NERACOOS
Product Development - Harmful Algal Blooms

Summary of user need based products in the focus area of HABs. Product summary link to full product description and functional requirements.

Description of Feasbility Ranking (Scientific Functional Requirements)	Feasibility
*Have data/science available to build product *Minimal collaboration needed	**HIGH**
*Need more data *Requires moderate collaboration *More scoping required	**MEDIUM**
*Need more science to understand problem *Need more data *Need more assets (buoys, sampling equipment) *Requires high level of collaboration *More scoping required	**LOW**

Ref #	Product Summary	Feasibility
4	Generate alert (email or SMS text message) of probablitity of HAB formation when oceanographic conditions are met. The variables set by known scientific criteria which could include wind speed, duration, stress; possibly freshwater runoff, etc. Full description	**HIGH**
6	DMR HAB Index of toxicity patterns (scope and duration of blooms based on previous years and direct relationship between size, severity, environmental conditions) Full description	**HIGH**
7	Web based portal to access real time (dynamic) data of toxicity and cell count measurements by state. *Limited availability to managers and scientists* *Full description*	**HIGH**
8	Web portal to all available updates about ongoing research, models, preliminary results from surveys, sampling, etc. *Limited availability to managers and scientists.* *Full description*	**HIGH**
3	Fuzzy Logic (HABES type model) - statistical probability that a bloom is likely to occur if recognized environmental conditions are met (wind direction, nutrient levels, salinity, other). By inputing past HAB event data (what environmental conditions were occurring during HAB, tool begins to make inferences. An example is the deduction that: *IF wind velocity = LOW *AND surface temperature = high *THEN stability of the water column = high Where a correlation-based early warning model can answer the question of whether a HAB will occur with a simple 'yes' or 'no', fuzzy logic might give an answer like 'very low', 'low', 'middle', 'high' or 'very large probability of HAB formation'. Full description	**MEDIUM**

5	Identify areas of likely HABs based on chlorophyll/phytoplankton presence. Correlation between stratification, fluorescence, nutrients - compare optical proxies to cell count and scores. Full description	**MEDIUM**
9	Detailed characterization of major HAB events as they unfold; similar to "Storm Center" treatment of major winter storms and hurricanes. Distributed via weekly reports to managers on distribution and abundance of HABs (NOAA tool currently in operation in GOM as PDF, proposed for Northeast) Full description	**MEDIUM**
15	Historical archive and synthesis of available model output, HAB patterns, toxicity counts. Full description	**MEDIUM**
1	Short term forecast (48 -72 hour) early warning forecasts of HAB events for specific sections of the coast. Includes severity, transport, projected die off rates, etc. Full description	**LOW**
2	Seasonal/Interannual forecast - what will the severity and duration of upcoming HAB seasons be like? Full description	**LOW**
10	Visualizations of brown tide blooms - model output of locations and projected die off rate. Full description	**LOW**
11	DO profile data - current and historical to overlay with HAB info Full description	**LOW**
12	Nutrient data made available for current profile and historic values - visualizations of data in specified regions Full description	**LOW**
13	Consolidated information on chlorophyll and nutrients for trophic index Full description	**LOW**
14	Visualizaton of nutrient levels - maps with nutrient layers in areas of concern. Full description	**LOW**
Other user needs, not specifically web products - More Information		
16	In-situ remote HAB detection from buoys with data reported in real-time (MBARI ESP project)	
17	Improvements in biotoxin detection	
18	Investigate ability to depurate shellfish to remove toxin	

Harmful Algal Blooms - Full Product Description and Functional Requirements

User Need Source:
E02 = ECOHAB/GLOBEC 2002
K06 = Keeley survey, 2006
E06 = ECOHAB 2006
WP07 = White Papers from PI meeting 2007
B07 = Bowdoin HAB Symposium 2007

