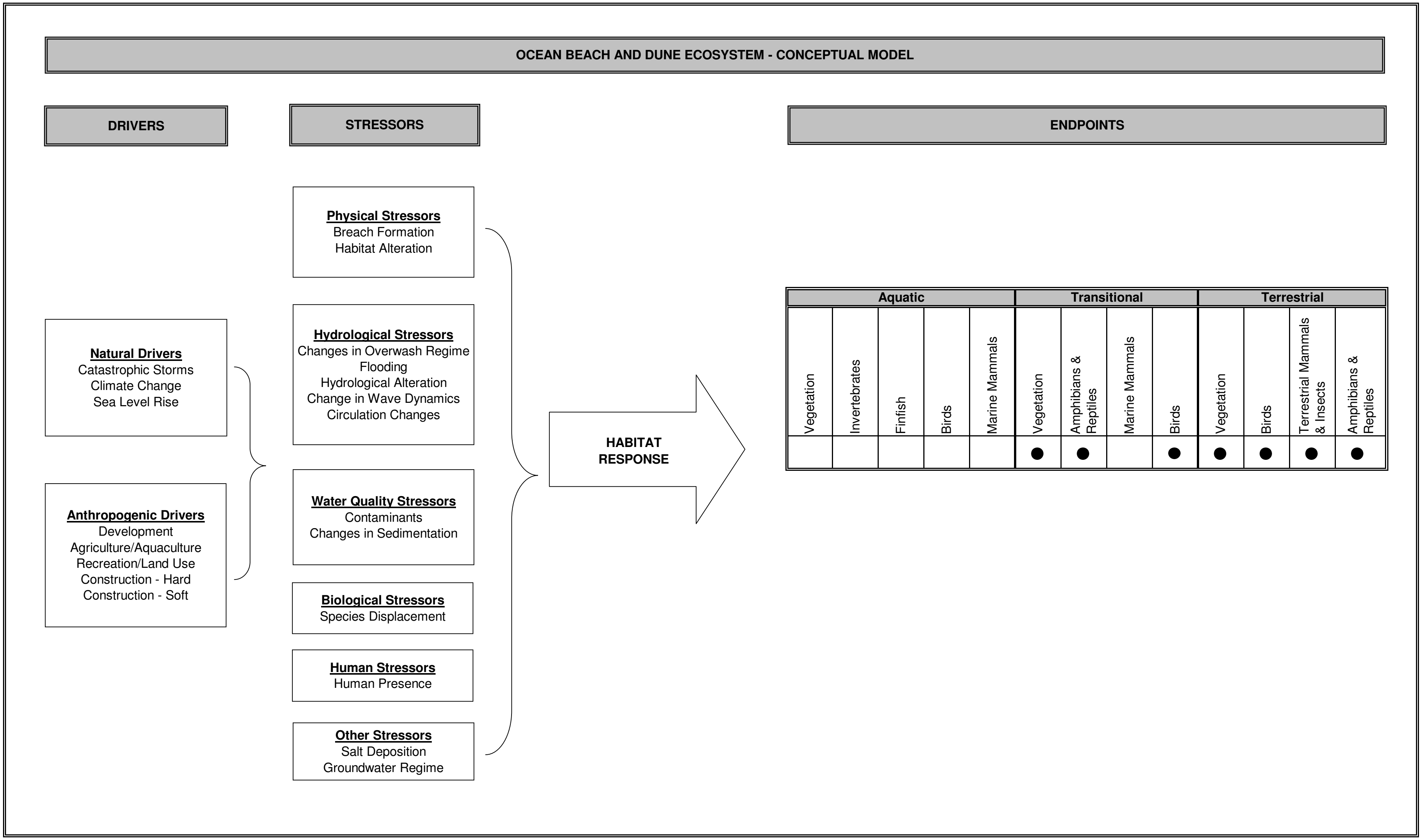
Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 10
Ocean Beach and Dune Ecosystem - Dunes and Swales Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



Note: Numbers in parentheses indicate the number of stressors associated with that driver.Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 11
Ocean Beach and Dune Ecosystem - Conceptual Model
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



6.3 BAY ECOSYSTEM

Habitats included within the Bay Ecosystem are Bay Intertidal, Sand Shoals and Mudflats, Salt Marsh, Bay Subtidal, Submerged Aquatic Vegetation Beds (SAV), and Inlets. The areal extent of this ecosystem extends from the Barrier Island Terrestrial Upland/MHW boundary, (or landward limit of high marsh vegetation on the bay side), to the Mainland Upland/Bay Intertidal boundary. The orientation of the Bay Ecosystem relative to other ecosystems and habitats is schematically shown in Figure 3. Habitats will be described in order beginning with the closest to the Barrier Island Upland, moving offshore into the bay. While the Bay habitats are discussed separately, given the close, complex relationships among all Bay habitats, changes in one habitat would most likely result in observable or measurable effects to endpoints within adjacent Bay habitats.

6.3.1 Bay Intertidal Habitat

The Bay Intertidal habitat extends from the Barrier Island Terrestrial Upland/MHW boundary, (or landward limit of high marsh vegetation), to MLW of the Bay (Figure3). The substrate is periodically exposed and flooded by semidiurnal tides (two high tides and two low tides per 24 hours). Tidal flushing results in alternating periods of inundation and dryness and fluctuating salinity making this area a naturally stressed habitat suitable only for biota that are adapted to these conditions. Figure 12 is the conceptual model for the Bay Intertidal habitat.

Drivers and Stresssors. The inclusion of all nine drivers in the Bay Intertidal habitat model suggests that this area is sensitive to potential stress. This habitat would be highly vulnerable to project-related impacts along with currently on-going drivers and associated stressors.

Catastrophic Storms are responsible for measurable impacts to the Bay Intertidal habitat that would occur with or without the project. Storms are responsible for 15 associated stressors, the maximum number for any habitat model. Catastrophic Storms can induce all of the stressors included in the Physical, Hydrological, Water Quality and Biological Stressors categories. The two remaining Natural Drivers of Climate Change and Sea Level Rise may also cause associated stressors due to the transitional nature of this habitat between barrier island upland areas and the bay.

Of the list of Anthropogenic Drivers; Development (9), Recreation and Land Use (7), and Construction-Hard (7) and Dredging (7) impacts result in the largest number of stressors. Human influence on this habitat is key and impacts Habitat Alteration, Hydrology, Nutrient and Contaminant Loading, Sedimentation, Turbidity, and the distribution and health of indigenous aquatic species and nonaquatic species that rely on this habitat for a portion of their life cycle. These Anthropogenic Drivers are currently influencing the study area and will continue with or without the project.

All stressors associated with Sand Shoals and Mudflats, Bare Sand and Salt Marsh habitats are included in the list of stressors for the Intertidal habitat because they are distributed partly or entirely in this habitat.

Endpoints. All endpoints associated with the Bay Intertidal habitat fall under the Aquatic or Transitional Endpoint groupings. Habitat responses to stressors have the potential to affect

Aquatic Vegetation, Invertebrates, Finfish, Marine Mammals, Birds and Transitional Birds, Vegetation, Amphibians and Reptiles endpoints.

Specific endpoints that utilize the Bay Intertidal habitat for all or a portion of their lives are presented in Table 5. Commercially and recreationally important aquatic Invertebrates and Finfish use this area; Invertebrates include the Horseshoe Crab, Blue Crab, Soft Shell Clam, and Blue and Ribbed Mussels. This habitat is essential to the Horseshoe Crab, since they are known to lay their eggs in the intertidal zone; especially in well-drained, sandy areas. Additionally, there are threatened and endangered species that forage in the area for eggs of the Horseshoe Crab and other food items. Threatened and endangered Piping Plover and Least Tern also use the Bay Intertidal habitat for foraging. Examples of commercially and recreationally important Finfish that utilize the Bay Intertidal habitat include Tautog, Weakfish, Bluefish, Black Sea Bass, Striped Bass, and Herring. The Diamondback Terrapin is a sensitive, socially important species that was de-listed in 2001 but also occurs in this habitat for portions of the year (6 NYCRR, Section 3.1). The Bay Intertidal habitat is traversed by Terrapins on their passage to lay eggs in the Dune habitats.

6.3.2 Sand Shoals and Mud Flats

The Sand Shoals and Mud Flats habitat is located within the intertidal zone and is periodically exposed at low tide. The specific habitat type, Sand Shoals or Mudflats, is defined by the substrate type (Figure 3). The configuration and distribution of Sand Shoals and Mudflats are greatly influenced by local hydrology and grain size deposition or sediment type (i.e., mud, clay or sand). Figure 13 is the conceptual model for the Sand Shoals and Mudflats habitat.

Drivers and Stressors. Any short or long term event that influences bay hydrology will affect Sand Shoals and Mudflats. Catastrophic Storms (8), Development (8), and Construction-Hard (7) result in the most stressors in the Sand Shoals and Mudflats habitat. While the driver Sea Level Rise (4) resulted in fewer stressors (Habitat Alteration, Flooding, Species Displacement, and Harmful Algal Blooms) these effects are likely to be of a larger scale and more permanent than stressors triggered by other more episodic drivers. In this habitat, stressors will have effects on the actual extent and distribution of Sand Shoals and Mudflats. These stressors will be manifested mainly as changes in the sediment dynamics of the bay, which may both reduce the extent of existing flats or increase areas suitable for sand habitat formation.

Since the biota that rely on this habitat are so dependent upon water depth and the nature of the substrate, any changes to the substrate or tidal range will influence associated endpoints. Changes in Sedimentation can also affect benthic invertebrates inhabiting Sand Shoals and Mudflats through burial and scouring, as well as birds and fish through displacement of prey items on which they feed.

The loss or impacts to Sand Shoals and Mudflat habitats represents a loss of both food and refuge for Diamondback Terrapins, Shore and Seabirds, benthic Invertebrates including commercial species such as Blue Mussels and Horseshoe Crabs, and Forage Fishes. Loss of Sand Shoals will also result in the loss of important nesting habitat for migratory and resident birds. Similarly, the loss of these shallow habitats may influence wave dissipation patterns that may ultimately affect other nearby habitats.

Human Presence can also have effects on this habitat with or without the project. Over exploitation can and does affect Fish and Mussel populations. Boating can cause localized effects such as sedimentation, wave activity and noise that will disrupt biota utilizing the habitat.

Endpoints. All endpoints associated with the Sand Shoals and Mudflats habitat fall under the Aquatic and Transitional Endpoint groupings. As discussed above, owing to the nature and sensitivity of the habitat to Physical and Hydrological Stressors habitat responses can impact any of the endpoints including aquatic Invertebrate, Finfish, and Bird, and Transitional Amphibian and Reptile and Bird endpoints.

Specific endpoints that utilize the Sand Shoals and Mudflats habitat are listed in Table 5.

This habitat provides space for endangered and threatened Piping Plover, Least and Common Terns and the Diamondback Terrapin. The Terrapin is of particular interest since they are uncommon and were only recently (2001) de-listed from the federal list of endangered and threatened species. Commercially important Invertebrates such as the Blue Mussel also utilize this habitat and could be impacted by loss or negative impacts to these areas.

6.3.3 Salt Marsh

The Salt Marsh habitat occurs from the landward limit of the high marsh vegetation, sometimes also MHW or slightly landward, to the seaward limit of the intertidal marsh vegetation, usually to the beginning of the sub-tidal Bay delineation (or –1’ MLW or slightly seaward predominantly on bay islands and on the bayside of barrier islands). Higher salt marshes are irregularly flooded by wind-driven or exceptionally high tides. In lower areas, salt marshes are regularly flooded with each tidal cycle. The habitat is characterized by a salt tolerant vegetation gradient from salt-tolerant shrubs (*Iva frutescens* and *Baccharis halimifolia*), to high marsh (*Spartina patens*, *Distichlis spicata*, and *Juncus gerardii*), to low marsh in the intertidal to below MLW (*Spartina alterniflora*). Figure 14 is the conceptual model for the Salt Marsh habitat.

The Salt Marsh habitat and associated vegetation provides a variety of services including:

- Sediment trap creating a substrate for invertebrates to colonize
- Niche for colonization of epiphytic plant and animal life
- Source of primary productivity and nutrients to the estuary
- Spawning and nursery areas for fish, and
- Foraging areas for fish and birds.

Drivers and Stresssors. Eight of the nine drivers are included in the Salt Marsh habitat model. In combination with on-going drivers and associated stressors, the inclusion of nearly all drivers indicates salt marshes would be highly vulnerable to effects of project implementation.

The Salt Marsh model has the greatest number of stressors (16) compared to any habitat modeled. Catastrophic Storms are an important catalyst in this habitat. Storms are responsible for impacts to this habitat that would occur with or without the project. In addition to storms, Sea Level Rise, Development, and Construction (Hard, Soft, and Dredging) are likely to result in the greatest potential impacts to the Salt Marsh habitat. Salt Marsh habitats are highly vulnerable to Habitat Alteration. As reflected in the model, nearly every driver has the potential to alter Salt Marsh habitat.

Catastrophic Storms can induce all of the stressors included in the Physical, Hydrological, Water Quality, and Biological Stressors categories. Additional Natural Drivers (Climate Change, Sea Level Rise) may also cause associated stressors. An increase in Sea Level could totally eliminate areas of Salt Marsh. The Anthropogenic Drivers of Development (8), and Construction-Hard (7) have the greatest number of associated stressors. These drivers have the greatest potential to impact this habitat with or without the project.

In general, any stressor that alters hydrology can have effects on the extent and distribution of Salt Marsh habitat. These stressors will be manifested mainly as changes in the sediment dynamics, which may both reduce the extent of existing marshes or increase areas suitable for marsh formation.

Endpoints. All endpoints associated with the Salt Marsh habitat fall under the Aquatic and Transitional Endpoint groupings. Habitat responses can impact any of the endpoints including Aquatic Vegetation, Invertebrate, Finfish, and Bird; and Transitional Vegetation and Bird endpoints.

Specific endpoints that utilize the Salt Marsh habitat are listed in Table 5. Commercially important Invertebrates such as the Blue and Ribbed Mussel, and fish such as the Tautog, Weakfish, Bluefish, Black Sea Bass, Striped Bass, and Herring also utilize this habitat for all or a portion of their lives and could be impacted by loss or negative impacts to Salt Marsh areas.

6.3.4 Bay Subtidal

The Bay Subtidal habitat extends from the MLW boundary of the Bay Intertidal habitat to the channel and deeper areas of the bay (Figure 3). Some of the bottom areas of the bay may be barren because of a lack of light, channel maintenance, or other factors. However, one of the most important features of the Bay Subtidal habitats is the growth of eelgrass or other SAVs that provide nursery areas for finfish, and a niche for colonization of epiphytic algae and invertebrates. SAV presence has been documented as existing throughout the Bay areas associated with the project. Owing to their sensitivity and importance to the ecosystem, SAV are addressed in a separate habitat model in Section 6.3.5. Figure 15 is the conceptual model for the Bay Subtidal habitat.

Drivers and Stresssors. Eight of the nine drivers for the FIMP study area have the potential to influence the Bay Subtidal habitat and are included in the habitat model.

Catastrophic Storms is the driver with the highest number of associated stressors (16). The other Natural Driver included in this model is Climate Change with associated stressors of Reduced Dissolved Oxygen and Water Temperature. All of the Physical and Hydrological Stressors are important to this habitat. Changes in hydrological features such as Overwash Regime, Flooding, Wave Dynamics, Hydrological Alteration, and Circulation can have effects on the Bay Subtidal habitat and the distribution of submerged habitats. These stressors are viewed as some of the most important to the Bay Subtidal habitat.

Of the list of Anthropogenic Drivers included in the model, Construction-Hard can result in the largest number of stressors (10). Associated stressors include all of the Physical, Hydrological and Human categories, along with Changes in Sedimentation, and Species Displacement. Of the Physical Stressors, the stressor Habitat Alteration can influence Bay endpoints mainly through changes in sedimentation and water circulation. Bulkheading is one example of Construction-

Hard in the Bay Subtidal system that can result in long term changes in hydrology and sedimentation. It can also add to cumulative potential effects on hydrological aspects of the Subtidal Bay habitat.

The driver Development (9) is also important with respect to Habitat Alteration, Hydrological Alteration, Changes in Nutrient Concentrations, Contaminants, Changes in Sedimentation, Turbidity, Biological Stressors, and Human Stressors. Owing to the configuration of the bay system, development of buildings, marinas and roads alter and affect runoff quality and quantity and hence, are a critical source of stress to the Bay Subtidal habitat.

The driver Agriculture/Aquaculture is particularly important in the Subtidal Bay due to the effects of clammers and other commercial harvest. All of these anthropogenically driven effects would occur with or without the project.

Changes in hydrology and sedimentation can have a major influence on biotic and abiotic components of the bay. Changes in water depth may influence navigation and could affect the configuration of habitats around the bay.

Endpoints. Endpoints associated with the Bay Subtidal habitat fall primarily under the Aquatic Endpoint groupings. Amphibian and Reptile Transitional endpoints are also relevant to the Bay Subtidal habitat owing to the presence of the Diamondback Terrapin. Aquatic Vegetation, Invertebrates, Finfish, and Birds can be impacted by habitat responses.

