Technical Support Document for U.S. EPA's Proposed Rule for Numeric Nutrient Criteria for Florida's Estuaries, Coastal Waters, and South Florida Inland Flowing Waters

Volume 2: Coastal Waters

November 30, 2012

nitrogen fixation, riverine inputs, benthic fluxes (e.g., from groundwater or remineralized diatom blooms), zooplantonkton excretion, and even organic matter from the decaying fish killed by *K. brevis* toxins. Anderson et al. (2008) also state that "clear evidence to support hypotheses about increased bloom frequency and biomass on the West Florida Shelf is still not yet available."

Acknowledging the potential for *K. brevis* blooms to increase coastal chlorophyll *a* concentrations, EPA also evaluated an approach for addressing *K. brevis* blooms within the context of a reference condition approach to numeric criteria development. Weekly *K. brevis* cell counts for the entire state of Florida were acquired from FWRI. EPA performed an analysis with *K. brevis* and one without *K. brevis* bloom data included in the criteria derivation for chlorophyll *a* (see Section 1.5.2).

1.4.3. Data Preparation

Use of Monitoring Sample Observations

Minimum metadata requirements for monitoring sample observations were date, time, latitude, longitude, and chlorophyll *a* or light extinction from photosynthetically active radiation (KdPAR). Latitude and longitude data rounded to the nearest degree or one-half degree were not used. Where multiple samples of chlorophyll *a* at different depths existed, the most surface (shallowest) sample was kept. The field observation sampling times were compared to the SeaWiFS, MODIS, and MERIS overpass times. Samples falling within a +/–3 hour time window were retained for further analysis (Bailey and Werdell 2006). Most of the retained chlorophyll *a* data were from laboratory filter extracted values. The Northeastern Gulf of Mexico data set used some fluorometric values, but the fluorometry data were adjusted on the basis of a regression with in situ extracted chlorophyll *a*. Therefore, all in situ chlorophyll *a* data were based on extracted values. For calculating KdPAR, all data were excluded for depths less than 5.6 ft (1.7 m), roughly the height of the conductivity, temperature, and depth apparatus. The $\log_{10}$ of photosynthetically active radiation (PAR) was plotted as a function of depth. Any regression of $\log_{10}$(PAR) against depth that returned an R^2 greater than 0.8 was retained for satellite validation. Field monitoring data included more than 5,500 chlorophyll *a* measurements, which were reduced to 1,947 after screening.

Use of Remote Sensing Data

EPA is proposing the use of SeaWiFS, MODIS, and MERIS satellites to provide measurements of chlorophyll_{RS} *a* (satellite-derived chlorophyll *a*). SeaWiFS provides a historical time-series of chlorophyll_{RS} *a* back to 1997, whereas MODIS and MERIS data collection began in 2002. Satellite ocean color data were obtained from the National Aeronautics and Space Administration's (NASA's) Ocean Color Web (Feldman and McClain 2010) and the European Space Agency's MERIS Catalogue and Inventory website. SeaWiFS, MODIS, and MERIS provided daily images with pixels having a nominal ~0.7 mi (1.1 km) spatial resolution. SeaWiFS data (reprocessing R2009) temporally spanned between September 14, 1997, and January 1, 2010. MODIS data (reprocessing R2009.1) temporally spanned between August 7, 2002, and January 1, 2010. MERIS reduced resolution data (2nd reprocessing) temporally spanned between April 29, 2002, and January 1, 2010. Imagery spatially covered between

31.0 to 23.0°N and 88.0 to 79.0°W. The SeaDAS version 6.1 was used to process data that met all standard quality control flags from level-1 to level-3 8-day composites (see Volume 2, Appendix B for more information on SeaDAS and the data products that were used).

SeaWiFS, MODIS, and MERIS derived chlorophyll *a* (chlorophyll$_{RS}$ *a*) were validated against field chlorophyll *a* measurements using the native resolution of the sensor. The closest satellite pixel corresponding to a monitoring chlorophyll *a* measurement that occurred within +/–3 hours of the satellite overpass was selected. Because satellite navigation might not be accurate to the pixel, a 3×3 box of pixels was selected with the center of the pixel box corresponding to a monitoring chlorophyll *a* measurement. Both the average chlorophyll$_{RS}$ *a* concentration and standard deviation was calculated from the 3×3 box if the satellite viewing angle was less than 60° and solar zenith angle was less than 75°. In addition, 50 percent of the pixels within the 3×3 box had to be unflagged. The coefficient of variation of the nine pixels was also determined. If the coefficient of variation was greater than 10 percent, the sample was excluded because of indicated spatial inhomogeneity. Satellite matchups were evaluated as described, which is from the method of Bailey and Werdell (2006) with a geometric mean (Type II) linear regression between the 3×3 pixel box extraction of satellite data and the corresponding monitoring sample measurement. The default ocean color chlorophyll *a* algorithms were selected because they were universal algorithms that could be applied to locations throughout Florida, and they were algorithms packaged within the SeaDAS Level 2 Processing program (l2gen) so future processing could easily be completed in SeaDAS (Schaeffer et al. 2011).

