Attachment 17 – Description of models used to choose attribute levels

EPA uses information from several sources in order to develop an appropriate range of attribute levels for the baseline and policy scenarios presented in the survey. This information includes different hydrological, biochemical and ecosystem models and represents a significant multi-agency effort. The purpose of this survey is to collect data that will enable EPA to value a variety of water quality improvements relative to a range of baseline scenarios. In order to estimate economic benefits of the Chesapeake Bay TMDLs the experimental design of the survey must include attribute levels for baseline predictions and policy scenarios that cover the range relevant to the TMDLs, *but need not be limited to that range*. EPA's choice to value changes in environmental outcomes and a range of attribute levels relative to multiple baselines provides the flexibility to estimate benefits as expectations of water quality in the Chesapeake Bay evolve. This Information Collection Request (ICR) and request for public comment pertain to the survey instrument and stated preference methodology described therein. The data collected from this survey will be combined with information from numerous other scientific models and studies to estimate the benefits of the TMDLs. EPA will submit a report of the stated preference study results for public comment and peer review which will include predictions of conditions under baseline and policy scenarios with descriptions of our modeling approach.

Summary information about the 3 main models used to generate data for the range of attribute levels in the baseline conditions and policy scenarios is described below. Briefly, the attribute levels for each endpoint are generated by the following models:

1. *Water clarity*: The Chesapeake Bay Water Quality Models produce water clarity measures for different baseline and policy scenarios when nutrient and sediment loadings change.
2. *Striped bass, Blue crab, and Oysters*: Changes in nutrient loadings from the Chesapeake Bay Water Quality Models are used as inputs in the Chesapeake Bay Fisheries Ecosystem Model (CBEFM) to forecast changes in striped bass, blue crab and oyster populations under baseline and policy scenarios.
3. *Watershed lakes*: Changes in nutrient loadings are used in an application of the SPARROW model to forecast changes in the eutrophication of freshwater lakes in the Watershed.

Chesapeake Bay Water Quality Models

In order to obtain a range of attribute levels projected for baseline conditions and policy scenarios in the survey for *water clarity* EPA uses output from the Chesapeake Bay Water Quality Models, a suite of models of the Chesapeake Bay Watershed developed by the Chesapeake Bay Program. The Chesapeake

Bay Program is a regional partnership that includes federal and state agencies, local governments, non-profit organizations, and academic institutions. The Chesapeake Bay Program oversees the largest, comprehensive modeling effort of the Chesapeake Bay Watershed, to the best of our knowledge. EPA has worked closely with the Chesapeake Bay Program to obtain scientific information on a range of *water clarity* predicted from the models. The Chesapeake Bay Program works with 5 models, several with sub-component models, to simulate and project pollution loads to the Chesapeake Bay. More on the Water Quality Model can be found at http://www.chesapeakebay.net/about/programs/modeling. The 5 models used by the Chesapeake Bay Program are described briefly below.

Watershed Model

The Watershed Model incorporates information about land use, fertilizer applications, wastewater plant discharges, septic systems, air deposition, farm animal populations, weather and other variables to estimate the amount of nutrients and sediment reaching the Chesapeake Bay and where these pollutants originate. This model divides the Bay into more than 2,000 river segments. Each segment is represented by several sub-models, including a hydrologic sub-model that calculates runoff and sub-surface flow for all land uses and a non-point source sub-model that simulates erosion and pollutant loads from land to rivers. Extensive documentation, including underlying data is available at: www.chesapeakebay.net/programs/modeling/53.

Estuary Model

The Estuary Model examines the effects that pollution loads generated by the Watershed Model have on water quality. In the Estuary Model, the Chesapeake Bay is represented by more than 57,000 computational cells and is built on two sub-models:

- The hydrodynamic sub-model simulates the mixing of waters in the Bay and its tidal tributaries.
- The water quality sub-model calculates the Bay's biological, chemical and physical dynamics.

Scenario Builder

Scenario Builder can generate simulations of the past, present or future state of the Chesapeake Bay Watershed to explore potential impacts of management actions and evaluate alternatives. Scenario Builder produces inputs for the Watershed Model based on factors from a wide range of land uses and management actions. For example, information such as acres of different crops, numbers of animals and extent of conservation practices is used to generate Watershed Model inputs for agricultural land use types.

Airshed Model

The Airshed Model uses information about nitrogen emissions from power plants, vehicles and other sources to estimate the amount of and location where these pollutants are deposited on the Chesapeake Bay and its Watershed. That information is fed into the Watershed Model.

Land Change Model

The Land Change Model analyzes and forecasts the effects of urban land use and population on sewer and septic systems in the Chesapeake Bay Watershed.

Chesapeake Bay Fisheries Ecosystem Model (CBFEM)

In order to obtain a range of attribute levels projected for baseline conditions and policy scenarios in the survey for populations of *striped bass*, *blue crabs*, and *oysters* EPA uses output from the Chesapeake Bay Fisheries Ecosystem Model (CBFEM). The CBFEM is a fisheries-oriented trophic network model developed by NOAA for the Bay using a publicly available and widely applied software package, Ecopath with Ecosim, or EwE, developed by the University of British Columbia Fisheries Centre and others. Ecopath is a static, mass-balanced snapshot of the system and Ecosim is a time dynamic simulation module for policy exploration. The major species for the CBFEM application of EwE include the multi-stanza (or life-stage) representations of commercially important species (striped bass, bluefish, weakfish, white perch, Atlantic menhaden, blue crab, and oyster) as well as single biomass pool groups of other commercially important species including American eel, Atlantic croaker, summer flounder, spot, alewife, American shad, black drum, catfish, and bivalves. CBFEM uses output from the Chesapeake Bay Water Quality Models, namely changes in nutrient loadings, in order to forecast changes in fish populations. CBFEM forecasts changes in relative biomass that can be used with current populations to forecast populations in the future. Documentation for the CBFEM can be found at http://chesapeakebay.noaa.gov/ecosystem-modeling/chesapeake-bay-fisheries-ecosystem-model.

SPARROW Model

In order to forecast the algae levels in lakes in the Watershed EPA uses information from the U.S. Geologic Survey's Spatially Referenced Regressions On Watershed Attributes (SPARROW) nutrient models. The SPARROW model is a well established hydrological nutrient delivery model that has been used by government agencies and academic researchers since 1997 to analyze the source and effect of nutrient loading to water bodies and is available for public review. Moore, et al. (2011) describes the development of a Northeast US SPARROW model which provides predictions of total phosphorus for lakes in the region. EPA's Office of Research and Development (ORD) uses the phosphorus predictions to convert lakes to trophic states which are associated with different levels of algae. The relationship between Phosphorus concentrations and the amount of algae are well established in the scientific literature (see Schindler and Vallentyne (2008) or Wetzel (2010)). Additional documentation for the SPARROW model and its application to the Chesapeake Bay can be found at http://water.usgs.gov/nawqa/sparrow/.

References

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