Table 5 includes a complete list of endpoints that use the Bay Subtidal habitat. Disturbance to eelgrass beds that occur in the Bay Subtidal habitat could affect fish and invertebrates that use these areas. Nutrient inputs to this habitat can result in increases in algal densities and result in less diversity and increased shading to the benthos. Algal blooms can also negatively affect SAV beds. The Subtidal Bay habitat can be particularly sensitive since it provides habitat to commercially important Hard Clams and Blue Crabs among other benthic Invertebrates. Changes in Sediment Dynamics from any Natural or Anthropogenic driver can bury or dislodge benthic Invertebrates. It also provides habitat to commercially important fish species such as the Winter Flounder and American Eel. Heavy sedimentation can affect fish directly by gill clogging, or indirectly from losses in food and refuge resources. Benthic feeding fish are especially vulnerable to loss of food resources as well as reduced foraging ability because of short term reduced visibility. As discussed above, the Diamondback Terrapin also uses the Bay Subtidal habitat.

The Bay Subtidal habitat also provides foraging area for commercially important Black Duck, and endangered and threatened birds including Common and Least Terns and the Black Skimmer. Other less sensitive birds such as Gulls, Cormorants, and Loons also use this area.

6.3.5 Submerged Aquatic Vegetation (SAV)

Areas of SAV occur in the Subtidal Bay habitat where dense communities of high value SAV such as widgeon grass (*Ruppia maritima)* or eelgrass (*Zostera marina*) become established and provide forage and habitat for other aquatic biota. Within the project area, the dominant SAV is eelgrass, with widgeon grass found in areas of less salinity. Some of the factors controlling the nature and distribution of SAV is availability of substrate, suitable depth, nutrient loading, water current, and availability of light. Light is one of the most limiting environmental factors affecting eelgrass distribution. Hence, any event that causes the bays to deepen greater than approximately 8', or reduce light penetration such as increased sedimentation, turbidity or nutrient flows, will negatively affect SAV distribution. Additionally, mainland stressors such as increased development, and point and nonpoint source pollution are also linked to impacts on SAV health.

As discussed above, SAV is one of the most important features of the Bay Subtidal habitats since it provides nursery areas for finfish and a niche for colonization of epiphytic algae and invertebrates. SAV was not captured as a discrete habitat model, but was combined with Bay Subtidal habitats in the Phase 1 model development. It is being listed as a separate habitat with a separate model in Phase 2 owing to its ecological sensitivity as habitat to unique communities of fish and benthos . Figure 16 is the conceptual model for the SAV habitat.

Drivers and Stresssors. Since SAV occurs within the boundaries of the Bay Subtidal habitat, the SAV model is similar in development to the Bay Subtidal model. Six of the nine drivers for the FIMP study area have the potential to influence the SAV habitat and are included in the habitat model. Catastrophic Storms (9), Development (7), Construction-Soft (5), and Construction-Dredging (5) are responsible for the most associated stressors.

As with the Bay Subtidal model, Catastrophic Storms is the driver with the highest number of associated stressors. The other Natural driver included in this model is Climate Change with the only associated stressor of Changes in Water Temperature. All of the Physical and Hydrological stressors are important to this habitat. As discussed above, changes in hydrological features can greatly affect the distribution of submerged habitats such as SAV. These stressors are viewed as some of the most important to the Bay Subtidal habitat and hence, SAV habitat.

Since the driver Development (7) can result in Habitat Alteration, Hydrological Alteration, Changes in Nutrient Concentrations, Contaminants, Changes in Sedimentation, Algal Blooms, and Human Stressors, it is a critical driver for the SAV habitat. Changes in water quality associated with Water Quality Stressors can affect Salinity, Nutrient and Contaminant Concentrations; all of which can influence the type and distribution of aquatic vegetation. Changes in Nutrient Concentrations can affect the plant communities. The main sources of dissolved nutrients are the barrier island upland tributaries which are influenced by development and discharge into the bay. High ecological value eelgrass beds can be affected by increases in epiphyte colonization and light reduction. Replacement of seagrasses by macroalgae may also take place under increased nutrient conditions. Macroalgae can also smother benthic invertebrates such as hard clams and out-compete phytoplankton for nutrients. This is one of the more sensitive habitats in the study area, where Harmful Algal Blooms brought on by impacts of Development can have measurable impacts. Changes in the abundance, distribution, and species composition of plant communities in response to Changes in Nutrient Concentrations can result in both negative and positive impacts to higher trophic levels.

Since the Hard Construction of bulkheading and other structures is typically spatially remote from the areas where SAV become established and NYS permitting requirements would greatly limit this, it is not a driver for SAV. Instead, Construction-Soft and Construction-Dredging are potentially more significant for this habitat model. Stressors common to both of these drivers are Habitat Alteration and Species Displacement.

Endpoints. Owing to the location of the SAV habitat in subtidal waters, all SAV endpoints are aquatic. Aquatic Vegetation, Invertebrates, Finfish, and Birds can all be impacted by habitat responses brought about by the stressors discussed above. Birds can be influenced by habitat responses since their primary use of SAV is forage. Any stressors that influence the the abundance and distribution of forage can have a potential effect on birds that use the SAV for forage.

Table 5 is a complete list of endpoints that use the SAV habitat. SAV beds provide a unique habitat for a diverse assemblage of invertebrates, including commercially important Blue and Ribbed Mussels and Blue Crabs. Epiphytic invertebrates in turn provide a food source for a variety of fish including commercially and recreationally important Tautog, Weakfish, Bluefish, Black Sea Bass, Striped Bass, Herring, Winter Flounder, and American Eel. SAV habitat also provides foraging area for commercially important Brant, and endangered and threatened Sea Turtles. Hence, disturbance to SAV habitat could affect Fish and Invertebrates, and Birds and Amphibians and Reptiles that use these areas. With the exception of invertebrates, since these organisms move among other habitats at different periods of their life cycle, effects to SAV can have broader range effects to other components of the ecosystem. This concept will be addressed in the alternative specific Phase 3 models.

6.3.6 Inlets

Inlets are areas of water interchange between the backbay and ocean zones. The tidal movement of water through these small gaps in the barrier island creates a zone of high water velocity. Inlet hydrodynamics will also impact sedimentation rates and movements, and distributions in the bays. These are unique habitats for many species, as well as being a transit zone between the bay and ocean for fish and other organisms. Figure 17 is the conceptual model for the SAV habitat.

Drivers and Stressors. While the Inlet habitat model includes the least number of drivers (4) that could potentially affect this habitat, the role of inlets in allowing passage and transport of surface water and associated biota makes potential impacts to this habitat particularly important.

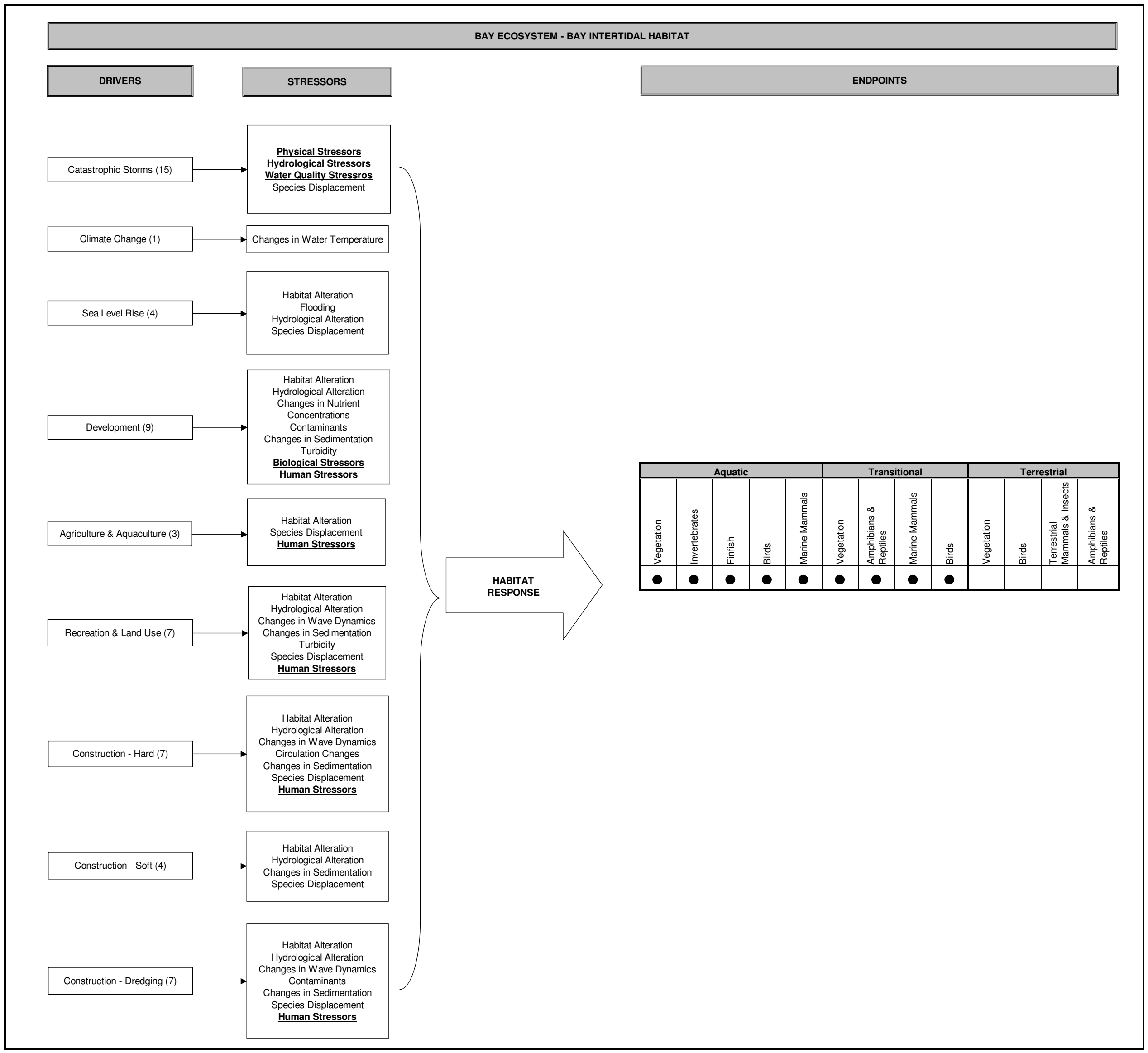
While the natural driver Catastrophic Storms can be important in influencing this habitat episodically, Anthropogenic Drivers can provide constant stress to the habitat. These drivers and their associated stressors would be present with or without the project.

The driver with the greatest number of associated stressors for this habitat is Construction-Dredging (9). The stressors Habitat Alteration and Circulation Changes, which could be associated with any of three drivers Catastrophic Storms, Construction-Hard, and Construction-Dredging, can be important in the Inlet model. The stressor Hydrological Alteration is also associated with the three drivers Catastrophic Storms, Construction-Hard, and Construction-Dredging, and can be important in this habitat model.

Habitat Alteration activities such as Dredging and Changes in Circulation that may alter sediment dynamics are important factors influencing inlet distribution. Inlets play an important role in water exchange between the bay and the ocean water, and their distribution will affect water chemistry and the hydrodynamics of the bay. Changes in Water Circulation will likely influence physical, chemical, and biological aspects of the bay, including temperature, water chemistry, transport, residence time, flushing frequency, mixing, tidal range and inundation levels, and delivery and uptake of nutrients and contaminants.

The driver Recreation and Land Use is also important in this habitat model, since it is associated with stressors that include over-exploitation and human activity such as boating and recreation.

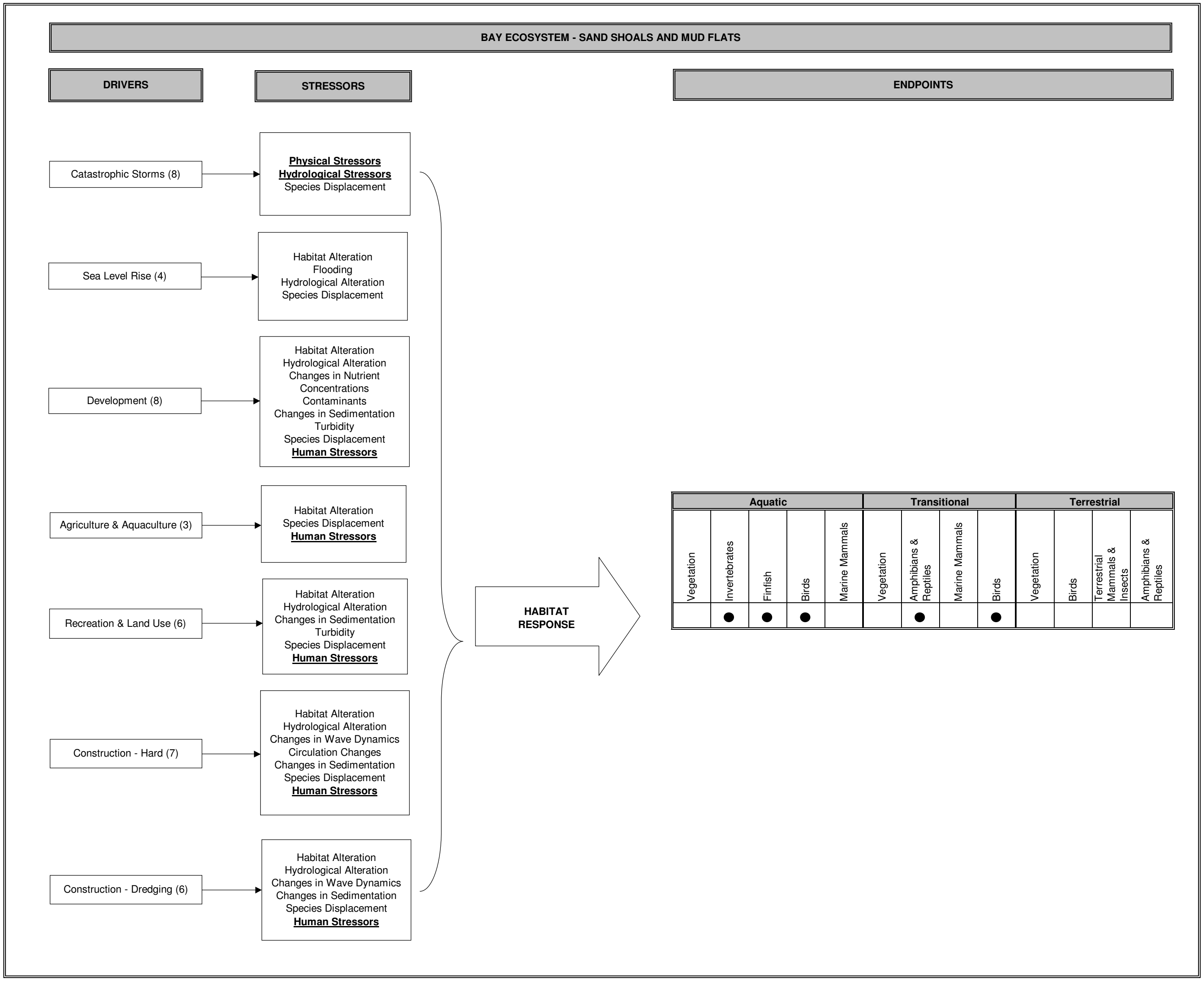
Figure 12
Bay Ecosystem - Bay Intertidal Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



Aquatic					Transitional				Terrestrial			
Vegetation	Invertebrates	Finfish	Birds	Marine Mammals	Vegetation	Amphibians & Reptiles	Marine Mammals	Birds	Vegetation	Birds	Terrestrial Mammals & Insects	Amphibians & Reptiles
●	●	●	●	●	●	●	●	●				

