Quality Assurance for EPA's National Coastal Survey

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Abstract

The U.S. Environmental Protection Agency maintains a Quality System to ensure that its environmental data have scientific integrity. This presentation will describe EPA's experiences and challenges in defining and monitoring quality during the National Coastal Condition Assessment survey. The survey is a coordinated effort among the EPA, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey, the U.S. Fish and Wildlife Service, coastal states, and the National Estuary Programs. During the summer of 2010, EPA and its partner teams sampled nearly 1400 sites within U.S. coastal waters and Great Lakes. Quality was considered at every phase of the survey and started with the creation of a Quality Assurance Project Plan. The QAPP includes requirements for field sampling, laboratory analysis, auditing, database development, and the data analysis.

Background: National Aquatic Resource Surveys

In the United States, states, tribes, federal agencies and other organizations collect water quality data to respond to requirements in the 1972 Clean Water Act. Traditionally, water quality data was largely collected for heavily used or problem waters. These targeted assessments provided coverage of only a small percentage of all the nation's waters. In addition, the assessments used widely different methods in field sampling, laboratory analyses, and data evaluations. While this approach is consistent with the Clean Water Act and is appropriate for management of state waters, it complicates the process of generating a regional and national picture of water quality. At the national level, water quality information is needed to inform water program management decisions, direct policy development and strategic planning, and track trends in water quality to measure progress toward meeting the nation's clean water goals. Statistically-valid assessments are critical for this evaluation.

To meet this need, the Environmental Protection Agency conducts National Aquatic Resource Surveys (NARS). The surveys use randomized sampling designs and consistent monitoring methods and laboratory protocols to assessments of water quality at the national and regional scales. Additionally, the national surveys help to build stronger monitoring programs across the country by fostering collaboration on new methods, new indicators and new water quality research. Many states are beginning to incorporate statistical surveys in their monitoring designs so that water samples are truly representative of the conditions across a specific water resource type, such as streams or lakes. These modifications can strengthen state programs as well as support better national assessments.

The NARS program consists of four surveys conducted on a five-year cycle in the lower 48 states. Each survey focuses on a different type of water body: lakes, wetlands, coastal waters, and streams and rivers. The rivers and streams survey collects samples at approximately 2000 sites during the summer index periods of two consecutive years. For each of the other surveys, EPA and its partners collect samples at more than 1000 randomly selected sites each year. Due to the staggered scheduling of the surveys, field sampling happens every year, but for only one survey at a time. Field sampling was conducted for the rivers and streams survey in 2008 and 2009, coastal survey in 2010; wetlands in 2011; and lakes in 2012.

The other years are used for research, survey design, laboratory evaluations, data analyses, and report writing. For example, for the coastal survey, research was conducted in 2008; survey designed in 2009; field sampling conducted in 2010; laboratory analyses performed in 2011; and data analyses and report writing are ongoing.

EPA requires quality assurance planning for all projects collecting environmental data. This requirement for quality planning is a longstanding policy at EPA. In addition, the QAPP process conforms to guidelines issued by the White House's Office of Management and Budget (OMB) under Section 515(a) of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Public Law 106-554; H.R. 5658). Within the NARS program, EPA