Category: Forecast		**Project #: 1**
Product Description	Short term forecast (48 -72 hour) early warning forecasts of HAB events for specific sections of the coast. Includes severity, transport, projected die off rates, etc.	
User Need | Source	Real-time to daily forecasts of bloom trajectories disseminated to both state agencies and aquaculture farmers to enable proactive management intervention. Start in early spring as early warning of what season will be.	E02, E06, B07
	3-7 day trajectory models to assist managers understand the timing, formation, duration, location and movement of HABs (e.g., projected shore-fall sites) and to support allocation of resources (e.g., state sampling staff, health advisories, beach closing, etc.). The Aquaculture industry can also move product to safer waters or harvest it.	K06
	Improved predictive capabilities for forecasting harmful algal bloom events, severity and transport.	E02
	Predict the timing, duration and location of HABs.	E02
	Predict the transport of nutrients, contaminants, HABs and larvae.	E02, E06
Technical Requirements (have)	Operation circulation model (Huijie Xue - U Maine); Codar (GoMOOS); Buoy Data (GoMOOS, UNH, MVCO)	
Technical Requirements (need)	Need more cell count samples at various coastal sites. Currently depends on research cruises detecting cells. Automated cell detection on moorings is exciting, but expensive at current time - $150k per unit. Would also need to adjust circulation models to do particle tracking (Science Center).	
Feasibility	Requires sustained operational models, buoy data, codar. Process for more regular cell counts and scientific analysis (automated detectors or weekly cruises).	**DIFFICULT**
Notes	Operational HAB forecast is a projected outcome of GOMTOX effort (WHOI and others - 2010 time frame). Experimental use of automated HAB detection devices is part of NERACOOS CSC proposed work.	

Category: Forecast		**Project #: 2**
Product Description	Seasonal/Interannual forecast - what will the severity and duration of upcoming HAB seasons be like?	
User Need | Source	Long-term forecasting of trends to conduct long-term planning.	E02
	Want yearly cyst bed data	E06
Technical Requirements (have)	Annual cyst bed survey, analysis by HAB scientists (ECOHAB/GOMTOX), NAO forecast, etc.; Have oceanography (circulation models, buoy data)	
Technical Requirements (need)	Regular cyst bed surveys (annual or bi-annual spring/fall), regular analysis of previous year combined with cyst bed survey results, statistical methods to maximize cyst sampling. Better codar.	
Feasibility	Would require sustained cyst bed surveys or confidence in statistical inference of fewer samples. Could be improved with better codar and wind forecast.	**DIFFICULT**
Notes	Not predicting specific weather driven events at particular location (not accurate wind forecast), more general prediction of what the season will be like (spring cyst sampling, circulation model), and following season (based on analysis of previous year, late fall cyst sampling). Anderson is working on statistical extrapolation with less actual cyst bed sampling.	

Category: Forecast		**Project #: 3**
Product Description	Fuzzy Logic (HABES type model) - statistical probability that a bloom is likely to occur if recognized environmental conditions are met (wind direction, nutrient levels, salinity, other). By inputing past HAB event data (what environmental conditions were occurring during HAB, tool begins to make inferences. An example is the deduction that: *IF wind velocity = LOW *AND surface temperature = high *THEN stability of the water column = high Where a correlation-based early warning model can answer the question of whether a HAB will occur with a simple 'yes' or 'no', fuzzy logic might give an answer like 'very low', 'low', 'middle', 'high' or 'very large probability of HAB formation'.	
User Need | Source	Probabilty of HAB if certain environmental conditions are reached (wind direction, fresh water input, NAO)	E06
Technical Requirements (have)	Conditions from previous events - input into system and outcomes will start to predict likelihood of HAB based on previous conditions. HABES product in EU for congener to *A. tamarense*.	
Technical Requirements (need)	Need to know what inputs could be relevant - wind, rain, air temp, etc. Talk to HABES folks in EU about what worked, what didn't.	
Feasibility	This would take time to get right. EU orginal models weren't that great until they startedh integrating recent history. Worthy of investigation in our region.	**MEDIUM**
Notes		

Category: Indices		**Project #: 4**
Product Description	Generate alert (email or SMS text message) of probablitity of HAB formation when oceanographic conditions are met. The variables set by known scientific criteria which could include wind speed, duration, stress; possibly freshwater runoff, etc.	