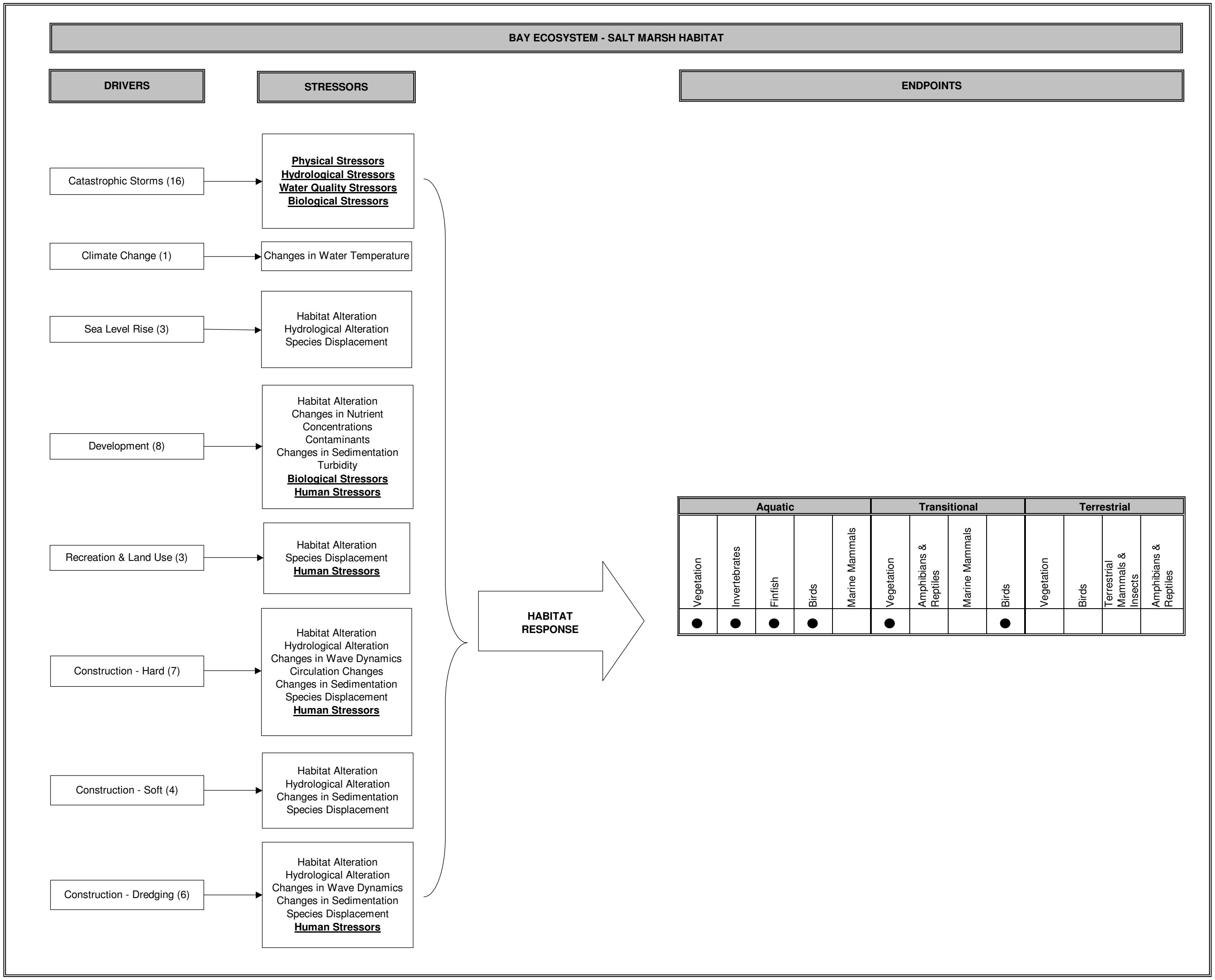
Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 13
Bay Ecosystem - Sand Shoals and Mud Flats
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



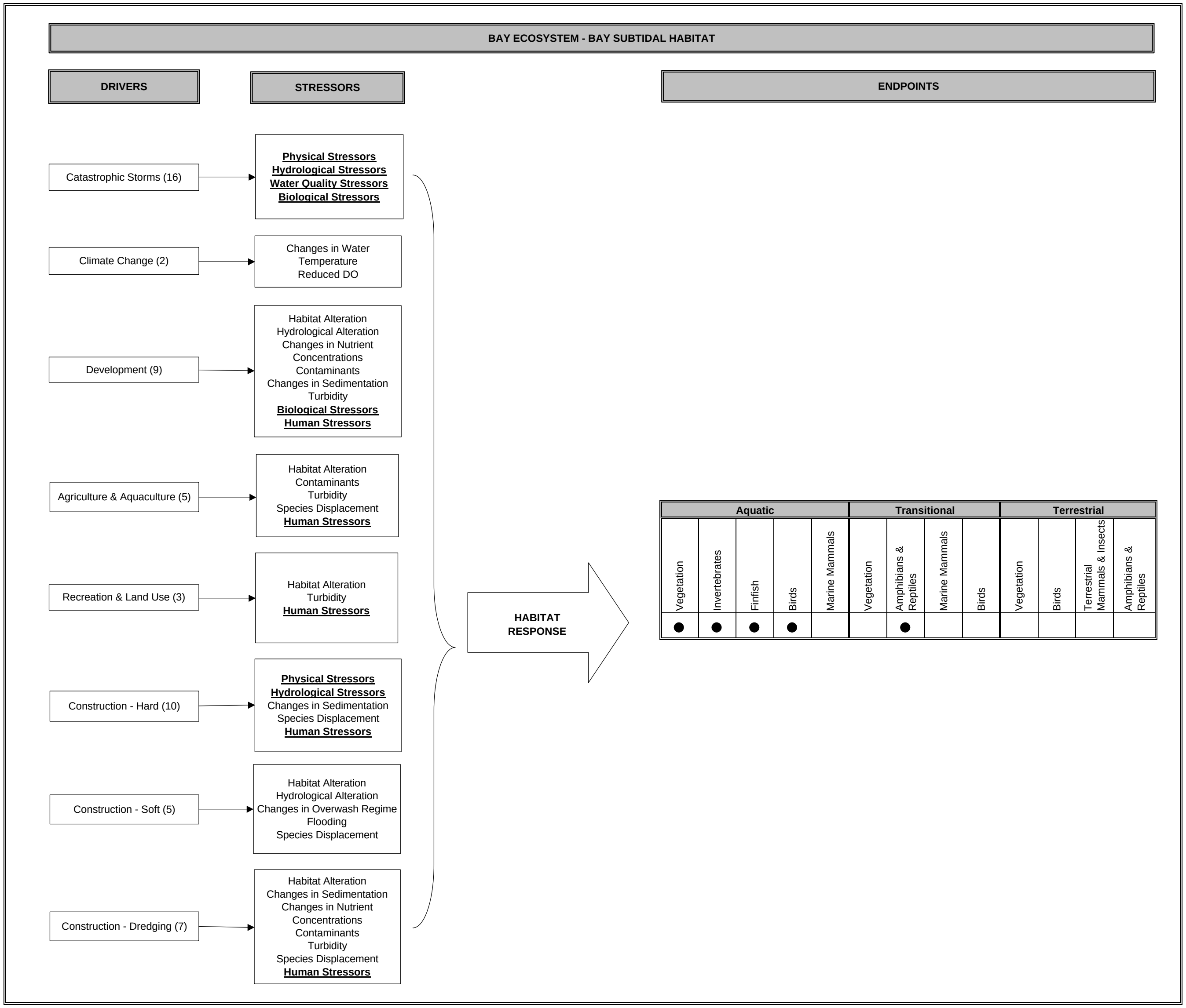
Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 14
Bay Ecosystem - Salt Marsh Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



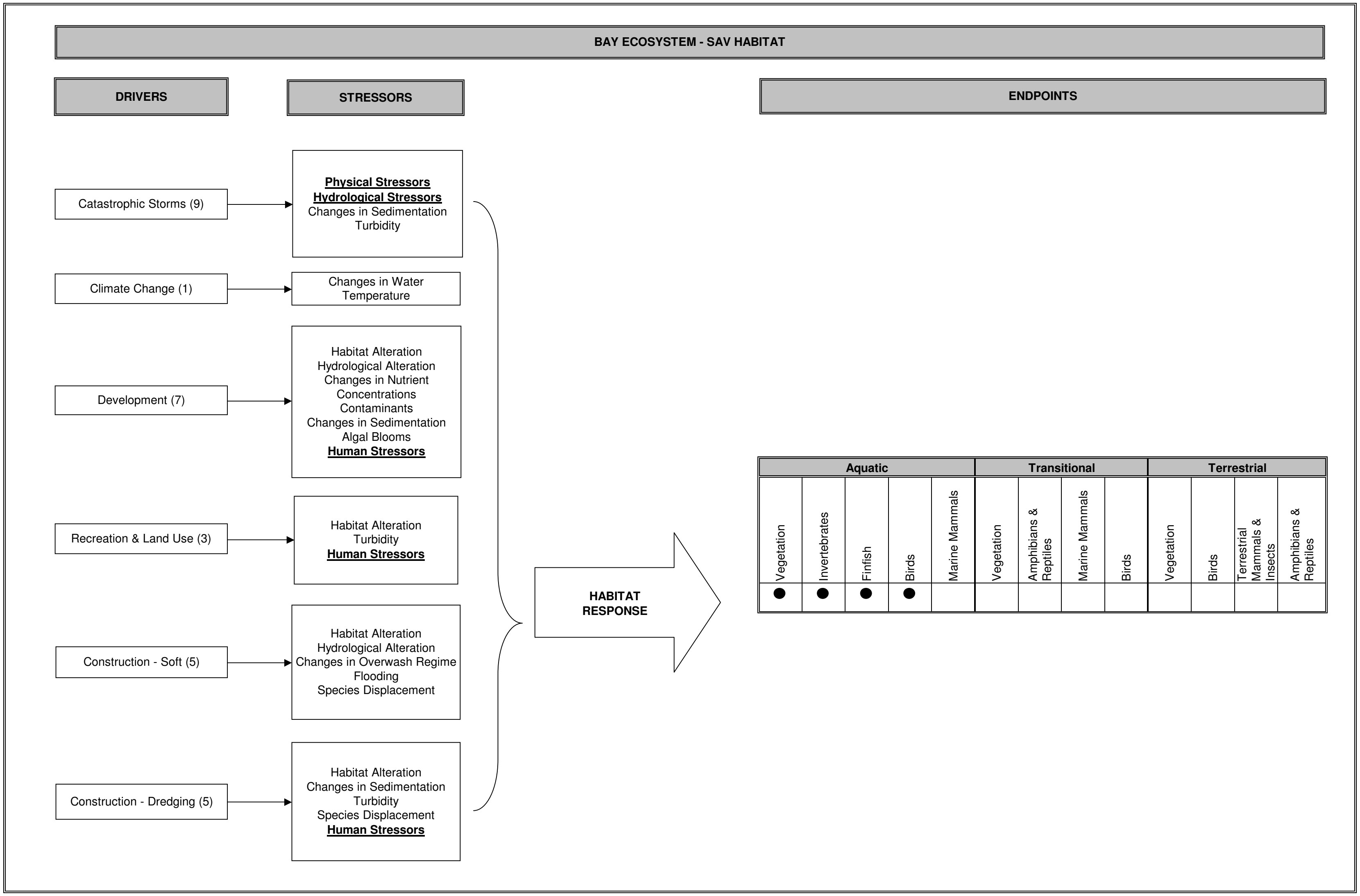
Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 15
Bay Ecosystem - Bay Subtidal Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



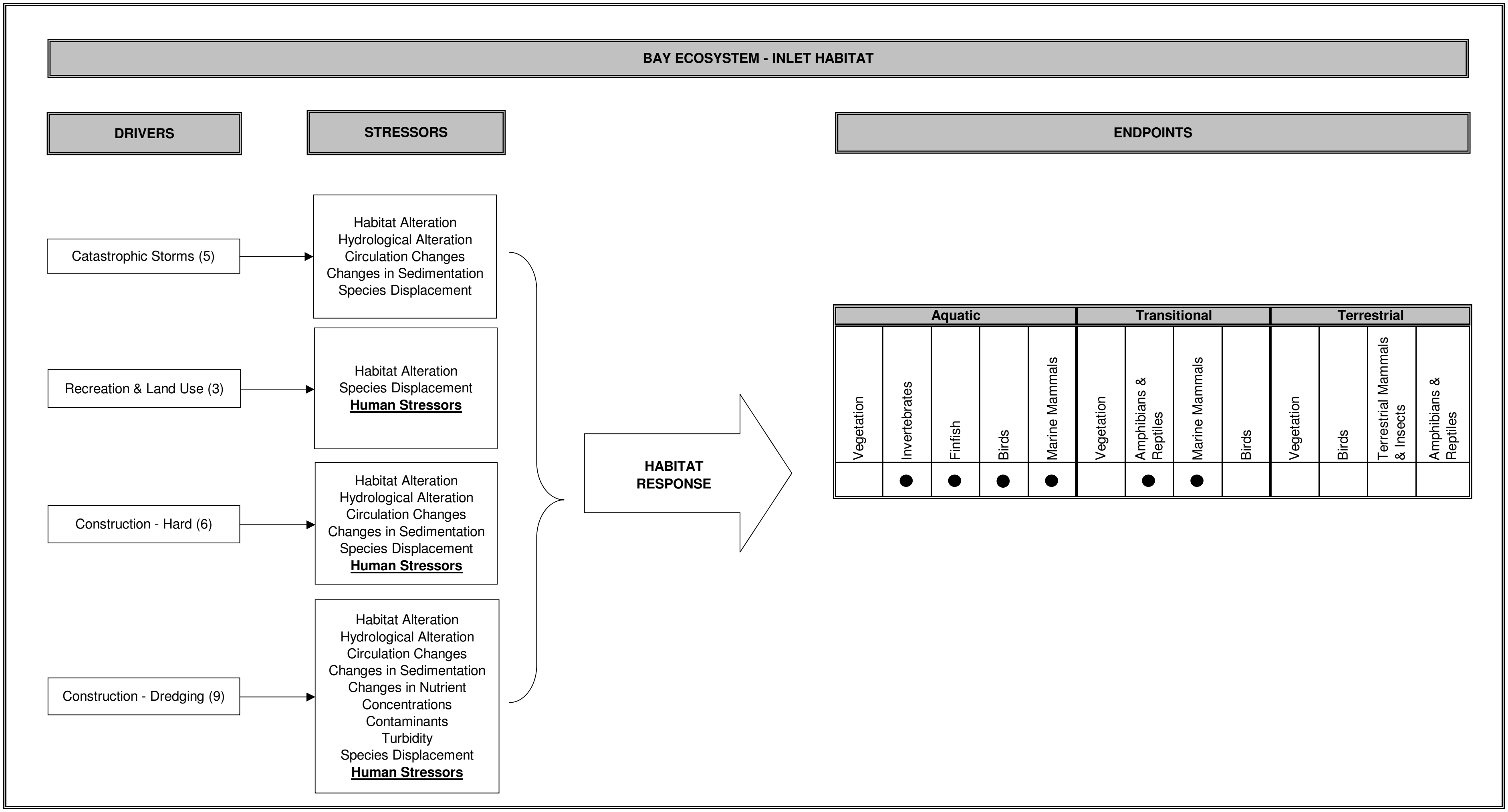
Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 16
Bay Ecosystem - SAV Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

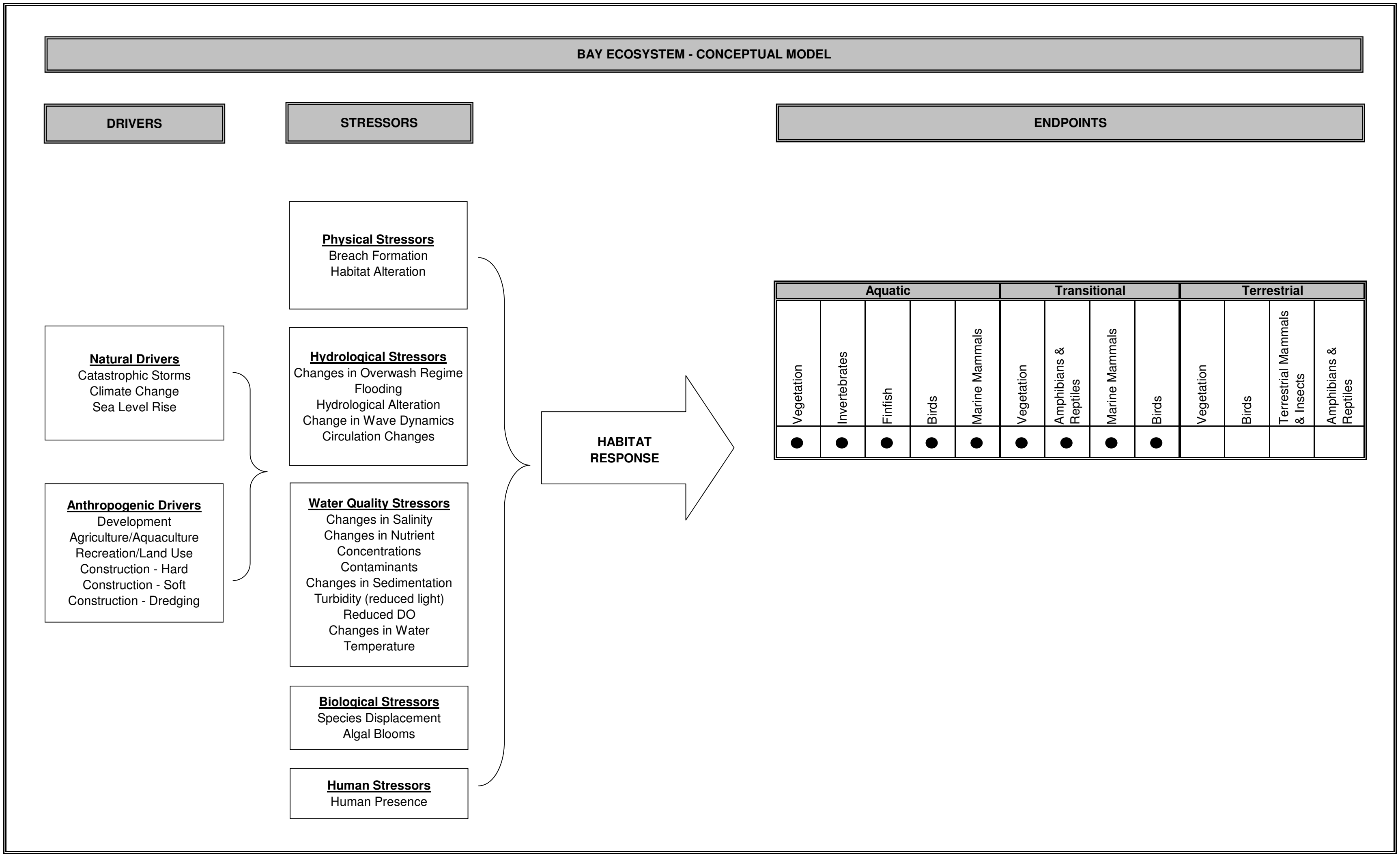
Figure 17
Bay Ecosystem - Inlet Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



Aquatic					Transitional				Terrestrial			
Vegetation	Invertebrates	Finfish	Birds	Marine Mammals	Vegetation	Amphibians & Reptiles	Marine Mammals	Birds	Vegetation	Birds	Terrestrial Mammals & Insects	Amphibians & Reptiles
	●	●	●	●		●	●					

Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 18
Bay Ecosystem - Conceptual Model
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



Over exploitation may affect fish and commercially important benthic invertebrates. Boating and recreational activities can cause localized sedimentation, contamination, wave activity and noise. As discussed above, all of these Anthropogenic Drivers would be present with or without the project.