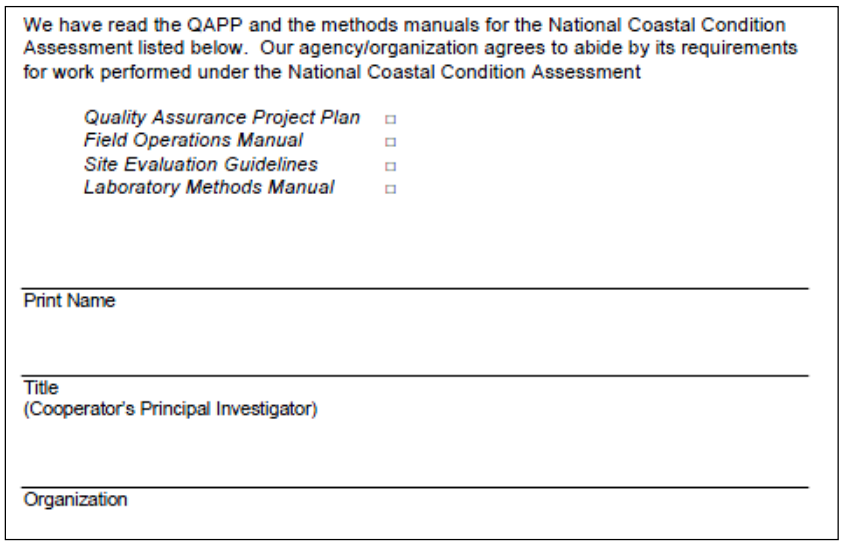
develops detailed quality assurance requirements for each survey to ensure consistency by all partners. EPA and its partners expend considerable effort in developing a Quality Assurance Project Plan (QAPP) that specifies precision and accuracy requirements for each stage of the survey. It is considered to be a living document that evolves as the survey planning progresses.

As a result of the initial research and planning, a draft version of the QAPP will identify the data quality objectives; the statistical and survey design; and the biological and chemical indicators to be evaluated in the survey. The draft QAPP will include detailed definitions of the locations that collectively make up the target population. EPA then uses reliable sources such as the United States Geological Service's National Hydrography Dataset as the basis of its sampling frame. Using a Generalized Random Tessellation Stratified (GRTS) survey design for an area resource, the survey design is a stratified design with unequal probability of selection based on area within each stratum. This design results in a geographically diverse selection of sites as required by the QAPP.

Before the field operations stage, the draft QAPP will incorporate, by reference, manuals that describe field operations, site selection, and laboratory analyses. It also outlines requirements for auditing, information management specifications, data analyses, and reporting. As a final step in ensuring quality and reliable results, the final data analyses and documents are released only after extensive peer and formal reviews are completed.

Throughout the survey planning, draft versions of the QAPPs are reviewed extensively by project staff, management, and EPA's quality assurance experts. As shown in the example provided in Figure 1, all partners must sign that they have read the QAPP and will adhere to its requirements. This agreement is generally collected before the field component of the survey. Throughout the life of the survey, EPA and its partners routinely identify and discuss ways to improve operations for the next cycle.

Figure 1 Excerpt from QAPP Signature Page for NCCA V


We have read the QAPP and the methods manuals for the National Coastal Condition Assessment listed below. Our agency/organization agrees to abide by its requirements for work performed under the National Coastal Condition Assessment

Quality Assurance Project Plan ☐
Field Operations Manual ☐
Site Evaluation Guidelines ☐
Laboratory Methods Manual ☐

Print Name

Title
(Cooperator's Principal Investigator)