User Need | Source	Winds, current real-time conditions; want to know when CC gate is "open" or "closed" to determine liklihood of bloom.	E06, B07
Technical Requirements (have)	Buoy data, known relationship to wind (stress/direction/time of year), would set conditions for user, wind forecast available (NCEP)	
Technical Requirements (need)	Operational wind forecast, wind stress calculation. Understanding of role freshwater plays in system, then would need freshwater data (precipitation data from NWS?)	
Feasibility	In concept, this product is relatively easy to develop. What remains to be understood is accuracy of wind data in prediciting HAB likelihood.	**EASY**
Notes	GoMOOS is developing wind forecast for CICOR project and notification services for buoy data; both would be integral to this product.	

Category: Indices		**Project #: 5**
Product Description	Identify areas of likely HABs based on chlorophyll/phytoplankton presence. Correlation between startification, fluorescence, nutrients - compare optical proxies to cell count and scores.	
User Need | Source	Where might a potential HAB occur (optical sensor network - real time, available on website)	B07
Technical Requirements (have)	Chlorophyll, fluorescence on a few buoys; chlorophyll from satellite, cell counts and scores from agency	
Technical Requirements (need)	For operational, need more chlorophyll and fluorescence meters on buoys.	
Feasibility	For prototype (regionally specific to areas with meters), we have the sensors. Need to evaluate the relationship proposed by scientists to determine if index would provide useful information.	**MEDIUM**
Notes	Dr. Roessler from Bigelow has been working in this area. Need more information from her on likelihood of developing index for GOM.	

Category: Indices		**Project #: 6**
Product Description	DMR HAB Index of toxicity patterns (scope and duration)	
User Need | Source	Correlation between toxicity patterns throughout GOM.	E07, B07
Technical Requirements (have)	Darcie Couture at DMR developed index, could be made dynamic with real time toxicity data, available to other managers and scientists in other states.	
Technical Requirements (need)		
Feasibility	Index has been developed (Maine DMR) would need to determine scope of product was a hindcast, forecast or real-time.	**EASY**
Notes		

Category: Real Time Updates		**Project #: 7**
Product Description	Web based portal to access real time (dynamic) data of toxicity and cell count measurements by state. Limited availability to managers and scientists	
User Need | Source	MA and NH want upstream conditions from ME	E06
	Cell count measurements	E06
	Need to know toxicity measurements from neighboring states as they are getting them (upstream conditions)	E06
	Vol phytoplankton results	E06
Technical Requirements (have)	Agency data is available. GoMODP to integrate, DMR would need automation to get cell data into system.	
Technical Requirements (need)	Agencies need to report in near real time to database. Maine to begin cell count protocol this year.	
	Agency needs to report volunteer data in near real time to database. Maine to begin cell count protocol this year.	
Feasibility	Technically easy to do; the agencies have the data. Would need to develop an easy to use, secure, dynamic portal for accessing the information.	**EASY**
Notes		

Category: Real Time Updates		**Project #: 8**
Product Description	Web portal to all available information about ongoing research, models, preliminary results from surveys, sampling, etc.	
User Need | Source	Consolitdate and make available known data sets, model output, etc	E06, K06
Technical Requirements (have)	Have data, model output, sampling results, etc.	
Technical Requirements (need)	Understanding of what tools are available, how they should be shared and secure access issues. Could be links to HAB scientists sites, or development of portal with scientist on their site (WHOI HAB)	
Feasibility	Similar in concept to the centralized agency (cell count, toxicity data). A place for accessing latest known information, survey results, cruise data. Would require collaboration with data providers (agency and scientist) to determine what types of data/tools should be there.	**EASY**