Endpoints. With the exception of two Transitional Endpoints, endpoints associated with the Inlet habitat model fall primarily under the Aquatic grouping. Invertebrates, Finfish, Birds, and Marine Mammals can be impacted by habitat responses.

Table 5 is a complete list of endpoints that use the Inlet habitat. Most of the endpoints would be influenced by habitat responses likely associated with physical alteration of the habitat. Impacts from habitat responses would also likely be indirect as a result of alteration to the density and variety of species in the Inlet habitat.

A variety of benthic Invertebrates utilize the Inlet habitats including the commercially important Surf Clam, Softshell Clam, Blue and Ribbed Mussels, Ocean Quahog, Blue Crab, and Lobster. Changes in Sedimentation from any Natural or Anthropogenic Driver can bury or dislodge benthic Invertebrates. The Inlet habitat also provides services to commercially important fish species such as the Winter and Summer, Scup, Tautog, Butterfish, Bluefish, Herrings, Striped Bass, Weakfish, Black Sea Bass, and American Eel. Commercially important ducks including the Scaup and Black Duck use inlets for the variety of prey items available for forage. Other less sensitive, more common birds such as Gulls, Grebe, Cormorant, and Loon also use this area.

Amphibian and Reptile and Marine Mammals Transitional Endpoints are included in the Inlet habitat model since Inlets provide a conduit between the ocean and bays for the endangered and threatened Kemps-Ridley, Loggerhead and Hawksbill Sea Turtles.

6.3.7 Bay Ecosystem Model

Owing to the number and proximity of different habitats in this ecosystem, the Bay Model is one of the most complex under development for the FIMP study area. Critical drivers and stressors included in the Bay Ecosystem Model are based on those identified in the Phase 1 model, and modified in Phase 2 as described in Section 4.0. The ecosystem model is presented in Figure 18 and includes and summarizes all of the drivers and stressors associated with the six habitats that are part of this ecosystem.

All drivers considered for the FIMP study area apply to the Bay Ecosystem. Critical drivers may include natural phenomena such as Catastrophic Storms, Climate Change, and Sea Level Rise, along with Anthropogenic Drivers of Development, Agriculture/Aquaculture, Recreation/Land Use, and Construction (Hard, Soft, Dredging). Catastrophic Storms (16), Construction-Hard (10), and Development (9) are responsible for the greatest number of stressors. Physical, Hydrological, Water Quality, Biological, and Human Stressors are all relevant to this ecosystem.

The Bay Ecosystem is particularly critical to Aquatic Invertebrate, Finfish, Bird, Marine Mammal, and Amphibian and Reptile organismal groupings, but is also important to several transitional endpoints of vegetation, amphibians and reptiles, and birds. Of particular concern are potential impacts to endangered and threatened Birds, and Amphibians and Reptiles that use the ecosystem for habitat for all of part of their lives. Commercially and recreationally important Invertebrates and Finfish are also important in this ecosystem.

6.4 BARRIER ISLAND UPLAND ECOSYSTEM

The Barrier Island Upland Ecosystem refers to the upland portion of the barrier islands. It extends from the seaward side upland boundary of the primary dunes and swales, to the MHW boundary of the Bay Intertidal habitat on the bay side of the island (Figure3). While a variety of potential Barrier Island Upland habitats can be identified based on the characterization of the New York Natural Heritage Program (Reschke 1990), for the purposes of this study, Barrier Island Upland habitats are limited to Terrestrial Upland, Maritime Forest, and Bayside Beach. They are further limited to the barrier island portions of the study area; mainland upland areas (i.e., mainland, South Shore Long Island) will be handled separately, if necessary, in Phase 3 of the model.

Terrestrial Upland is the most typical upland habitat type on the barrier island and hence, it is the surrogate for all barrier island upland habitats with the exception of the Maritime Forest and Bayside Beach. Individual models were developed for the Maritime Forest and Bayside Beach because of their uniqueness and sensitivity. Instead of developing individual models for the remainder of all barrier island upland habitats that may not be relevant to the FIMP study area, the Barrier Island Upland Terrestrial model was developed. If necessary, additional habitat specific models will be developed if any ‘new’ unique or significant Barrier Island Upland habitats become apparent in Phase 3. For example, during Phase 1, and again as part of this Phase 2 investigation, it was decided that freshwater wetlands do not warrant a separate model since the extent of freshwater wetlands in proximity to project areas is not known. If it is determined during Phase 3 that a freshwater wetland falls within the boundaries of a portion of the project area, development of a separate freshwater wetland model will be considered at that time. The same will hold true for terrestrial tidal creeks, deltas, coastal ponds, and upland portions of dredge material disposal islands.

6.4.1 Terrestrial Upland

This habitat type falls within the boundaries of the Barrier Island Upland Ecosystem, and hence, as described above, extends from the seaward upland boundary of the primary dunes and swales, to the MHW boundary of the Bay Intertidal habitat on the bay side of the island (Figure 3). Figure 19 is the conceptual model for the Terrestrial Upland habitat.

Drivers and Stressors. Seven of the nine possible drivers for the FIMP study area are relevant to the Terrestrial Upland habitat. While both Natural and Anthropogenic Drivers are relevant to this habitat, the latter result in more stresssors that are on-going. The drivers Construction-Hard (12), Development (11), and Catastrophic Storms (10) are the drivers resulting in the most stressors. Construction-Hard includes the building of hard, permanent structures such as walls and other vertical structures in the upland. These features are currently in place and will stay in place with or without the project. The engineered or constructed environment is important in the Terrestrial Uplands compared to other habitats within the FIMP study area. Similarly, development of buildings, roads and other impervious surfaces decrease available, natural, habitat for upland biological communities. Additionally, these impervious surfaces are likely to cause an increase in runoff to adjacent habitats, such as the Intertidal Bay, resulting in potential contamination sources that alter and reduce the quality of habitat available to biota.

Habitat Alteration and Hydrological Alteration were found to be the dominant and most widespread stressors in Phase 1 of model development. In Phase 2 each of the relevant drivers selected for the model could result in Habitat Alteration, and five of the seven drivers could result in Hydrological Alteration.

Despite the potential influence of Anthropogenic Drivers, the natural driver Catastrophic Storms can also result in substantial impacts to the Barrier Island Upland Terrestrial habitat through Physical Stressors, Changes in Overwash Regime, Flooding, Hydrological Alteration, Changes in Salinity, Salt Deposition, Changes in Nutrient Concentrations, Changes in Sedimentation, and Species Displacement. All of these potential effects would occur in the absence of project implementation.

Endpoints. All endpoints associated with the Barrier Island Upland habitat fall under the Transitional and Terrestrial Endpoint groupings. Habitat responses can potentially impact Transitional Endpoints of Vegetation, Amphibians and Reptiles, and Birds; and Terrestrial Endpoints of Vegetation, Birds and Amphibians and Reptiles. Habitat responses, such as the elimination of habitat space through development could affect Terrestrial Endpoints of Terrestrial Mammals and Insects.

Specific endpoints that utilize the Terrestrial Upland habitat are listed in Table 5. There are no commercially or recreationally important endpoints noted for this habitat. In addition, while Vegetation endpoints listed are common, since much of the habitat is a result of the presence of vegetation communities, any negative impact to this endpoint may be important since it has the potential to alter or eliminate the habitat itself.

Several endangered and threatened Amphibians and Reptiles may use the Terrestrial Upland habitat including the Mud Turtle, Eastern Box Turtle, Spotted Turtle, and the Tiger Salamander. Endangered and threatened, and special concern bird species such as the Osprey and Hawks, may also use the Terrestrial Upland for habitat. Additionally, the Diamondback Terrapin is known to use this habitat. Since some of these endpoints also use other habitats of the study area, if these endpoints are negatively impacted, endpoints of other habitats may also be affected.

6.4.2 Bayside Beach

This habitat type is included within the Terrestrial Upland Ecosystem but is treated as a separate habitat for its unique role in species migration from Bay to Upland habitats. Additionally, this area is often seen as the “buffer” between the Upland zone and the Intertidal Bay. Within the FIMP project area much of the Bayside Beach has been eliminated due to bulkhead construction, immediate upland development and/or sedimentation pattern changes resulting in severe erosion such as occurs in the Sunken Forest. However, in areas where it does exist, it offers a unique escape from both aquatic and terrestrial lifestyles. The Bayside Beach extends from the landward limit of the MHW on the bay side to the seaward upland boundary of the upland as delineated by either vegetation, drastic slope change and/or structural barriers (Figure 3). Figure 20 is the conceptual model for the Bayside Beach habitat.

Drivers and Stressors. Eight of the nine possible drivers for the FIMP study area are relevant to the Bayside Beach habitat. The drivers Construction-Hard (10), Construction – Soft (9), Development (9), and Catastrophic Storms (9) result in the most stressors. As noted in discussions for the Terrestrial Upland, Construction-Hard includes the building of hard, permanent structures such as bulkheads and other vertical structures in the upland. These features are currently in place and will stay in place with or without the project.

Endpoints. All endpoints associated with the Bayside Beach habitat fall under the Aquatic, Transitional and Terrestrial Endpoint groupings. Habitat responses can potentially impact Aquatic Endpoints relating to Invertebrate species (especially benthic invertebrates and those associated with wrack communities), Transitional Endpoints of Amphibians and Reptiles and Birds; and Terrestrial Endpoints of Birds, Mammals, Insects and Amphibians and Reptiles.

Specific endpoints that utilize the Bayside Beach are listed in the "Terrestrial Upland habitat" section of Table 5. There are no commercially or recreationally important endpoints noted for this habitat. Several endangered and threatened birds may use the Bayside Beach habitat including the Piping Plover, Common Tern and Least Tern. Additionally, the Diamondback Terrapin is known to use this habitat to migrate from bay to upland dune habitats to lay eggs.

6.4.3 Maritime Forest

The Maritime Forest is a 40-acre, 200- to 300-year old *Ilex opaca* (American holly)-*Sassafras albidum* (white sassafras)-*Amelanchier canadensis* (shadbush) forest located in Sailors Haven, in the central portion of the Fire Island National Seashore section of the barrier island (Figure 1). The community heavily uses this area. It includes an environmental education center for the Park Service and is one of the most well known areas of the Fire Island National Seashore. Boardwalks traverse the area to facilitate public access. High surrounding sand dunes that protect the habitat create the illusion of being lower than sea level; hence it is referred to as the Sunken Forest.

The Maritime Forest represents one of the three maritime forests on the eastern seaboard. The presence of a secondary dune system has sheltered the trees and enabled the development of a unique upland forest habitat on the barrier islands. Trees near the top of the dune are stunted because of the high salt spray. Further down the dunes and in the middle of the forest, sheltered trees can grow to a more normal height.

Where groundwater discharges at the ground surface of the Maritime Forest, bogs and other freshwater wetlands, complete with sphagnum, ferns, mosses, cattails, rushes, and other wetland species develop. These wetland areas a maintained by a lens of fresh groundwater that floats on top of saltwater. This freshwater may extend as deep as 120 feet or more below sea level. In addition to the smaller bogs found throughout the Maritime Forest, one large *Phragmites*-dominated marsh is also present.

Since the Maritime Forest habitat was not addressed individually in Phase 1, this new habitat model was created in Phase 2. Figure 21 is the conceptual model for the Maritime Forest habitat.

Drivers and Stresssors. With the exception of the driver Construction-Dredging, the inclusion of the remaining eight drivers in the Maritime Forest habitat model suggests that this area could be highly vulnerable to effects of project implementation. Anthropogenic Drivers have the potential to result in the greatest impacts to this habitat. All three Natural Drivers are also present with or without project implementation.

Catastrophic Storms (11), Construction-Hard (10), Sea Level Rise (8) and Construction-Soft (6) impacts have the potential to result in the largest number of stressors. Any storm effects that could result in changes to hydrology could negatively impact the Maritime Forest owing to its sensitivity to the salinity regime. These changes could result in Habitat Alteration and resulting Species Displacement that would occur with or without the project. While Anthropogenic Drivers also result in numerous stressors, these are less likely to affect the habitat since there are currently regulations in place calling for the protection of the Maritime Forest and other unique and sensitive areas. Owing to the uniqueness and environmental sensitivity, the Maritime Forest habitat has the greatest vulnerability to Habitat Alteration. In fact, this stressor was identified for each of the eight drivers included in this habitat model.

Endpoints. The Maritime Forest habitat model has seven (7) endpoint groupings. Habitat responses have the potential to affect all Transitional and Terrestrial Endpoints.

Specific endpoints that utilize the Maritime Forest habitat are listed in Table 5. The Maritime Forest habitat is of particular ecological importance since it is a singularly unique habitat. In addition, it provides habitat for threatened and/or endangered Amphibians and Reptiles such as the Tiger Salamander, Mud Turtle, Eastern Box Turtle, Spotted Turtle, and Eastern Hognose Snake. While there are no other commercially or recreationally important or endangered and threatened species noted for the Maritime Forest, again it should be noted that in its uniqueness, the Maritime Forest is a highly sensitive 'endpoint' to be protected.

6.4.4 Barrier Island Upland Ecosystem Model

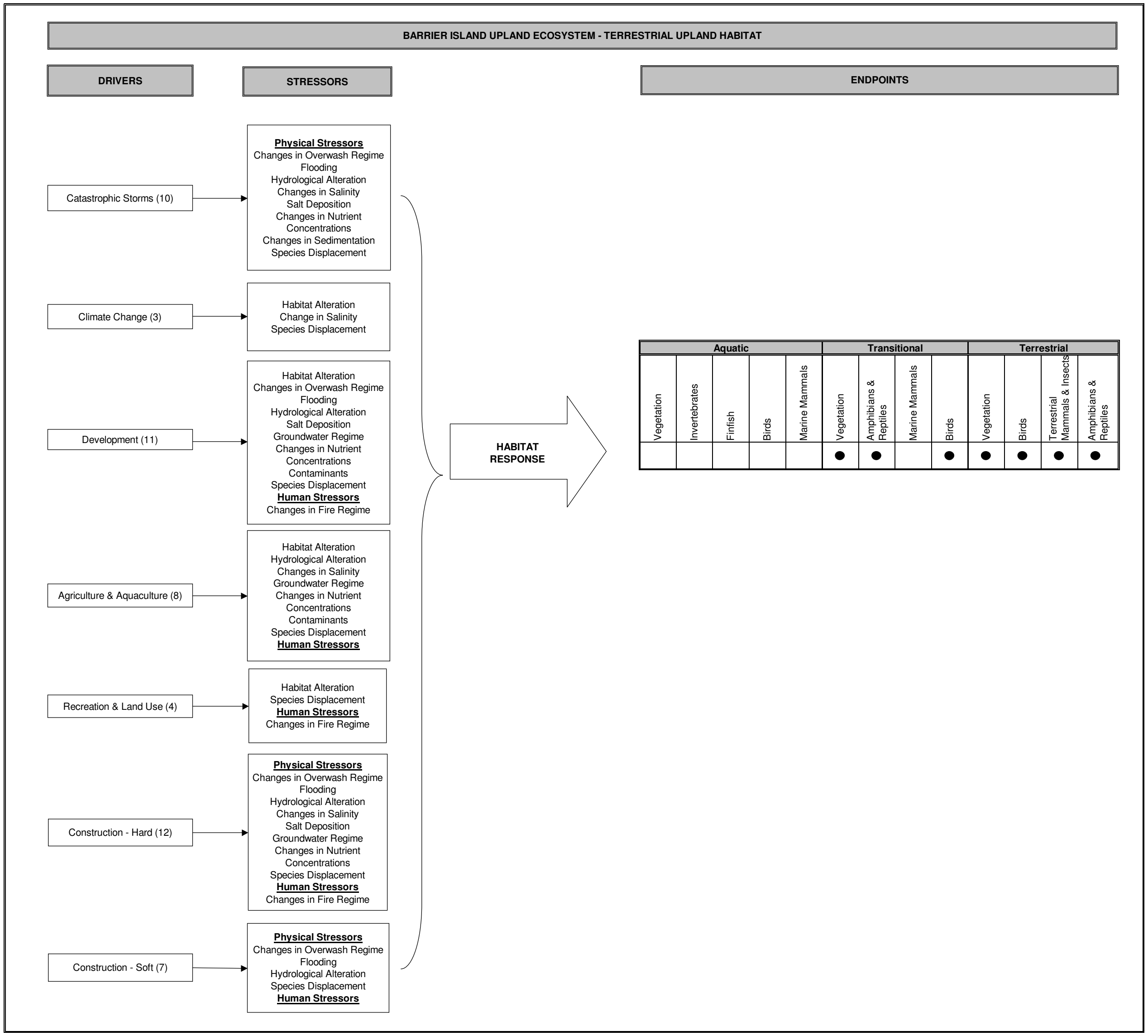
Critical drivers and stressors of the Barrier Island Upland Ecosystem are defined based on those identified in the Phase 1 model, and modified in Phase 2 as described in Section 4.0. The ecosystem model is presented in Figure 22 and includes and summarizes all of the drivers and stressors associated with the two habitats that are part of this ecosystem.