Organization

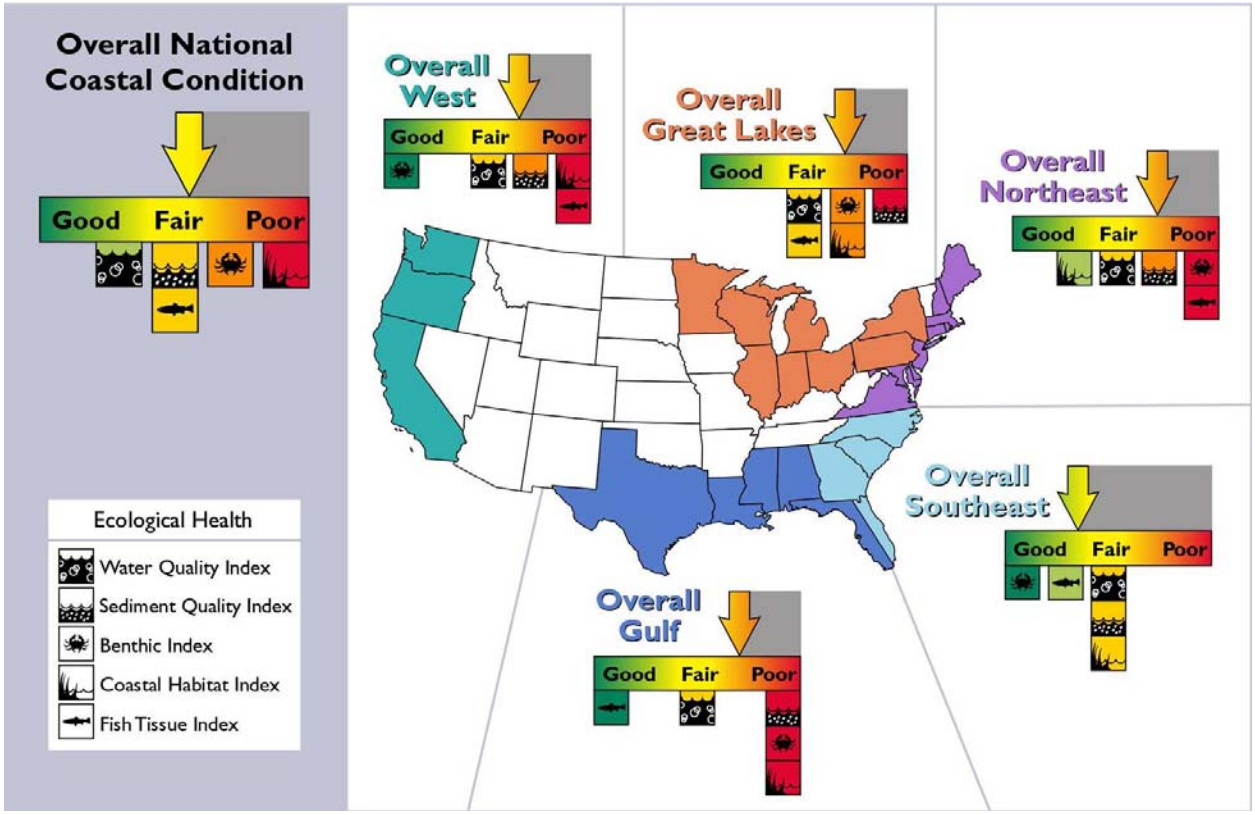
Coastal Survey

The formal title for the coastal survey is the National Coastal Condition Assessment (NCCA). Although the NARS program is relatively recent, the coastal survey is the fifth of a series of statistically designed surveys of the United States coastal waters and Great Lakes. Previously, the efforts were led by EPA's Office of Research and Development. For consistency between the water survey efforts, it was transferred to EPA's Office of Water a few years ago. It is unique among the NARS with its long history of data collection and evaluation.

According to the 2008 report for NCCA III, the overall condition of the Nation's coastal waters is fair, using five key indices of ecological health. The key indicators include water chemistry, sediment toxicity, macroinvertebrates, fish tissue, and coastal habitat. For each of these five key indices, a score of good, fair, or poor was assigned to each

coastal region of the U.S. These ratings were then averaged to create overall regional and national scores illustrated in the map below, using "traffic light" color scoring. The conclusions may change for NCCA V, but the underlying methodology will be similar to NCCA III. (NCCA IV is in draft form and undergoing final reviews at the time of the presentation.)

Figure 2 NCCA III (2008): Overall Condition



For NCCA V, the goal was to address two key questions. First question is “What percent of the Nation’s coastal waters are in good, fair, and poor condition for key indicators of water quality, ecological health, and recreation?” The second question is “What is the relative importance of key stressors such as nutrients and pathogens?” To answer these questions, the biological indicators for NCCA V are basically the same as those used in the previous four surveys. The most prominent change was the inclusion of coasts along the Great Lakes which required the addition of sample collection and laboratory methods for freshwater samples in addition to the coastal saltwater samples. Other EPA programs conducted special studies under the NCCA in the Great Lakes only: the Great Lakes Human Health Fish Tissue Study and the Great Lakes Embayment Enhancement Study. (Embayments are semi-enclosed by shoreline features, making them less hydrologically-open to open lake wind and waves.)