Chlorophyll$_{RS}$ *a* values within coastal segments were extracted by matching segment polygon vertex coordinates with corresponding satellite image pixel and line values on 8-day composites within SeaDAS (Schaeffer et al. 2011). The satellite image pixel and line locations were used to build a polygon using the 8-day array with Interactive Data Language. Values from the 8-day array were then averaged if bins were completely contained within the coastal segment polygon using Interactive Data Language's region of interest (ROI, Figure 1-5). If bins fell on or outside the coastal segment polygon, they were excluded from further analysis. EPA coastal segment seaward boundaries were delineated at 4 nautical miles to avoid exclusion of bins up to the 3 nautical mile limit. A single nautical mile is approximately equivalent to 1.85 km or almost two 1 km by 1 km satellite data bins. The ROI should then include one of the additional data bins from the extra 1.85 km extension. This one additional data bin would be on the landward side, proximal to the 3 nautical mile limit. If EPA had kept the seaward delineation at 3 nautical miles, the ROI would more likely only include data from land to approximately 2 nautical miles. EPA acknowledges bins adjacent to land are masked in this process, but it considers the response from the ROI to represent the trend for the entire delineated coastal segment. Advection, mixing events, coastal upwelling, and other physical dynamics are expected to result in a homogeneous and parallel response, between the masked area and averaged bins in the ROI, for each coastal segment. Averages were calculated from the beginning of the satellite mission until January 1, 2010.