Critical drivers may include all of the natural phenomena such as Catastrophic Storms, Climate Change and associated Sea Level Rise, along with all Anthropogenic Drivers. The Drivers Construction-Hard, Catastrophic Storms, and Development are responsible for the greatest number of stressors. Physical, Hydrological, Water Quality, Biological, Human, and Other Stressors are all relevant to this ecosystem.

The Barrier Island Upland Ecosystem model has a great variety of endpoint categories (8), second only to Bay Intertidal, in the FIMP study area. The Barrier Island Upland Ecosystem provides critical habitat space for all three endpoint categories. Specific organismal groupings include Transitional Vegetation, Aquatic Invertebrates, Amphibians and Reptiles, and Birds; and Terrestrial Vegetation, Birds, Terrestrial Mammals and Insects, and Amphibians and Reptiles. Of particular concern are potential impacts to endangered and threatened birds, and amphibians and reptiles that use the Upland Terrestrial habitat for all of part of their lives, and the sensitivity of the Maritime Forest as a whole and the rapidly increasing loss of available Bayside Beach habitat.

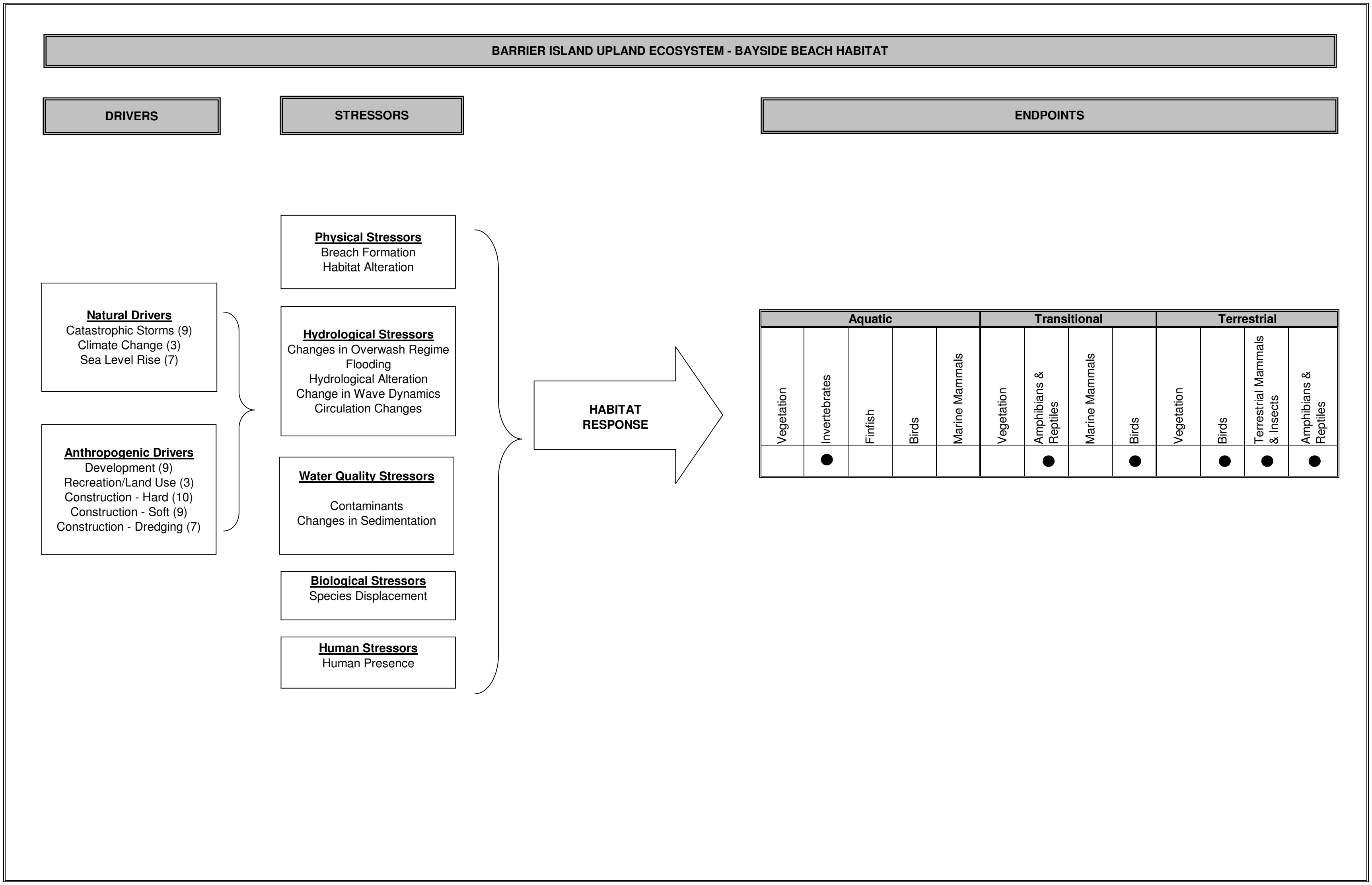
While no habitat models were developed in Phase 2 for terrestrial tidal creek and coastal ponds, freshwater wetlands, or dredge material disposal islands habitats that occur in the Barrier Island Upland Ecosystem, Table 5 includes endpoints for these habitats. If warranted, models for these habitats will be developed in Phase 3.

Figure 19
Barrier Island Upland Ecosystem - Terrestrial Upland Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



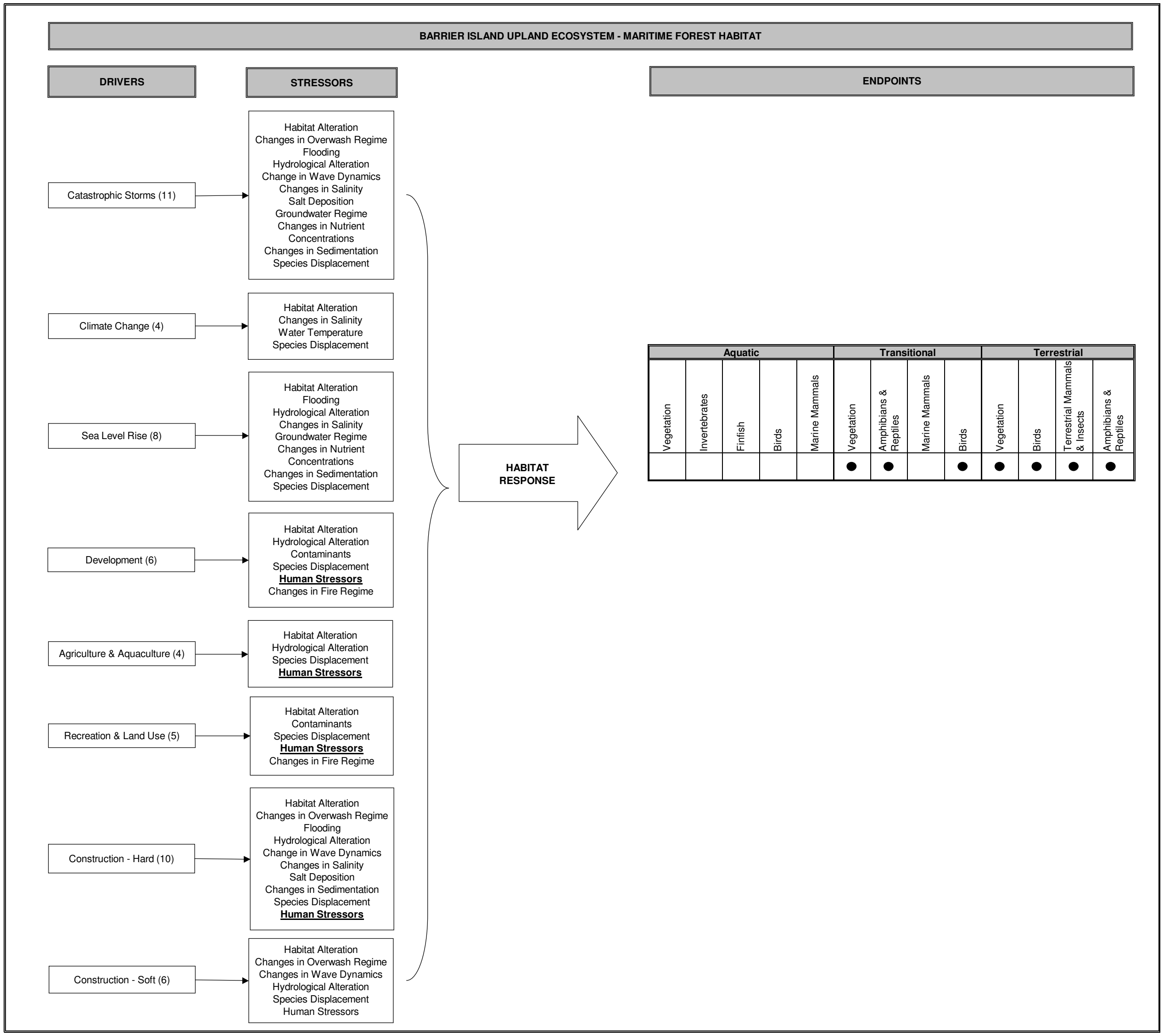
Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 20
Barrier Island Upland Ecosystem - Bayside Beach Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



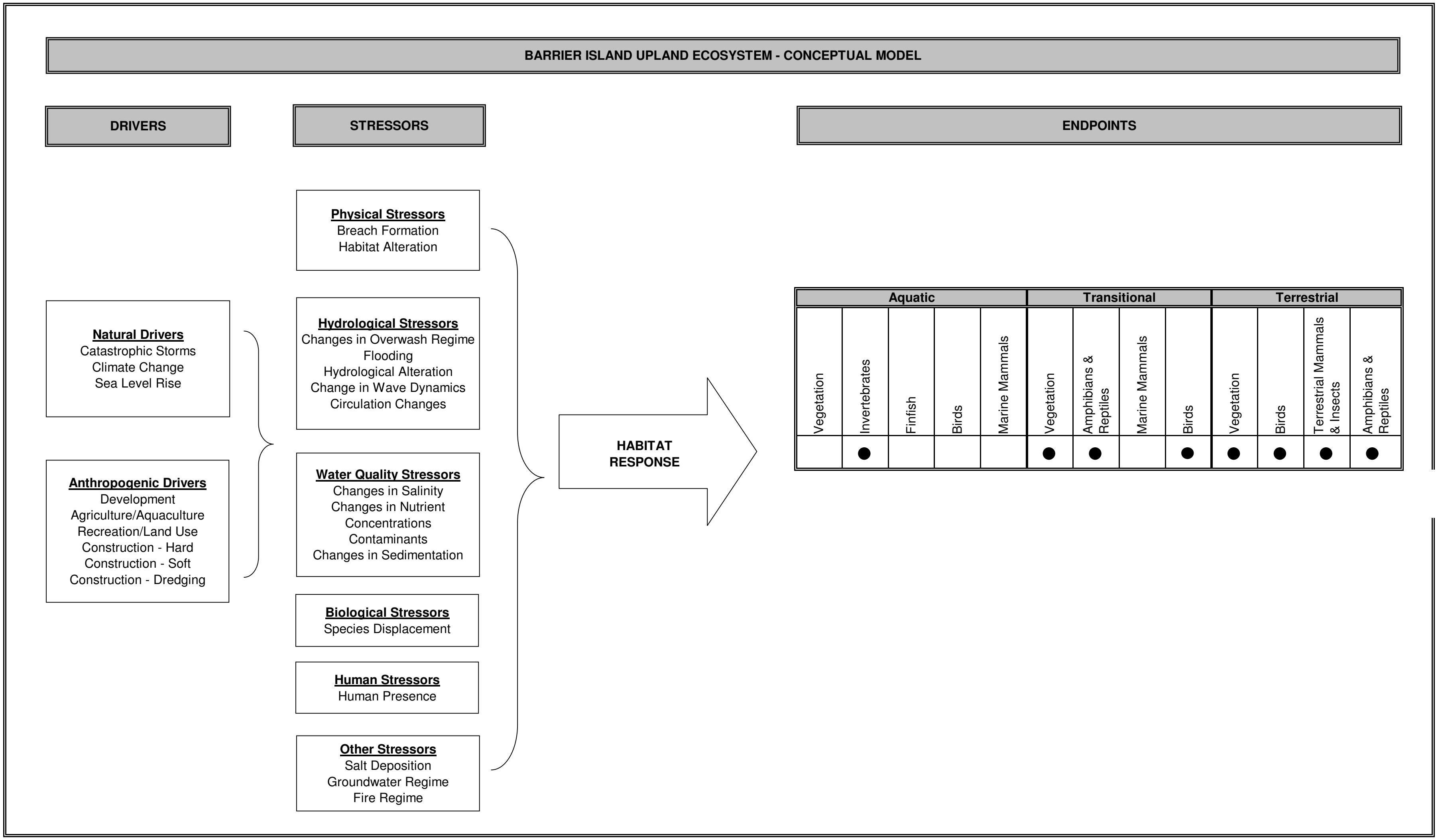
Aquatic					Transitional				Terrestrial			
Vegetation	Invertebrates	Finfish	Birds	Marine Mammals	Vegetation	Amphibians & Reptiles	Marine Mammals	Birds	Vegetation	Birds	Terrestrial Mammals & Insects	Amphibians & Reptiles
	●					●		●		●	●	●

Figure 21
Barrier Island Upland Ecosystem - Maritime Forest Habitat
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



Note: Numbers in parentheses indicate the number of stressors associated with that driver.
Stressors that appear in underlined bold indicate that all stressors in that category apply.

Figure 22
Barrier Island Upland Ecosystem - Conceptual Model
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



Aquatic					Transitional				Terrestrial			
Vegetation	Invertebrates	Finfish	Birds	Marine Mammals	Vegetation	Amphibians & Reptiles	Marine Mammals	Birds	Vegetation	Birds	Terrestrial Mammals & Insects	Amphibians & Reptiles
	●				●	●		●	●	●	●	●

The Phase 1 model development comprehensively and systematically identified all ecosystems, habitats, drivers, stressors and endpoints that could have any relevance to the FIMP study area and storm damage reduction project. This Phase 2 document refined and focused the Phase 1 work using a systematic review of all ecosystems, habitats, drivers, stressors and endpoints. The goal of Phase 2 model development was to refine a tool that could be more readily applied to the indigenous habitats and alternative management options being considered for the study area. Conceptual models for 14 habitats within four ecosystems of the FIMP study area have been developed for use as an assessment tool to delineate complete linkages or pathways between important drivers, stressors and endpoints that should be further investigated as part of the EIS for the storm damage reduction project. Each ecosystem, and each habitat and interrelated component endpoints within each habitat, are unique and potentially vulnerable to an ecosystem-specific set of drivers and stressors developed for each model. The potential for impacts to a specific ecosystem or habitat will be dependent upon the final selection of alternatives.

In Phase 3, specific alternatives (that are yet to be defined) for the five reaches of the FIMP study area will be modeled. Each Phase 3 model will be specific to the selected alternative or combination of alternatives, reach or subreach, and habitats involved to identify potentially important impacts that should be assessed in more detail in the EIS. The objectives of the Phase 3 or Final Conceptual Model are to:

- Identify relevant habitats for each reach specific alternative or combination of alternatives
- Consider development of additional habitat specific models if needed
- Compile reach/alternative specific models
- Delineate complete pathways or linkages that should be addressed in the EIS

In Phase 3, once the elements of each alternative are defined, the FIMP study area cover map will be consulted to delineate potentially involved habitats. Corresponding models for each habitat potentially affected by the alternative will be assessed concurrently so that landscape level impacts can also be considered. Once defined, alternatives will include storm damage reduction, no-action and restoration. Once the specific area is known, potential habitat responses and specific endpoints can be better evaluated.

