

I00S
U.S. Integrated Ocean Observing System
**NOAA's Role in Harmful Algal Bloom
Notifications and Warnings**



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1 NOAA's Role in HAB Notifications and Warnings

Harmful Algal Blooms (HABs) represent a major water quality issue of concern to multiple federal, state, and local agencies because of the impact on public health, water use by the public, and environmental impacts related to fish, shellfish, and other major biological species of interest. HABs are studied and evaluated with regard to: occurrence, causes, prevention, mitigation, migration, treatment, toxicity, exposure, effects, and risk assessment. HABs are events that need to be identified and then reported to those affected. In the case of beaches or recreational waters this includes the general public. Otherwise, state and federal agencies and commercial enterprises operating in those waters and exploiting fish/shellfish that could be contaminated need to know. Also, public health agencies need to be informed.

Currently the largest amount of data is collected manually with lab analysis performed on samples. Buoys can be equipped to measure chlorophyll as well as salinity, temperature, and currents. Depending on area this is done at different time intervals.

Using remote sensing technology, scientists at the National Oceanic and Atmospheric Administration (NOAA) have developed a way to identify and monitor harmful algal blooms. This monitoring detects HABs along the coastal areas of the U.S. where they are a growing concern and provides information to managers on how to reduce the impacts of these toxic blooms. Scientists from the National Centers for Coastal Ocean Science (NCCOS) monitor HABs using a combination of ocean color satellite imagery with field and meteorological data. The Sea-viewing Wide Field-of-view Sensor (SeaWiFS), owned by OrbImage, and the Moderate Resolution Imaging SpectroRadiometer (MODIS) provide information on the color of the water that can be used to determine characteristics of algal blooms. This satellite data, in conjunction with analysis of wind data from the National Weather Service and National Data Buoy Center, and field data from water samples provides enough information to predict bloom movement, landfall, persistence, and intensity.

Reducing nutrient inputs will reduce the number and severity of phytoplankton blooms, as measured by chlorophyll-a concentration in bays, estuaries, and their tidal tributaries. Fewer phytoplankton blooms will help to increase concentrations of dissolved oxygen, which is vital to aquatic living resources because there will be less organic material to consume oxygen when the phytoplankton mass dies, sinks to the bottom waters, and decomposes. These Systems also relate directly to Physical, Chemical, Biological, Geological, and Meteorological Measurements.

Currently, NOAA is routinely monitoring HABs in the Gulf of Mexico. The SeaWiFS data has helped identify the extent and magnitude of the blooms. On the Florida coast, the satellite imagery, coupled with models, provides advanced detection of blooms, allowing the state and local officials to better direct resources for sampling. In Washington State, the technology has improved sampling and research on domoic acid, a neurotoxin produced by a diatom, which may cause permanent short-term memory loss in victims and is associated with Amnesic Shellfish Poisoning (ASP). HABs Systems and Bulletins relate directly to the IOOS Societal Benefits to mitigate natural hazards (e.g., HABs, contaminated Beaches); reduce public health risks (e.g., direct exposure to humans, and contaminating seafood); protect ecosystems (e.g., food web distributions, fish and marine mammal kills); and sustain marine resources (e.g., contaminated fish and shellfish)