NCCA V was an extensive undertaking with approximately 50 field crews sampling nearly1400 sites in 30 states, several territories, and Canada. The states included 23 coastal states and eight Great Lake states. (New York had coastal and Great Lakes sites.) The field crews completed seven pages of field data observations. If they also collected samples for additional studies, they completed another five pages of field observations corresponding to the additional samples. The simultaneous measuring and recording often required a 2-person team. For this reason and others, EPA received many comments that the paperwork burden was rather intensive. For typical surveys, 7-12 pages of paperwork would be considered relatively minor. However, the paper itself was coded for scanning and required crews to use precise and legible hand-writing. Windy conditions also made dealing with multiple pages of paper difficult and cumbersome. Because of the windy and wet conditions, the paperwork sometimes was completed or recopied under cover away from survey operations. For future surveys, EPA is evaluating electronic devices that would provide quicker and easier recording under adverse conditions; improve the overall quality of data; and allow for and real-time access to field data in the NARS information management system.

For each site, the field team collected and labeled approximately 10 jars of water and sediment samples. To comply with short holding times generally accepted for water chemistry analyses, each team either docked soon afterwards or made arrangements to somehow transfer the water samples for overnight shipping. Because of the differences between water and sediment, the same rigorous requirement for overnight shipping was not required for sediment samples. Instead, these samples often were stored and shipped in batches at some later time.

Twenty-six state and contract laboratories participated in the survey. EPA reviewed certifications and other documentation to evaluate the laboratory's capabilities. EPA did not proscribe any particular analytical method, but instead identified QA and quality control specifications such as timing of equipment calibration (e.g., before each batch of 20 samples), the number of duplicate samples, and the minimum level of detection required for measuring particular chemical parameters. The NARS program encourages analytical method flexibility wherever possible because it allows more laboratories to participate, and thus, will improve the water measurement capabilities across the country.

As required by EPA policy and the NARS program, EPA developed a QAPP. As consistent with NARS practice, the NCCA team also developed the Field Operations Manual and Laboratory Manual. A fourth document detailing site selection was incorporated into the field operations manual. A fifth manual was laminated for use in the field and provided the highlights of the Field Operations Manual.

Consistency and Quality by All Partners

The more than 50 field crews for NCCA came from a variety of backgrounds. Some were EPA employees, but most were state employees who are responsible for implementing state specific programs as well as the NCCA. Other partners included the United States Geological Survey, United States Fish and Wildlife Service, the National Park Service, and the United States Forest Service. Because each of the partners generally have their own protocols for sampling, EPA required that each field crew member be trained in the NCCA field sampling protocols to ensure consistency in the survey operations. To facilitate the training, EPA conducted the 3 to 5 day sessions at various locations throughout the country. As the final step in training, EPA staff conducted assistance visits to evaluate each crew's adherence to the required protocol as evaluated using a lengthy 26-page form that details step by step the NCCA protocol. The visit was conducted early in the crew's sampling assignments, so that corrections could be incorporated early in the process.

Additional consistency is achieved through the use of common sets of materials for the field sampling. Although it would be impractical to provide all materials, EPA provided identical supply kits with sample labels, appropriately sized bottles and jars, and other materials specifically required for NCCA sampling.

In contrast to field sampling for which many experts are available for assistance visits, laboratory visits require more specialized knowledge. The team consulted with experts elsewhere in the Office of Water. These experts helped the team identify the important elements that should be evaluated, the expertise required to perform the evaluation (e.g., ability to identify equipment), and the need for such evaluations. For example, certain laboratories had certifications that are only granted after intensive week-long audits of the laboratory facilities. If a laboratory passed such a rigorous review, the team debated what more would be gained by an onsite visit. In addition, many laboratories participate in every survey conducted by the NARS program, and the team determined that it was not necessary to revisit the laboratory each year.