In the developmental phases of the conceptual model, habitats were combined to facilitate model development. For example, freshwater wetlands that may occur in the Barrier Island Upland Ecosystem were lumped into the Upland Terrestrial habitat. Once reach specific alternatives are defined and relevant habitats listed, a determination will be made as to whether any additional habitat specific models will be developed. Models that might be considered based on their frequency of occurrence, uniqueness and sensitivity include habitats such as freshwater wetlands, tidal creeks, and coastal ponds.

Reach/alternative specific models will be developed for the following 13 transects that have been selected to be representative of the mosaic of habitats and land use types that currently occur throughout the FIMP study area. Note that these representative transects are subject to change if more suitable areas are identified in the course of the project:

- Democrat Point, Fire Island Inlet, Great South Bay;
- Ocean Beach, Great South Bay;
- Watch Hill, Great South Bay;

- Sunken Forest, Great South Bay;
- Wilderness Area, Great South Bay;
- Old Inlet Great South Bay;
- Pikes Breach, Moriches Bay;
- Moriches Inlet;
- Westhampton Groin Field, MorichesBay;
- Tiana Beach, Shinnecock Bay;
- West of Shinnecock Inlet;
- Georgica Pond; and
- Sagaponack.

The alternatives include storm damage reduction, no-action and restoration. This compilation of individual habitat models that may be involved in the implementation of an alternative will provide for the assessment of the relationships among species and habitats over a wider area. This step will also provide the opportunity to consider the significance of a stressor to a particular habitat and alternative. If endpoints utilize several habitats in a life cycle for different essential life stages, certain potential impacts may be realized both in the immediate habitat and in other habitats utilized by the endpoint.

In the identification of endpoints, the analysis will examine a range of species and choose representative or indicator species for the reach being modeled. Once the specific organismal grouping such as Vegetation, Invertebrate, or Finfish is indicated in a conceptual model for a specific habitat, the detailed list of endpoints provided in Table 5 will be consulted for identification of specific endpoints that would be involved in the conceptual model under the specific alternative being considered. Indicator species may be chosen from data collected as part of the extensive FIMP studies performed to date based on similarity in habitat requirements and behavior to its associated guild species. Indicator species may also include species of importance or relevance to a specific habitat zone.

The overall objective of the final model development is to identify relevant pathways or linkages that must be explored in the EIS for the project, including the rationale for inclusion or elimination of each potential pathway. In this way, the EIS will be a comprehensive, environmentally sound and technically defensible document that incorporates the interests of all stakeholders and addresses all potential positive and negative impacts of the FIMP storm damage reduction project on the 83-mile study area.

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Table 1
Stakeholder Input
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

STAKEHOLDERS	PHASE 1 INPUT	PHASE 2 INPUT
FEDERAL		
US Geological Survey	✓	✓
USACE New York District	✓	✓
NOAA-National Marine Fisheries Service	✓	✓
US Environmental Protection Agency	✓	✓
National Parks Service	✓	✓
STATE		
New York State Department of Environmental Conservation	✓	✓
New York State Department of State	✓	✓
UNIVERSITIES		
State University of New York, Stoney Brook		✓
Williams College Center for Environmental Studies	✓	
University of Miami	✓	
OTHER OFFICES		
Suffolk County Department of Health Services	✓	
The Nature Conservancy	✓	
Town of Brookhaven Division of Environmental Protection	✓	
USAERDC Environmental Laboratory	✓	
New York Sea Grant Program	✓	
CONSULTANTS		
URS Corporation	✓	✓
Moffatt & Nichol Engineers	✓	✓
Allee, King, Rosen & Fleming, Environmental Consultants	✓	✓
EEA, Inc.	✓	✓

Table 2
Habitat Summary
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

ECOSYSTEM/HABITAT	DEFINITION
Coastal Marine Ecosystem	
Marine Offshore	Subtidal marine habitat ranging in depth from 10 to 30 meters; includes pelagic and benthic zones
Marine Nearshore	MLW to depth of 10 meters; includes pelagic and benthic components
Sandy Intertidal	Extends from the boundary of the Marine Nearshore at MLW to MHW with a sandy substrate
Ocean Beach and Dune Ecosystem	
Sandy Beach	Extends from the MHW line on the ocean side to the boundary of the primary Dune and Swale habitat with the Terrestrial Upland; sandy substrate
Dunes and Swales	Primary dune through most landward primary swale system;
Bay Ecosystem	
Bay Intertidal	Extends from the Terrestrial Upland boundary with MHW, or landward limit of high marsh vegetation of the barrier island Terrestrial Upland habitat, to MLW. May include other habitats such as Salt Marsh, Shoals, and/or Mud Flat.
Sand Shoals, Bare Sand, Mud Flats	Found within the Intertidal zone and exposed at low tide; specific habitat type is defined by the substrate type
Salt Marsh	Bayside vegetation communities dominated and defined by salt-tolerant species; occurs from the landward limit of the high marsh vegetation, sometimes also AHW or slightly landward to the seaward limit of the intertidal marsh vegetation
Bay Subtidal	Bayside aquatic areas below the MLW
SAV	Bayside vegetation communities found within the subtidal zone
Inlets	Areas of water interchange between backbay and ocean zones (e.g., Fire Island Inlet, Moriches Inlet, and Shinnecock Inlet)
Barrier Island Upland Ecosystem	
Terrestrial Upland	Extends from the landward boundary of the primary dunes and swales on the ocean side, to the MHW boundary of the Bay Intertidal habitat on the bay side of the island contains all upland habitats excluding the maritime forest; scrub/shrub are also included in this habitat, along with bayside beach areas
Maritime Forest	Forested area on barrier island defined by salt tolerant vegetation, high salinity and salt spray adapted soils and vegetation assemblages such as trees, shrubs, and herbaceous species (i.e. Sunken Forest)
Bayside Beach	Area between MHW to seaward limit of vegetation or “upland” boundary

Table 3
Summary of Specific Habitat Drivers
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

	Coastal Marine	Coastal Marine Offshore	Coastal Marine Nearshore	Coastal Marine Sandy Intertidal	**Ocean Beach and Dune**	Sandy Beach	Dunes & Swales	**Bay**	Bay Intertidal	Sand Shoals & Mudflats	Salt Marsh	Bay Subtidal	SAV	Inlets	**Barrier Island Upland**	Terrestrial Upland	Maritime Forest	Bayside Beach
Natural Drivers																		
Catastrophic Storms		x	x	x		x	x		x	x	x	x	x	x		x	x	x
Climate Change			x	x			x		x		x	x	x			x	x	x
Sea Level Change			x	x		x	x		x	x	x						x	x
Anthropogenic Drivers																		
Development			x	x		x	x		x	x	x	x	x			x	x	x
Agriculture & Aquaculture		x	x	x			x		x	x		x				x	x	
Recreational & Land Use		x	x	x		x	x		x	x	x	x	x	x		x	x	x
Construction-Hard			x	x		x	x		x	x	x	x		x		x	x	x
Construction-Soft			x	x		x	x		x		x	x	x			x	x	x
Construction-Dredging		x	x	x					x	x	x	x	x	x				x

Table 4
Summary of Specific Habitat Stressors
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

	Coastal Marine	Coastal Marine Offshore	Coastal Marine Nearshore	Coastal Marine Sandy Intertidal	**Ocean Beach and Dune**	Sandy Beach	Dunes & Swales	**Bay**	Bay Intertidal	Sand Shoals & Mudflats	Salt Marsh	Bay Subtidal	SAV	Inlets	**Barrier Island Upland**	Terrestrial Upland	Maritime Forest	Bayside Beach
Physical Stressors																		
Breach Formation				x		x	x		x	x	x	x	x	x		x		x
Habitat Alteration		x	x	x		x	x		x	x	x	x	x	x		x	x	x
Hydrological Stressors																		
Changes in Overwash Regime				x		x	x		x	x	x	x	x			x	x	x
Flooding				x		x	x		x	x	x	x	x			x	x	x
Hydrological Alteration		x	x	x		x	x		x	x	x	x	x	x		x	x	x
Change in Wave Dynamics			x	x		x	x		x	x	x	x	x				x	x
Circulation Changes		x	x	x		x	x		x	x	x	x	x	x				x
Water Quality Stressors																		
Changes in Salinity									x		x	x				x	x	
Changes in Nutrient Concentrations			x	x		x			x	x	x	x	x	x		x	x	
Contaminants			x	x		x			x	x	x	x	x	x		x	x	x
Changes in Sedimentation		x	x	x		x	x		x	x	x	x	x	x		x	x	x
Turbidity		x	x	x					x	x	x	x	x	x				
Reduced Dissolved Oxygen									x		x	x						
Changes in Water Temperature			x	x					x		x	x	x				x	
Biological Stressors																		
Species Displacement		x	x	x		x	x		x	x	x	x	x	x		x	x	x
Algal Blooms									x		x	x	x					
Human Stressors																		
Human Presence		x	x	x		x	x		x	x	x	x	x	x		x	x	x
Other Stressors																		
Salt Deposition							x									x	x	
Groundwater Regime							x									x	x	
Changes in Fire Regime																x	x	

Table 5
Ecological Endpoint Summary
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

HABITAT	COASTAL MARINE ECOSYSTEM ENDPOINTS						
	Vegetation	Marine Invertebrates	Amphibians & Reptiles	Finfish	Birds	Marine Mammals	Terrestrial Mammals & Insects
Marine Offshore		**Benthic:** Polychaetes, Amphipods, Sand Dollar, Sea Star, *Yoldia* sp., Horseshoe Crabs **Epibenthic:** Shrimp **Pelagic:** Jellyfish, Phytoplankton, Zooplankton **Commercial & Recreational:** Clams, Lobster, Squid, Surf Clam, Scallop, Ocean Quahog, Crabs	**Sea Turtles:** Kemps-Ridley, Hawksbill, Loggerhead, Green, Leatherback	Skates **Commerical & Recreational:** **Pelagic:** Hake, Scup, Bluefish, Butterfish, Striped Bass, Herring **Benthic:** Sandlance, Winter, Summer and Windowpane Flounders		**Mammals:** Atlantic Right & Pygmy-Sperm Whales	
Marine Nearshore		**Benthic:** Polychaetes, Amphipods, Sea Stars, *Yoldia* sp. **Epibenthic:** Shrimp **Pelagic:** Jellyfish, Phytoplankton, Zooplankton **Commercial & Recreational:** Clams, Lobster, Squid, Surf Clam, Ocean Quahog	**Sea Turtles:** Kemps-Ridley Hawksbill, Loggerhead	**Commercial & Recreational:** **Benthic:** Winter and Summer Flounders **Pelagic:** Silversides, Anchovies, Bluefish, Striped Bass	**Piscivorous:** Cormorant, Osprey, Common & Least Terns, Roseate Terns, Mergansers, **Other:** Loons **Commercial & Recreational:** Sea Ducks	**Seals:** Harbor, Gray	
Marine Sandy Intertidal		**Benthic:** Polychaete (*Scolelepis),* Bivalve (*Donax),* Mole Crab		Silversides, Kingfish, Bluefish	**Shorebirds:** Sandpipers, Piping Plover, Gulls **SeaBirds:** Osprey, Common & Least Terns		

Table 5
Ecological Endpoint Summary
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

HABITAT	OCEAN BEACH AND DUNE ECOSYSTEM ENDPOINTS						
	Vegetation	**Marine Invertebrates**	**Amphibians & Reptiles**	**Finfish**	**Birds**	**Marine Mammals**	**Terrestrial Mammals & Insects**
Sandy Beach	Sea Beach Amaranth, Annuals, Sea Beach Knotweed				Least & Common Terns, Piping Plover, Shorebirds, Snowy Owls		**Mammals:** Red Fox **Insects:** Northeast Tiger Beetle
Dunes & Swales	Beach Grass, Shrubs, Panic Grass, *Salicornia,* Sea Beach Amaranth, Herbaceous Perennials		Frogs, Diamondback Terrapin		Piping Plover, Residents (Horned Lark, Snow Bunting), Owls (Snowy, Short-eared)		**Mammals:** Deer, Red Fox, Raccoon **Insects:** Ticks, Northeast Tiger Beetle

Table 5
Ecological Endpoint Summary
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

HABITAT	BAY ECOSYSTEM ENDPOINTS						
	Vegetation	**Marine Invertebrates**	**Amphibians & Reptiles**	**Finfish**	**Birds**	**Marine Mammals**	**Terrestrial Mammals & Insects**
Bay Intertidal	Macroalgae, Intertidal & High Marsh Species, *Phragmites*	Horseshoe Crab, Barnacle, Eastern Mudsnail, Say Mud Crab, Hermit Crabs, Green Crab, Other Crabs Amphipods, Isopods, Sea Star, Phytoplankton, Zooplankton **Commercial & Recreational:** Blue & Ribbed Mussels, Blue Crab, Softshell Clam	Diamondback Terrapin	**Forage/Bait:** Silversides, Killifish, Cunner **Commercial & Recreational:** Tautog, Weakfish, Bluefish, Black Sea Bass, Striped Bass, Herrings	Piping Plover, Least Tern, Shorebirds, Wading & Migratory spp., Cormorant, Gulls, Sparrow (Sharp-tail and Sea-side), Oystercatcher	Harbor Seal	Mosquitoes
Bay Subtidal	**Macroalgae:** *Cladophora, Ulva,* Phytoplankton (brown tide) **SAV:** Eelgrass, Widgeon Grass	Say Mud Crab, Green Crab, Other Crabs, Comb Jelly, Sea Star, Polychaetes, Jellyfish, Shrimp, Phytoplankton, Zooplankton **Commercial & Recreational:** Hard Clam, Blue Crab, Scallop	Diamondback Terrapin	**Forage/Bait:** Cunner, Killifish, Silversides, Northern Puffer, Pipefish Sticklebacks **Commercial & Recreational:** Winter Flounder, American Eel	Gulls, Common & Least Terns, Cormorant, Loons, Black Skimmer **Commercial & Recreational:** Black Duck		

Table 5
Ecological Endpoint Summary
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

HABITAT	BAY ECOSYSTEM ENDPOINTS						
	Vegetation	**Marine Invertebrates**	**Amphibians & Reptiles**	**Finfish**	**Birds**	**Marine Mammals**	**Terrestrial Mammals & Insects**
Sand Shoals, Bare Sand & Mud Flats	Cyanobacteria	Horseshoe Crab, Fiddler Crabs **Commercial & Recreational:** Blue Mussel	Diamondback Terrapin	**Forage/Bait:** Killifish	Shorebirds, Egrets, Herons, Seabirds, Oystercatcher, Migratory & Resident Species, Piping Plover, Least & Common Terns		
Salt Marshes	Intertidal & High Marsh Species, *Salicornia, Phragmites*	Horseshoe Crab, Barnacle, Eastern Mudsnail, Say Mud Crab, Blue Crab, Hermit Crabs, Other Crabs Amphipods, Isopods **Commercial & Recreational:** Blue & Ribbed Mussels		**Forage/Bait:** Silversides, Killifish, Cunner **Commercial & Recreational:** Tautog, Weakfish, Bluefish, Black Sea Bass, Striped Bass, Herrings	Osprey, Egrets, Herons, Sparrow (Sharp-Tail and Sea-side), Oystercatcher, Rails		

Table 5
Ecological Endpoint Summary
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

HABITAT	BAY ECOSYSTEM ENDPOINTS						
	Vegetation	Marine Invertebrates	Amphibians & Reptiles	Finfish	Birds	Marine Mammals	Terrestrial Mammals & Insects
SAV	Macroalgae **SAV:** Eelgrass, Widgeon Grass	Horseshoe Crab, Barnacle, Eastern Mudsnail, Say Mud Crab, Hermit Crabs, Green Crab, Other Crabs Amphipods, Isopods, Softshell Clam, Hard Clam, Sea Star, Comb Jelly, Scallop, Polychaetes, Jellyfish, Shrimp **Commercial & Recreational:** Blue & Ribbed Mussels, Blue Crab	Sea Turtles	**Forage/Bait:** Cunner, Killifish, Silversides, Northern Puffer, Pipefish Sticklebacks **Commercial & Recreational:** Tautog, Weakfish, Bluefish, Black Sea Bass, Striped Bass, Herrings, Winter Flounder, American Eel	**Commercial & Recreational:** Brant		

Table 5
Ecological Endpoint Summary
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

HABITAT	BAY ECOSYSTEM ENDPOINTS						
	Vegetation	**Marine Invertebrates**	**Amphibians & Reptiles**	**Finfish**	**Birds**	**Marine Mammals**	**Terrestrial Mammals & Insects**
Inlets		**Benthic:** Polychaetes, Horseshoe Crab, Amphipods, Sea Star, *Yoldia,* Eastern Mudsnail, Say Mud Crab, Hermit Crabs, Green Crab, Other Crabs, Isopods, Phytoplankton, Zooplankton **Epibenthic:** Shrimp, Barnacle **Pelagic:** Jellyfish **Commercial & Recreational:** Clams (Ocean Quahog), Lobster, Squid, Blue Crab, Blue & Ribbed Mussels, Surf Clam, Softshell Clam	**Sea Turtles:** Kemps-Ridley, Loggerhead, Hawksbill	**Pelagic:** Hake, Skates **Benthic:** Sandlance, Windowpane **Forage/Bait:** Silversides, Killifish, Cunner, Anchovies Northern Puffer, Pipefish Sticklebacks **Commercial & Recreational:** Winter & Summer Flounders, Scup, Tautog, Butterfish, Bluefish, Herrings, Striped Bass, Weakfish, Black Sea Bass, American Eel	**Seabirds:** (Cormorant) Loons, Grebes **Commercial & Recreational:** Ducks (Scaup, Black)	**Seals:** Harbor Gray	