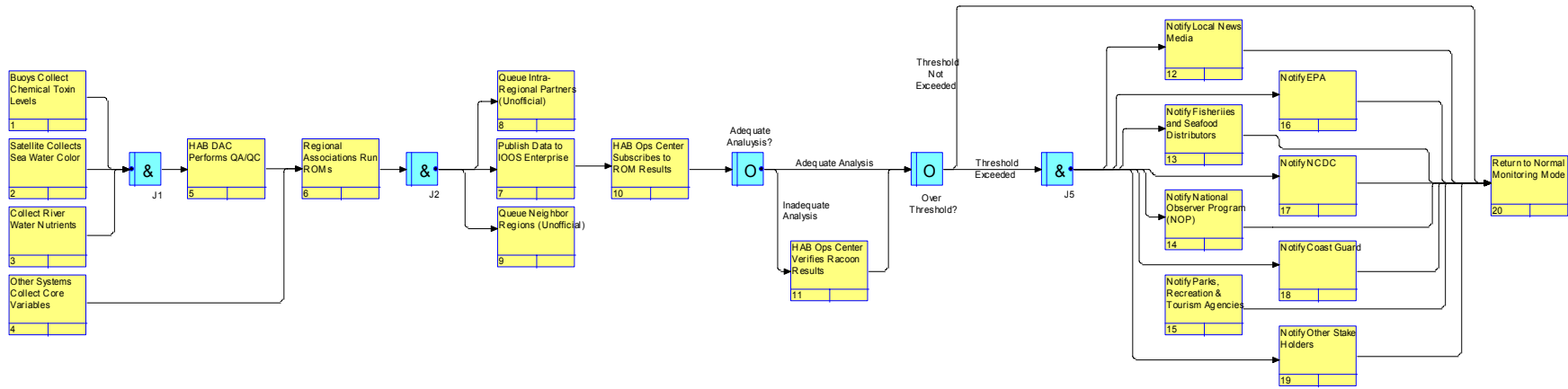


Figure 1, Harmful Algal Bloom Notifications and Warnings

Figure 1 has been extracted from Popkin's System Architect where it resides as an OV-6a diagram.

2 External Actors

The major external actors are the general public, fisheries and seafood distributors, as they are affected by warnings and notifications. Other external actors include the news media relaying notifications and warnings and unaffiliated local health organizations, hospitals, and medical personnel. On the upstream end external actors include the operations of the major satellite sensors SeaWiFs and MODIS.

3 Interfaces

Satellite sensor data is brought into NCCOS through what will be the CLASS integration point for IOOS. Notifications and warnings will go out through subscriber services and postings on websites and Real-time Subscriber Service (RSS) feeds.

4 Functional Flows

4.1 Primary Flow – Harmful Algal Bloom Detection & Notifications

4.1.1 Pre-Condition

The nominal pre-condition is sensor (remote and *in situ*) data flowing into NCCOS for analysis on a routine basis.

4.1.2 Trigger

The trigger is the end of the prior process as this is an ongoing scenario.

4.1.3 Process Description

Use Case Steps	Architecture Viability Assessment
<p>Step 10: Buoys Collect Chlorophyll Levels RCOOS automated near shore stations consist of a suite of sensors at locations along the coast. These automated sensors measure temperature, salinity, chlorophyll, turbidity and water level at frequent intervals in the nearshore coastal ocean. This data can provide local and regional information on mixing and upwelling, land run-off, and algal blooms.</p>	<p>This is a function performed by the IOOS Asset. Data from this asset is made available through the IOOS enterprise. Subscribers to this data are notified by metadata services the new data is available.</p>
<p>Step 20: Satellite Collects Sea Water Color The Sea-viewing Wide Field of view Sensor (SeaWiFS), owned by OrbImage, and the Moderate Resolution Imaging Spectroradiometer (MODIS) provide information on the color of the water that can be used to determine characteristics of algae blooms. This satellite</p>	<p>This is a function performed by the IOOS Asset. Satellite and buoy data is processed at their respective data assembly centers and made available to the IOOS enterprise. IOOS notifies subscribers and</p>

