Four indices of estuarine trophic status, total N (TN), total P (TP), chlorophyll a (Chl a) and Secchi disk depth were assembled from long-term monitoring data sets collected at monitoring stations within Albemarle Sound, Pamlico River, Pamlico Sound, Neuse River, and the Cape Fear River estuaries. Data for Albemarle Sound, Pamlico River and Neuse River were produced on an approximately monthly interval by the NC Div. of Water Resources Ambient Monitoring Program (NC DWR AMS) and were retrieved using the Water Quality Portal [Water Quality Data Home](https://www.waterqualitydata.us/). Cape Fear River data were collected by the Lower Cape Fear River Project and were downloaded from the Cape Fear Basin Monitoring Coalition data portal <http://capefearwq.com/>. Data from Pamlico Sound were collected by the Neuse River Modeling and Monitoring Program (ModMon) operated by UNC Chapel Hill’s Institute of Marine Sciences. For TN data produced by NC DWR AMS and the Lower Cape Fear River Program (LCFRP), total N was calculated as the sum of total Kjeldahl nitrogen and nitrate/nitrite. For Pamlico Sound data produced by ModMon, TN was calculated as the sum of total dissolved N and particulate N. When multiple measurements were made on a single day, the arithmetic mean was calculated to determine a single daily value. Average annual values were calculated as the median of all monthly values within each year. An example of code (“ChowanRiverTN.m”) is provided on Github in the scripts folder that shows how the annual median values were calculated. In the rare case (<4%), that no data were collected in a particular year for a particular station, the average annual value from the previous year was used for the year with no data. Thus, the analysis defaults to maintaining a constant concentration. No chlorophyll *a* data were available from the DEQ AMS during the time period 1997-2000 and we did not attempt to fill this gap with values from 1996.

For Albemarle Sound, Pamlico River, Neuse River, and Cape Fear Rivers, estuary-wide annual average concentrations were calculated as the volume weighted average of 6 to 10 estuarine segments corresponding with the volume of estuarine water surrounding each water quality monitoring station according to equation 1 below and shown in Table 1. Estuary-wide average Secchi disk depths were calculated in the same manner except surface area of each segment rather than volume was used and the resulting value is an area-weighted estuarine average.

Equation 1: Cavg =

where Cavg is the annual estuary-wide average concentration, *Ci* is the annual average concentration for estuarine segment *i*, and *Vi* is the volume of estuarine segment *i*.

Segment volumes for Albemarle Sound, Pamlico River, and Cape Fear River were estimated by multiplying the area of estuarine segments determined using Google Earth (see Figures 1-3 below) by the average depth of each segment determined as the average charted depth using NOAA’s Electronic Navigational Charts viewer. Estimates of total estuarine volume calculated in this manner agreed to within 15% of published estuarine volumes for all three estuaries (Giese et al. 1985). For the Neuse River Estuary, segment volumes were borrowed from segment volumes were adapted from the segment volumes used by Peierls et al. (2012). Peierls’s downstream most four segments were combined into two larger segments that corresponded with the DEQ AMS sampling stations J953000 and J981000. For Pamlico Sound, the median annual water quality concentration was calculated as the median of all values collected from the nine stations during each year.

Annual averages of estuarine-wide total N and chlorophyll *a* were calculated as the volume-weighted average concentration of values from the Albemarle Sound, Pamlico River, Neuse River and Pamlico Sound. Pamlico Sound volume was estimated as 25900 million m3 (Giese et al. 1985).

Giese, G.L. 1985. Hydrology of major estuaries and sounds of North Carolina. US Geological Survey water-supply paper, 2221.

Peierls, BL, NS Hall, and HW Paerl. 2012. Non-monotonic responses of phytoplankton biomass accumulation to hydrologic variability: A comparison of two coastal plain North Carolina estuaries. *Estuaries and Coasts* 35:1376–1392.

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| --- | --- | --- | --- | --- | --- |
| Table 1. Monitoring stations used to calculate estuary-wide, volume-weighted annual averages of total N, total P and chlorophyll *a* within NC estuarine waters. | | | | | |
| **Estuary** | **Monitoring Program** | **Monitoring stations** | **Segment volumes**  **(106 m3)** | **Parameters** | **Time span** |
| Cape Fear River Estuary | LCFRP | B9050100  B9795000  B9800000  B9850100  B9910000  B9921000 | |  | | --- | | 3.5  69  20  86  44  32 | | TN, TP | 2011-2022 |
| Neuse River Estuary | NC DWR AMS | J7930000  J8290000  J8900800  J8910000  J9530000  J9810000 | 2.9  5.9  50  108  251  1116 | TN, TP, Chl a | 1989-2019 |
| Tar/Pamlico River Estuary | NC DWR AMS | O787000  O865000  O982500  O7650000  O7680000  O8498000  O9059000 | 68  118  545  6.1  39  133  197 | TN, TP, Chl a | 1989-2019 |
| Albemarle Sound | NC DWR AMS | M390000  M610000  M698000  D999500  M2750000  M5000000  M7175000  D8950000  D9490000  N9700000 | 3713  2598  18  693  249  96  520  247  278  84 | TN, TP, Chl a | 1982-2019 |
| Pamlico Sound | ModMon | Stations 1-9 | 25900 | TN, Chl a | Chl a: 2000-2022  TN: 2002-2022 |

Figure 1. Polygons used to estimate estuarine segment areas for determining segment volumes in the Cape Fear River, Pamlico River, and Albemarle Sound.

A map of the cape fear river

Description automatically generated with medium confidence