Table 5
Ecological Endpoint Summary
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

HABITAT	BARRIER ISLAND UPLAND ECOSYSTEM ENDPOINTS						
	Vegetation	Marine Invertebrates	Amphibians & Reptiles	Finfish	Birds	Marine Mammals	Terrestrial Mammals & Insects
Terrestrial Upland (including Bayside Beach)	Short, Prostrate Pine species, Pitch Pines, Red Maple Swamp Forest, Maritime Scrub, Maritime Oak/Holly Forest, Disturbed "vegetated" land (non-indigenous species), Pine Barren Community	Benthic Invertebrates, Wrack Invertebrates (Amphipods, Isopods)	Frogs, Diamondback Terrapin, Turtles (Mud, Box, Spotted)		**Raptors:** Owls, Hawks, Osprey Migratory Neotropical Species, Resident & Migratory Passerine Species Piping Plover, Least & Common Terns		**Mammals:** Deer, Red Fox, Raccoon, White-footed Mouse, Voles, Moles **Insects:** Bees, Mosquitoes, Ticks, Greenhead Fly, Wrack Insects
Maritime Forest	Sunken Forest Species (Trees, Shrubs, Herbaceous Perennials), Cherries Vines		Salamander (Tiger), Turtles (Mud, Box, Spotted), Eastern Hognose Snake		Warbler, Migratory Species		**Mammals:** Deer **Insects:** Ticks, Mosquitoes
Coastal Ponds (e.g. Georgica Pond)	SAV, Emerged Species, *Phragmites,* Purple Loosestrife, Intertidal and High Marsh Species	**Commercial & Recreational:** Oysters	Diamondback Terrapin	Migratory & Resident Species (e.g., Trout), Anadromous Species (Eels)	Least & Common Terns, Osprey, Shorebirds		
Freshwater Wetlands	Bogs & Vines, Sedges, Rushes, Grasses, Cattail, *Phragmites*		Salamanders (Tiger), Toads, Turtles, Frogs	**Commercial & Recreational:** Anadromous (Salmonids, Herrings, Eels) Stocked Trout (Rainbow, Brook)	**Waterfowl:** Canada Goose, Waders, Rails **Commercial & Recreational:** Ducks		Mosquito

Notes: (1) Coastal Ponds, and Freshwater Wetlands endpoints are listed here as part of the Barrier Island Upland Ecosystem, but no models for these habitats have been presented. If warranted, these models will be developed in Phase 3.

(2) Endangered and Threatened species are underlined throughout the table; Diamondback Terrapin is not an Endangered and Threatened species, but underlined due to its local importance. Similarly, the Northeast Tiger Beetle is extirpated but has been retained on the list of Endangered and Threatened Species for the purposes of the Conceptual Model due to its potential local importance.

Table 6
Threatened/Endangered/Special Concern Species
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

Habitat	Coastal Marine Ecosystem Endpoints						
	Vegetation	Marine Invertebrates	Amphibians & Reptiles	Finfish	Birds	Marine Mammals	Terrestrial Mammals & Insects
Coastal Marine Offshore			**Sea Turtles:** Kemps-Ridley, Hawksbill, Loggerhead Green, Leatherback			**Mammals:** Atlantic Right & Pygmy-Sperm Whales	
Coastal Marine Nearshore			**Sea Turtles:** Kemps-Ridley Hawksbill, Loggerhead		Osprey, Common & Least Terns, Roseate Terns		
Coastal Marine Sandy Intertidal					**Shorebirds:** Piping Plover, **Other:** Osprey, Common & Least Terns		

Table 6
Threatened/Endangered/Special Concern Species
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

Habitat	Bay Ecosystem Endpoints						
	Vegetation	Marine Invertebrates	Amphibians & Reptiles	Finfish	Birds	Marine Mammals	Terrestrial Mammals & Insects
Intertidal Bayside			Diamondback Terrapin		Piping Plover, Least Tern		
Bay Subtidal			Diamondback Terrapin		Common & Least Terns, Black Skimmer		
Sand Shoals, Bare Sand & Mud Flats			Diamondback Terrapin		Piping Plover, Least & Common Terns		
Salt Marshes					Osprey		
SAV			Sea Turtles				
Inlets			**Sea Turtles:** Kemps-Ridley, Loggerhead, Hawksbill				

Table 6
Threatened/Endangered/Special Concern Species
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

Habitat	Ocean Beach and Dune Ecosystem Endpoints						
	Vegetation	Marine Invertebrates	Amphibians & Reptiles	Finfish	Birds	Marine Mammals	Terrestrial Mammals & Insects
Sandy Beach	Sea Beach Amaranth				Least & Common Terns, Piping Plover		**Insects:** Northeast Tiger Beetle
Dunes & Swales	*Salicornia,* Sea Beach Amaranth		Diamondback Terrapin		Piping Plover, Short-eared owl		**Insects:** Northeast Tiger Beetle

Table 6
Threatened/Endangered/Special Concern Species
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

Habitat	Barrier Island Upland Ecosystem Endpoints						
	Vegetation	Marine Invertebrates	Amphibians & Reptiles	Finfish	Birds	Marine Mammals	Terrestrial Mammals & Insects
Terrestrial Upland (including Bayside Beach)			**Turtles:** (Diamondback Terrapin, Mud, Box, Spotted)		**Raptors:** Hawks, Osprey Piping Plover, Common & Least Terns		
Maritime Forests			**Turtles:** (Diamondback Terrapin, Mud, Box, Spotted), Tiger Salamander, E. Hognose Snake				
Coastal Ponds			Diamondback Terrapin		Least & Common Terns, Osprey		
Freshwater Wetlands			Salamanders (Tiger), Turtles				

Notes: (1) Coastal Ponds, and Freshwater Wetlands endpoints are listed here as part of the Upland Ecosystem, but no models for these habitats have been presented. If warranted, these models will be developed in Phase 3.

(2) Diamondback Terrapin is not an Endangered and Threatened species, but is included in the table due to its local importance. Similarly, the Northeast Tiger Beetle is extirpated but has been retained on the list of Endangered and Threatened Species for the purposes of the Conceptual Model due to its potential local importance.

Table 7
Commercial/Recreational Species
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

Habitat	Coastal Marine Ecosystem Endpoints						
	Vegetation	Marine Invertebrates	Amphibians & Reptiles	Finfish	Birds	Marine Mammals	Terrestrial Mammals & Insects
Coastal Marine Offshore		**Benthic:** Surf Clam, Scallop, Ocean Quahog **Pelagic:** Squid **Commercial:** Clams, Lobster, Squid		**Pelagic:** Hake, Scup, Bluefish, Butterfish, Striped Bass, Herring **Benthic:** Sandlance, Winter, Summer and Windowpane Flounders			
Coastal Marine Nearshore		**Benthic:** Surf Clam, Ocean Quahog **Commercial:** Clams, Lobster, Squid		**Pelagic:** Silversides, Anchovies, Bluefish, Striped Bass **Commercial:** Winter and Summer Flounders	**Piscivorous:** Sea Ducks		
Coastal Marine Sandy Intertidal							

Table 7
Commercial/Recreational Species
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

Habitat	Bay Ecosystem Endpoints						
	Vegetation	**Marine Invertebrates**	**Amphibians & Reptiles**	**Finfish**	**Birds**	**Marine Mammals**	**Terrestrial Mammals & Insects**
Intertidal Bayside		Blue & Ribbed Mussels, Blue Crab, Softshell Clam		Tautog, Weakfish, Bluefish, Black Sea Bass, Striped Bass, Herrings			
Bay Subtidal		Hard Clam, Blue Crab, Scallop		**Commercial:** Winter Flounder, American Eel	Black Duck		
Sand Shoals, Bare Sand & Mud Flats		Blue Mussel					
Salt Marshes		Blue & Ribbed Mussels, Blue Crab		Tautog, Weakfish, Bluefish, Black Sea Bass, Striped Bass, Herrings			
SAV		Blue & Ribbed Mussels, Blue Crab		Tautog, Weakfish, Bluefish, Black Sea Bass, Striped Bass, Herrings, Winter Flounder, American Eel	Brandt		
Inlets		**Benthic:** Surf Clam, Softshell Clam **Epibenthic:** Blue & Ribbed Mussels **Commercial:** Clams (Ocean Quahog), Lobster, Squid, Blue Crab		Winter & Summer Flounders, Scup, Tautog, Butterfish, Bluefish, Herrings, Striped Bass, Weakfish, Black Sea Bass, American Eel	Ducks (Scaup, Black)		

Table 7
Commercial/Recreational Species
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

Habitat	Ocean Beach and Dune Ecosystem Endpoints						
	Vegetation	Marine Invertebrates	Amphibians & Reptiles	Finfish	Birds	Marine Mammals	Terrestrial Mammals & Insects
Sandy Beach							
Dunes & Swales							

Table 7
Commercial/Recreational Species
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point

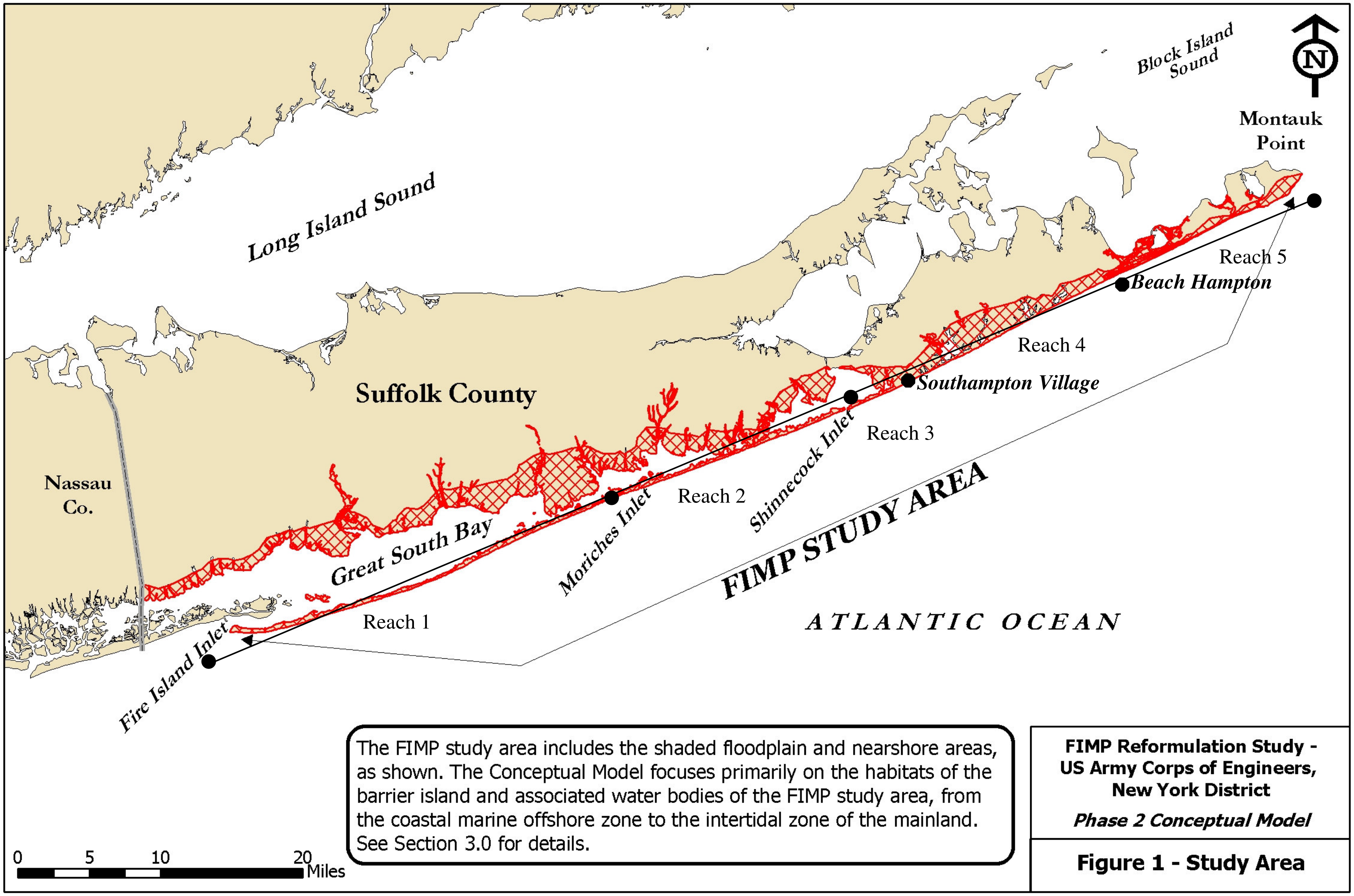
Habitat	Barrier Island Upland Ecosystem Endpoints						
	Vegetation	Marine Invertebrates	Amphibians & Reptiles	Finfish	Birds	Marine Mammals	Terrestrial Mammals & Insects
Terrestrial Upland (including Bayside Beach)							
Maritime Forests							
Coastal Ponds		Oyster					
Freshwater Wetlands				Anadromous (Salmonids, Herrings, Eels) Stocked Trout (Rainbow, Brook)	**Waterfowl:** Ducks		

Notes: (1) Coastal Ponds, and Freshwater Wetlands endpoints are listed here as part of the Upland Ecosystem, but no models for these habitats have been presented. If warranted, these models will be developed in Phase 3.

US Army Corps
of Engineers
New York District

Fire Island Inlet to Montauk Point, New York Reformulation Study

NYS Department of Environmental Conservation



The FIMP study area includes the shaded floodplain and nearshore areas, as shown. The Conceptual Model focuses primarily on the habitats of the barrier island and associated water bodies of the FIMP study area, from the coastal marine offshore zone to the intertidal zone of the mainland. See Section 3.0 for details.