<p>data, in conjunction with analysis of wind data from the National Weather Service and National Data Buoy Center, and field data from water samples provides enough information to predict bloom movement, landfall, persistence and intensity.</p>	<p>updates the metadata catalog.</p>
<p>Step 30: Collect River Water Nutrient Levels The US Geological Survey, in cooperation with state and local agencies, and the US Environmental Protection Agency calculates the loads of nutrients and suspended sediments delivered to the bay or estuary being monitored. USGS calculates loads with a statistical model using flow data and nutrient and suspended sediment samples collected at specific monitoring sites.</p>	<p>This is a function performed by the IOOS Asset. Water quality data is processed at a data assembly center and made available to the IOOS enterprise. IOOS notifies subscribers and updates the metadata catalog.</p>
<p>Step 40: HAB DAC Performs QA/QC on HAB Data Satellite, buoy, and in-situ sample lab analysis data go to data assembly centers. QA/QC needs to be applied, with assessment placed into IOOS metadata.</p>	<p>This is a function performed by the IOOS Asset. QA/QC services are provided as an enterprise function by IOOS.</p>
<p>Step 50: Regional Associations Run ROMS In order to determine a forecast of both movement and growth of a bloom, the Regional Association runs the regional ocean modeling system (ROMS), which includes physical and biological modules.</p>	<p>ROMS is integrated at Level 3 so there are applications that have been encapsulated and made available as part of the RIN software.</p>
<p>Step 60 Publish Data to IOOS Enterprise Standard products out of ROMS will be published to IOOS Database, with appropriate metadata.</p>	<p>Since the ROMS is integrated at Level 3, the output is stored at the RIN and it's existence is exposed to the enterprise through the metadata catalog.</p>
<p>Step 70: Queue Intra-regional Partners (Unofficial) Standard products from ROMS can be sent to local agencies and governments for further sub-regional analysis.</p>	<p>The publish and subscribe services provide these activities.</p>
<p>Step 80: Queue Neighbor Regions (Unofficial) Standard products from one region can be placed into boundary and initial conditions for all neighboring partner regions.</p>	<p>The publish and subscribe services provide these activities.</p>
<p>Step 90: HAB Ops Center Subscribes to ROM Results Relevant standard product of ROMS is placed on the subscription list of HAB Ops center.</p>	<p>The publish and subscribe services provide these activities.</p>
<p>Step 100: Junction: Adequate Analysis? If analysis inadequate proceed to Step 110. If analysis adequate proceed to Step 120.</p>	<p>Decision. Manual determination of adequacy.</p>
<p>Step 110: HAB Ops Center Verifies Results HAB Ops Center performs another level of QA/QC on the data.</p>	<p>This is a function performed by the IOOS Asset. IOOS provides QA/QC processes for use by Regional Association.</p>

<p>Step 120: Junction: Threshold Exceeded? If threshold exceeded proceed to Step 130, If threshold not exceeded proceed to Step 230.</p>	<p>This is a decision point that it is possible to automate within IOOS but it may remain a manual process based on established policies.</p>
<p>Step 130: Junction: Simultaneous Notifications Notification of all agencies, preferably members of a regional HAB Community of Interest.</p>	<p>Messages are automatically generated by IOOS and sent to NOAA personnel who manually perform the notifications.</p>
<p>Step 140: Notify Local News Media Notification of news media that an event has been identified. Appropriate forecast data (like a weather report) should be provided.</p>	<p>NOAA personnel manually perform the notifications.</p>
<p>Step 150: Notify Local Health Organizations Notification of health organizations that an event has been identified. Appropriate forecast data (like a weather report) should be provided.</p>	<p>NOAA personnel manually perform the notifications.</p>
<p>Step 160: Notify Fisheries and Seafood Distributors Notification of fisheries and distributors that an event has been identified. Appropriate forecast data (like a weather report) should be provided.</p>	<p>NOAA personnel manually perform the notifications.</p>
<p>Step 170: Notify National Observer Program (NOP) Notification of NOP that an event has been identified. Appropriate forecast data (like a weather report) should be provided.</p>	<p>NOAA personnel manually perform the notifications.</p>
<p>Step 180: Notify Parks, Recreation & Tourism Agencies Notification of parks, recreation, and tourism agencies that an event has been identified. Appropriate forecast data (like a weather report) should be provided.</p>	<p>NOAA personnel manually perform the notifications.</p>
<p>Step 190: Notify EPA Notify EPA (should be part of Community of Interest). Appropriate forecast data (like a weather report) should be provided.</p>	<p>NOAA personnel manually perform the notifications.</p>
<p>Step 200: Notify NCDC Notify NCDC (should be part of Community of Interest). Appropriate forecast data (like a weather report) should be provided.</p>	<p>NOAA personnel manually perform the notifications.</p>
<p>Step 210: Notify Coast Guard Notify USCG (should be part of COI). Appropriate forecast data (like a weather report) should be provided.</p>	<p>NOAA personnel manually perform the notifications.</p>
<p>Step 220: Notify Other Stake Holders As above.</p>	<p>NOAA personnel manually perform the notifications.</p>
<p>Step 230: Continue to Monitor Data collection, analysis, QA/QC, and ROMS are all operational processes. Forecasts will be updated based on these ongoing processes.</p>	<p>This is a function performed by the IOOS Assets. Repeat above steps to continue monitoring operations.</p>

4.1.4 Post Condition:

The post condition is again the nominal state of acquiring data for analysis.