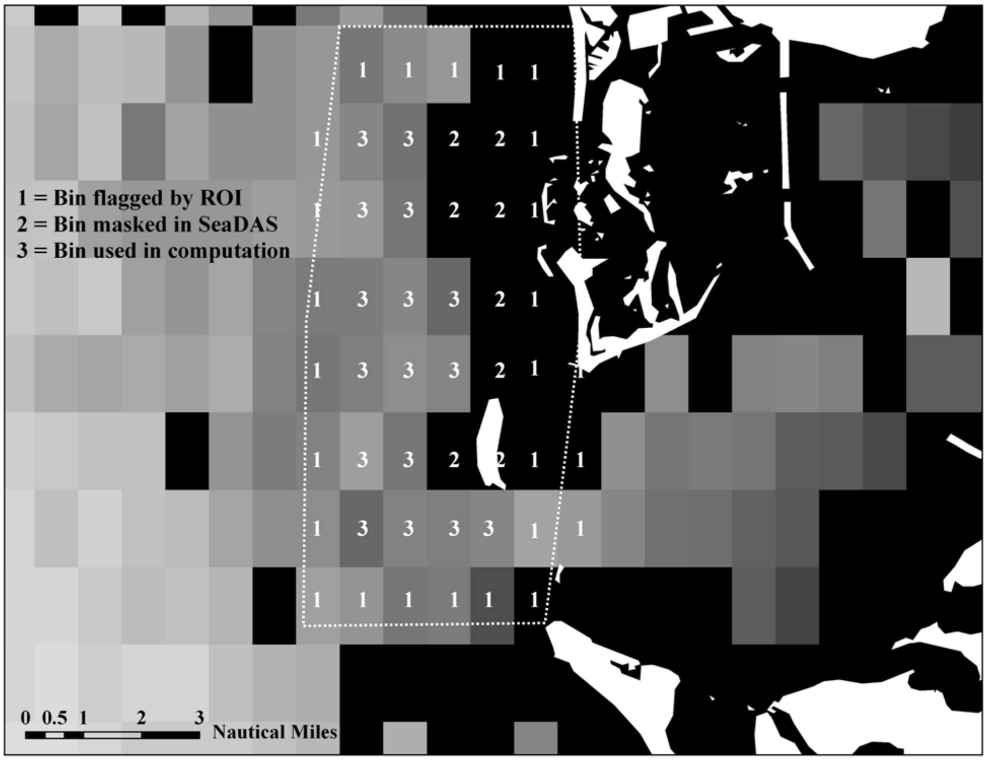

Figure 1-5. Enlarged view of coastal segment #22 near Tampa Bay. The dotted white line defines the coastal segment polygon. As an example, ROI would not include any chlorophyll$_{RS}$ *a* bins (#1) that were on the polygon line or a vertex. Bins masked by SeaDAS standard quality control flags (#2), including stray light contamination and land, had no value and were not included in the computation. Chlorophyll$_{RS}$ *a* bins completely within coastal segment polygon (#3) were included in the computation.

1.4.4. *K. brevis* Data Preparation

The FWRI data were combined into 8-day periods that matched the satellite dates. Satellites detect *K. brevis* blooms when cell counts are above 50,000 cells/L (Heil and Steidinger 2009; Stumpf et al. 2003). If a single count greater than 50,000 cells/L occurred at any point during the 8-day period, it was retained for flagging. The FWRI *K. brevis* cell count data were then spatially matched to the coastal segments in ArcGIS. The chlorophyll$_{RS}$ *a* data were flagged in any coastal segment for the 8-day period that had a count greater than 50,000 cells/L. In addition, the same segment was flagged one week before and after a bloom was detected, unless data indicated lower counts, to provide a temporal buffer as blooms were transported along the coast (Schaeffer et al. 2011). The number of flag occurrences in each coastal segment is presented in Figure 1-6.

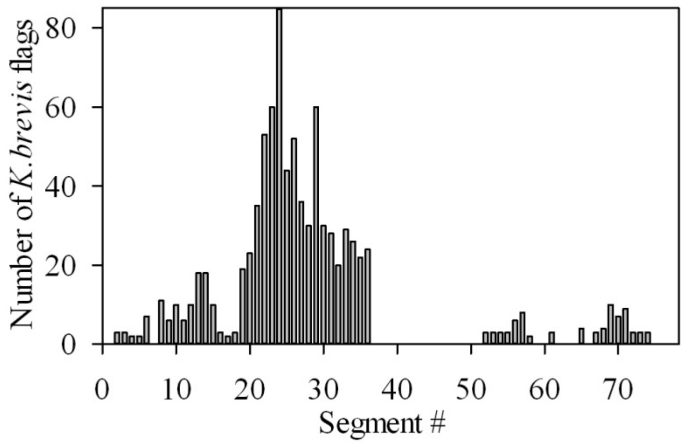

Figure 1-6. Number of *K. brevis* events greater than 50,000 cells/L flagged in each segment.

1.5. Analytical Approach for Numeric Nutrient Criteria Derivation

EPA proposes a reference condition approach for coastal numeric criteria development that uses data from satellite remote sensing. Few monitoring data from field samples are available for Florida's coastal waters; however, a robust data set is available from satellite remote sensing that can be used (Schaeffer et al. 2011).

EPA had previously recommended (e.g., USEPA 2001) that a percentile of water quality measurements in a sample of minimally disturbed water bodies, which currently are supporting designated uses, could serve as a basis for setting criteria for water quality in similar water bodies. Therefore, EPA is considering using a reference condition approach when current water quality conditions are supporting balanced natural populations of aquatic flora and fauna to protect against harmful/adverse impacts on aquatic ecosystems. Further discussion of the reference condition approach as applied to coastal waters in Florida is discussed in Section 1.5.1 below.

1.5.1. Using Reference Analysis to Maintain Designated Use Support

A reference condition approach involves computing criteria on the basis of water quality conditions present in reference water bodies that are known to be supporting or protecting the designated uses. The reference condition could be based on data collected in the past, when the water body was determined to be minimally disturbed by nitrogen or phosphorus pollution (historical reference condition) or from a similar water body that was determined to be minimally affected by nitrogen or phosphorus pollution (comparative reference condition). Therefore, EPA is proposing to base the reference condition approach for Florida's coastal waters on water quality conditions during times when those waters support designated uses in order to maintain these conditions and protect these waters from eutrophication.

Several steps were taken to ensure that the data used in criteria derivation and analyses were representative of waters that are supporting designated uses. EPA conducted a review of water quality information, using CWA section 303(d) listings for nutrients, chlorophyll *a*, and DO; identified coastal segments adjacent to 303(d) listed estuarine segments; consulted available