FIMP Reformulation Study - US Army Corps of Engineers, New York District

Phase 2 Conceptual Model

Figure 1 - Study Area

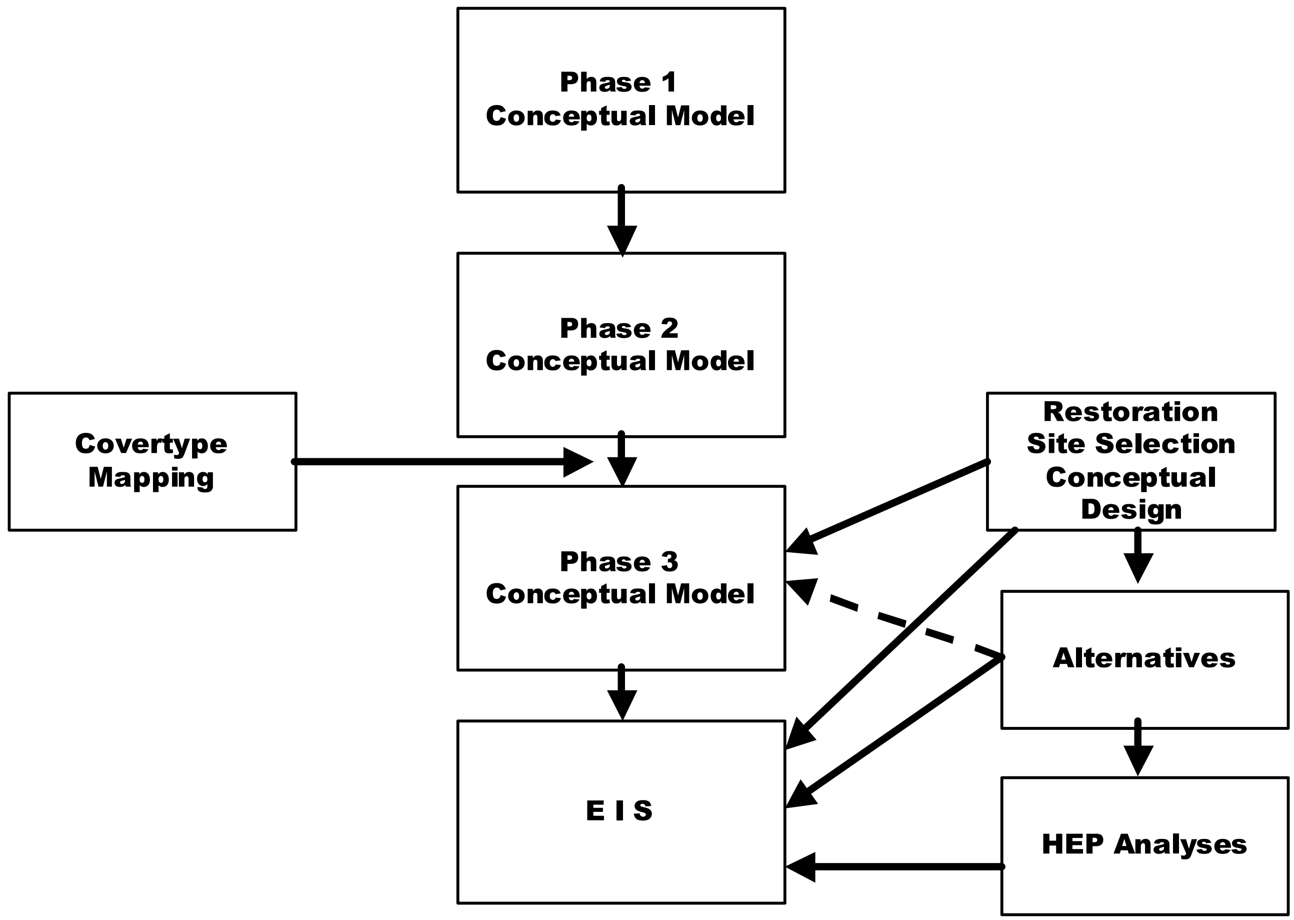
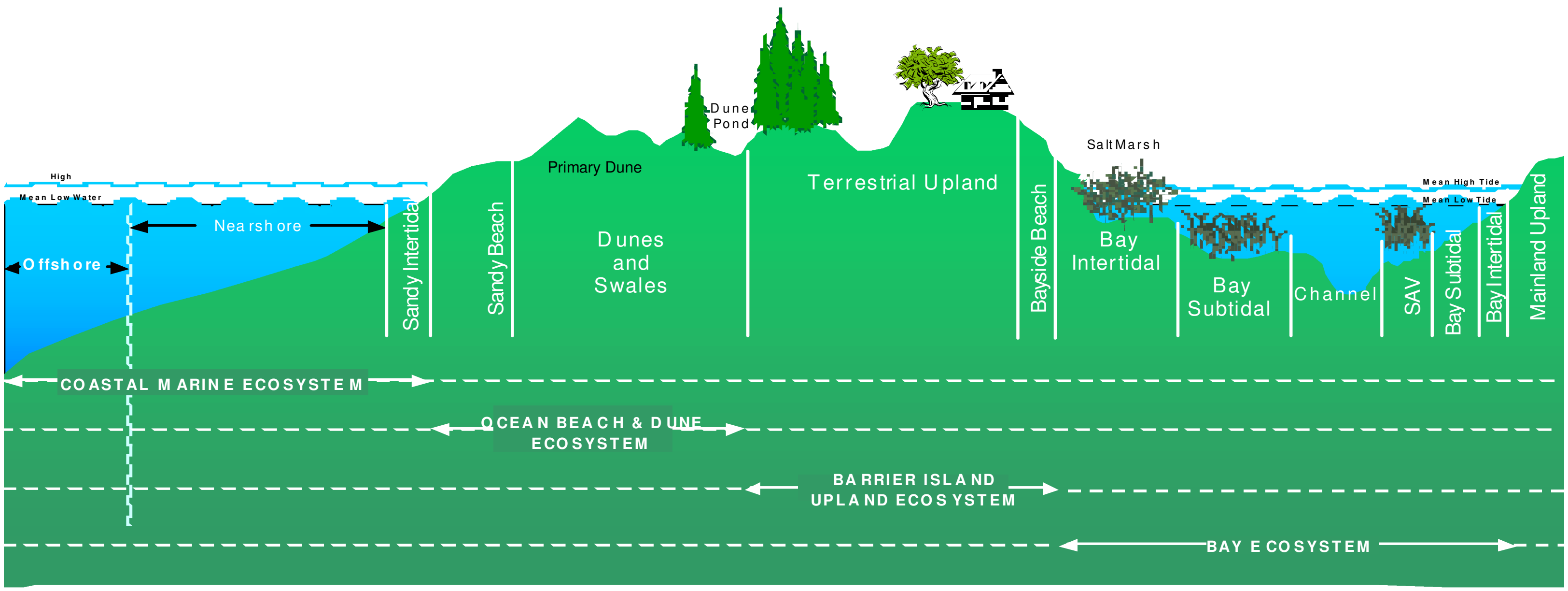


Figure 2 – Conceptual Model Development Process

Phase 2 Conceptual Model

FIMP Reformulation Study –

U.S. Army Corps of Engineers, NY District



Note:

1 - Nearshore habitat extends from mean low tide to 10 m depth

2 - Offshore habitat extends from 10 m depth to 30 m depth

3 – Bay Ecosystem also includes Sand Shoals and Mudflats, and Saltmarsh and Inlets habitats

Drawing not to Scale

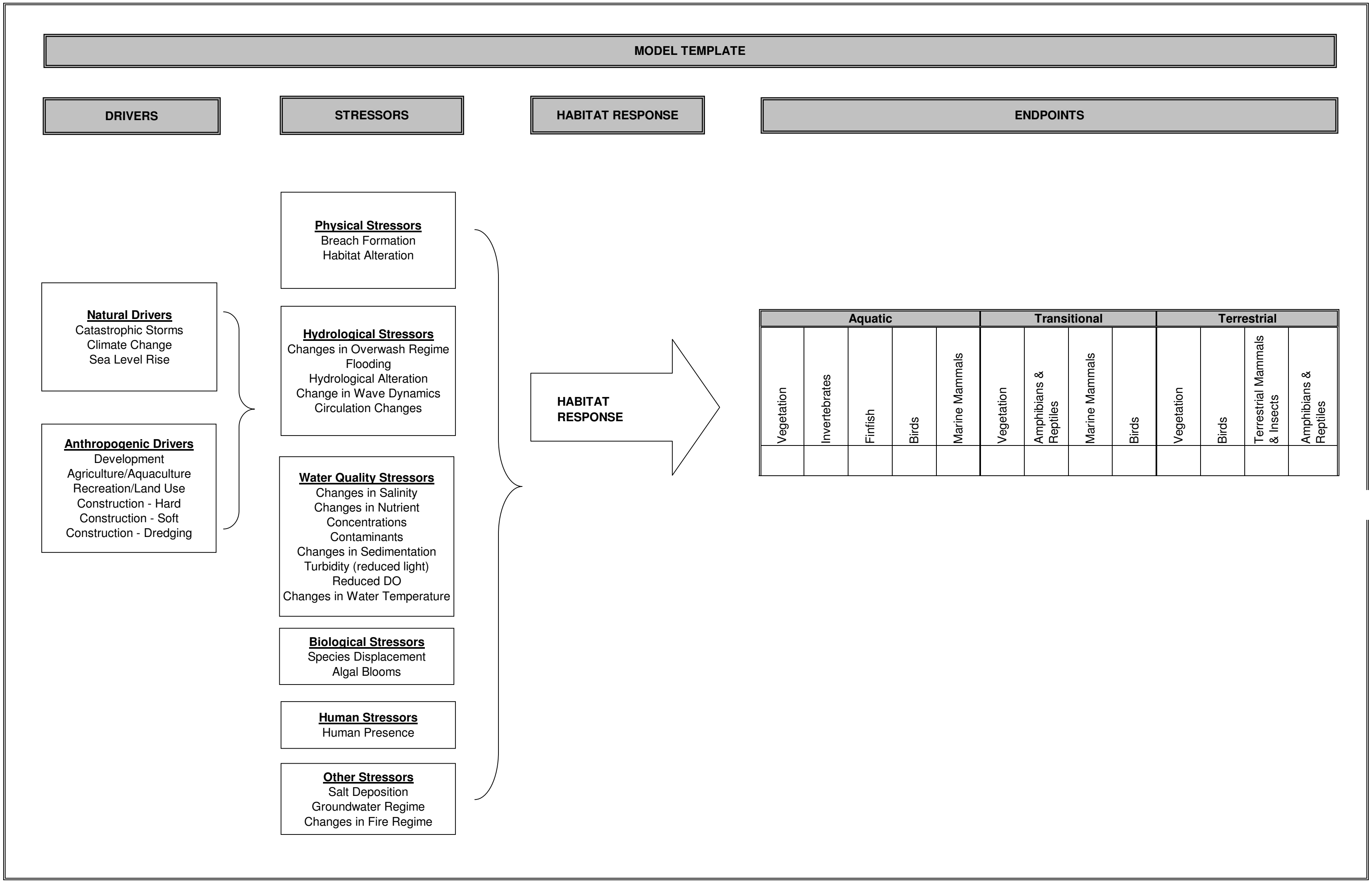
Figure 3 –

Idealized Transect of Barrier Island Ecosystems

Phase 2 Conceptual Model

FIMP Reformulation Study –
U.S. Army Corps of Engineers, NY District

Figure 4
Model Template
Phase 2 Conceptual Model
Fire Island Inlet to Montauk Point



Appendix A

Driver/Stressor Definitions

DRIVERS

The following definitions describe newly selected drivers for the Conceptual Model, Phase 2. This final list of drivers is based on the original comprehensive list developed as part of the Phase 1 effort. The Phase 1 list had four natural and eight anthropogenic potential drivers. This final list to be incorporated in the models for the FIMP study area has eliminated some of the Phase 1 drivers due to non-applicability, redundancy or lack of relevance to the study area. For example, the two Phase 1 drivers "shoreline change" and "erosion and deposition" were removed as drivers from the natural drivers category because they are listed (and function) as stressors. The Phase 1 anthropogenic driver of "changes in natural populations" was removed because it is now included (in various aspects) of both Development and Recreation. The Phase 1 anthropogenic driver of "harvesting" was removed because it is now included in Agriculture/Aquaculture.

The anthropogenic driver of "non-indigenous and nuisance species" was removed because it is now included (in various aspects) in both Development and Recreation. The final list includes the following three natural and six anthropogenic drivers:

NATURAL DRIVERS:

1. **Catastrophic Storms:** Storms can dramatically and catastrophically change the ecosystem or shoreline structures; storms can be either Nor-Easters or hurricanes.
2. **Climate Change:** This driver includes changes from natural causes only and is not used in the context of a stressor or habitat response. It includes all manifestations of climatic change, from global warming to changes in precipitation, or other effects.
3. **Sea Level Rise:** Increase in sea level due to environmental changes such as global warming and other geologic causes, over the next 50 years.

ANTHROPOGENIC DRIVERS:

1. **Development:** Includes development of buildings, marinas, roads; resultant alteration of run-off and nutrient loading (including all non-point source pollution). Development yields decreased (natural) habitat availability to natural biological populations. Solid waste and impervious surfaces increase with development. This definition of development includes primary structures only (houses, roads, etc.) not accessory structures (bulkheads etc.) that are addressed under the Construction drivers.
2. **Agriculture/Aquaculture:** Harvesting or other forms of resource consumption (including commercial harvesting) of marine and terrestrial species that may result in habitat alteration (e.g., introduction of new species).
3. **Recreation and Land Use**: Refers to land use by humans that is associated with recreation not covered under development, including camping, boating, land use by vehicles, human presence and disturbance (of natural habitats and species), fishing and camping. As such, all associated visitor impacts are also included (such as the introduction of nuisance and/or non-native species).
4. **Construction**: This activity is broken into three separate drivers that all include the construction of some type of engineered device or land alteration. The three types of construction are Hard, Soft, and Dredging:

(4a) **Construction-Hard:** includes seawalls, bulkheads, groins, jetties and other types of permanent shoreline alteration.

(4b) **Construction-Soft**: includes beach replenishment, dune enhancement, various restoration measures such as plantings, structural removal and habitat creation, restoration plantings and other types of permanent and temporary shoreline alteration.

(4c) **Construction-Dredging:** includes only the actual dredging operation of removal of offshore and nearshore sediment and sand. This does not include the placement of sand or machinery impacts.

STRESSORS

The following definitions describe newly selected stressors for the Conceptual Model, Phase 2. As with the list of drivers, this final list of stressors is based on the original comprehensive list developed as part of the Phase 1 effort. The Phase 1 list had 27 potential stressors. This final list to be incorporated in the models for the FIMP study area has eliminated some of the Phase 1 drivers due to non-applicability, redundancy or lack of relevance to the study area. The final 20 stressors were grouped into the following six categories to facilitate application of the models in the assessment process:

PHYSICAL STRESSORS

This category includes all relevant stressors that could impart a physical change to the habitat or ecosystem. Two Physical Stressors are included in the conceptual models:

1. **Breach Formation:** refers to the condition where severe overwashing erodes a new inlet permitting exchange of ocean and bay waters under normal tidal conditions. While overwashing can lead to breach formation they are distinct events.
2. **Habitat Alteration:** refers to the loss, fragmentation, or conversion of habitat from one type to another whether through natural or anthropogenic drivers. This includes shoreline change, accretion, and erosion from sedimentation.

HYDROLOGICAL STRESSORS

These stressors act through any change in surface water hydrology. Since water can be a medium in sedimentation patterns, all hydrological stressors may include changes in sedimentation patterns. Five Hydrological Stressors are included in the conceptual models:

1. **Changes in Overwash Regime:** is a change in the temporal, spatial or severity of the temporary overtopping of the barrier island by tides and/or waves during a storm.
2. **Flooding:** is an inundation event where ocean or bay waters rise to a level above mean high tide; flooding relates only to inundation due to catastrophic storms and sea level rise.
3. **Hydrological Alteration:** is a change in the frequency, duration, and severity of the pattern and availability of surface water. This does not include a sole inundation or drought event.
4. **Change in Wave Dynamics:** refers to a long-term change in the frequency, duration, direction and/or intensity of ocean and bay waves. Change in wave dynamics includes the "scour" effect.

5. **Circulation Changes:** refers to any change in water movement patterns from the water along shore and the flushing dynamics of bays and their habitats.

WATER QUALITY STRESSORS

These stressors result in a change to any aspect of the chemical or nutrient quality of surface water. Seven Water Quality Stressors are included in the conceptual models:

1. **Changes in Salinity:** refers to bay, tidal, or coastal pond systems where salinity changes might affect the survival and reproduction of plants and animals with specific salinity tolerance ranges.
2. **Changes in Nutrient Concentrations:** refers to any alteration of surface water nutrient levels or distribution relative to typical regional conditions, particularly with respect to aquatic and marine and plant communities. Eutrophication is an extreme case of changes in nutrient concentrations.
3. **Contaminants:** refers to alteration of nature and/or extent of concentrations of toxic substances in the aquatic or marine environment relative to typical regional conditions. Examples of toxic substances include metals, organics, or pesticides. Acidification effects of acid rain on small ponds is also included in this stressor.
4. **Changes in Sedimentation:** refers to both the frequency, distribution pattern and amount of sediment loads, suspended sediments and sediment transport. While this stressor is included in the Water Quality category because increased suspended sediments cause negative effects on water quality through turbidity and sediment-associated contamination, it also addresses stressors such as erosion and accretion. (Note: In future model development, sedimentation may be separated out to be included in areas of habitat alteration resulting from either hydrological or physical stressors.)
5. **Turbidity:** refers to the continuous or long term condition of reduced water clarity caused by either the growth of phytoplankton or the presence of suspended sediments in the water column (e.g., bays and marinas with constant, heavy boat traffic).
6. **Reduced Dissolved Oxygen (DO):** refers to the condition of a lowering of the optimal ambient levels of dissolved oxygen necessary to sustain aquatic and marine life, to a level that may impair communities ability to maintain and reproduce.
7. **Changes in Water Temperature:** refers to a general increase or decrease in air temperature resulting from global climate change or other extreme climatic variability that results in a long term extreme change in surface water temperature.

BIOLOGICAL STRESSORS

Stress associated with these elements is related to effects associated with a change in biological components of the system. Two Biological Stressors are included in the models:

1. **Species Displacement:** is the relocation of any existing floral or faunal species by either natural or anthropogenic activities. This can include the introduction of nuisance or non-native species.

2. **Harmful Algal Blooms:** applies not only to toxic microscopic algae but also to benthic or planktonic macroalgae which can proliferate in response to anthropogenic nutrient enrichment, leading to major ecological impacts such as the displacement of indigenous species, habitat alteration, or oxygen depletion. Stressor does not include growth of phytoplankton that might create turbidity.

HUMAN STRESSORS

Stress associated with specific human activities. Only one Human Stressor is included in the models:

1. **Human Presence:** represents direct and indirect impacts as a result of human disturbance to the natural plant and animal communities and their associated habitats. Generation of solid waste, noise, over-exploitation of resources, or pollution, and air quality degradation are all examples of Human Presence. Human Presence is considered to be less severe than related Anthropogenic Drivers listed, and focuses on stress as a result of regular daily use of a habitat.

OTHER STRESSORS

These miscellaneous stressor elements were put in this category since no single existing category was appropriate. Two Other Stressors are included in the models:

1. **Salt Deposition:** refers to sea salt deposit from spray on vegetation in beach, dune, and maritime communities.
2. **Groundwater Regime:** relates to a lateration of either groundwater inputs to fresh or saltwater areas, depth to groundwater for plant growth, or other stress relating to the availability of groundwater.
3. **Changes in Fire Regime:** would indicate not just a single fire, but rather a change in the frequency and/or severity of fires in that system. Many organisms are adapted to a specific fire regime, and cannot survive when this regime is altered.