Data reviews are ongoing and the QA aspects continue to evolve. The initial QA elements focused on the field crew documentation collected during the sampling event itself. The next step was to perform the optical scan of the forms and correct obvious errors. The laboratory results have been consolidated and parsed out to subject matter experts for additional review. They use their expertise to confirm that the data are consistent with biological and chemical conditions associated with such sites. They also are comparing the NCCA V data to the previous versions of the survey.

Example of QAPP Application to Secchi Disk Measurements

The following example demonstrates the interplay between the QAPP requirements and the Field Operations Manual in using a Secchi disk to measure the transparency of the water to light. It is simple example for a parameter measured in the field, and thus, does not require additional laboratory elements. Figure 3 shows a Secchi disk being lowered into the water.

Figure 3 Secchi Disk

Figure 4 The QAPP's Table 5.2-1 (page 46) identifies the NCCA In situ indicators including the Secchi disk. The Field Operations Manual (page 43) defines the Secchi disk: "The Secchi disk is used to give a measurement of the transparency of the water column, also called the Secchi depth. This measurement is made at every station and is recorded on the datasheet. A 20 cm black and white Secchi disk is held by a non-stretch line that is marked in two tenths of a meter intervals."

Figure 4 QAPP In situ Indicators and Secchi Disk

Measure/Indicator		Specific data type	Assessment outcome
Water Quality	Dissolved oxygen	Observable on-site	Hypoxia/anoxia
	Salinity (marine), temperature, Depth, Conductivity (freshwater)	Observable on-site	Water column characterization
	Secchi/light measurements PAR	Observable on-site	Societal value and ecosystem production
	pH	Observable on-site	Water column characterization

The QAPP (page 46) provides followed by a brief summary of the procedure for using the disk (Figure 5).

Figure 5 QAPP: Secchi Disk General Procedures

> Secchi Depth Readings:
>
> Secchi depth will be determined by using a standard 20-cm diameter black and white secchi disc. The disc will be lower to the depth at which it can no longer be discerned, then it is slowly retrieved until it just reappears; that depth is marked and recorded as secchi depth (rounded to the nearest 0.5 m). This process is repeated two additional times for a total of three depth readings for each disappear/reappear measurement.

Although a Secchi disk is a common tool for water quality monitoring, EPA provides even more explicit instructions beyond the QAPP requirements. Page 43 of the Field Operations Manual provides step by step instructions for using it to obtain appropriate measurements. As shown in Figure 6, the instructions specify that vision be unaltered (e.g., by sunglasses), the disk be lowered on the shady side of the boat, and other requirements. It also specifies the required number of replications (three times) and the consistency of the measurements (within 0.5 meters).

Figure 6 Instructions for Using Secchi Disk

1. Remove sunglasses, hats or other devices used to shade the eyes.
2. Slowly lower the Secchi disk on the shady side of the boat until it is no longer visible and note the depth using the markings on the line (interpolate between markings to the nearest 0.1 meter).

   If the disk hits the bottom, meaning the Secchi depth is greater than the water depth, note this on the datasheet by marking the "Yes" circle under "Clear to Bottom?" and recording the depth of the water in both the "disappears" and "reappears" boxes.
3. Slowly raise the Secchi disk until it just becomes visible and note the depth.
4. Perform steps 1 and 2 two more times, noting both disappearance and reappearance depths each time.
5. Record all six measurements on the Field Measurement Form.
6. Flag any measurements that the team feels needs further comment or when a measurement cannot be made.
7. Repeat the entire process if the three sets of measurements vary by more than 0.5 m.

Lessons Learned

The NARS program, including NCCA, embeds quality within every aspect of planning, field sampling, laboratory analysis, and reporting. To ensure consistency, the Quality Assurance Project Plan is essential for each survey and necessitates many reviews and extensive supporting documentation to address the many challenges associated with environmental surveys. EPA and its partners are always eager to talk about improvements for the next survey in the series.

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