Notes	

Category: Real Time Updates		**Project #: 9**
Product Description	Detailed characterization of major HAB events as they unfold; similar to "Storm Center" treatment of major winter storms and hurricanes. Distributed via weekly reports to managers on distribution and abundance of HABs (NOAA tool currently in operation in GOM as PDF, proposed for Northeast)	
User Need | Source	Real-time weekly reports on the distribution and abundance of HABs	E06, K06, WP07
Technical Requirements (have)	northeastpsp listserv from WHOI is current method for communication between scientists and managers	
Technical Requirements (need)	To measure HABs and have useful numerical model (Huijue - operational, McGill - research, Quoddy, Chen). Requires buoys (EW current), codar, ships, drifters, gliders (looking for coastal current). Also requires analysis during event. Synthesis of real-time data (observations, analysis, sampling, surveys) and transfer via email or other method.	
Feasibility	Requires operational capacity to synthesize and distribute this data. NOAA has done this in other regions, has plans to do for GOM	**MEDIUM**
Notes	NOAA working on this as part of larger GOM HAB work. 2009 rough timeline. Would require someone to assimilate and transfer info via email (PDF) or Text message.	

Category: Environmental Data		**Project #: 10**
Product Description	Visualizations of brown tide - locations and die offs	
User Need | Source	Spatial coverage of the rates and locations of brown-tide die off	K06
Technical Requirements (have)	Brown tide blooms tend to occur at end of non-brown tide bloom die off (can be fed by organic nutrient in water as well as benthic sources outcompeting other species). Grazing (shellfish, zooplankton) seems to play a large role in reducing bloom.	
Technical Requirements (need)	More science on the cause of brown tide blooms and relationship to non-brown tide blooms. Suspected to be nutrient/temperature related. Need point specific flushing rates/circulation data for estuarine systems. Need a model that understands biology of organism (nutrient rate/die off/etc)	
Feasibility	Need more understanding of issue - where is it happening, is prevention or mitigation the goal, or both? Is the product a circulation model?	**DIFFICULT**
Notes	Big problem in NY and Mid-Atlantic states, possible issue in RI/CT. New York Sea Grant published document on brown tide research initiative in 2006).	

Category: Real Time Updates		**Project #: 11**
Product Description	DO profile data - current and historical to overlay with HAB info	
User Need | Source	Trend data on DO levels to document bloom die-off and effect on marine organisms	K06
Technical Requirements (have)	There are only a few DO sensors on buoys - New Meadows, Bowdoin buoys	
Technical Requirements (need)	More sensors, small buoys and gliders to deploy during low DO events. Talk to Al Hansen (URI) and LI people.	
Feasibility	Will require more sensors -	**DIFFICULT**
Notes		

Category: Real Time Updates		**Project #: 12**
Product Description	Nutrient data made available for current profile and historic values - visualizations of data in specified regions	
User Need | Source	Nutrient climatolgoy	E06
Technical Requirements (have)		
Technical Requirements (need)	Nutrient measurement capability on buoys. Talk to Ru at UNH (have on buoy. Using model to compare this year to normal), Hanson at URI (ISIS - optical from Satlantic).	
Feasibility		**DIFFICULT**
Notes		

Category: Real Time Updates		**Project #: 13**
Product Description	Consolidated information on chlorophyll and nutrients for trophic index	
User Need | Source	Trophic index updated no less than weekly (such data would be very useful in conjunction with satellite (e.g. MODIS) data and surface temperatures)	K06
Technical Requirements (have)	chlorophyll data, and info from satellites is available.	

Technical Requirements (need)	Is this a solution watiting for a problem? (relevance? Trophic index?)	
Feasibility		**DIFFICULT**
Notes		

Category: Real Time Updates		**Project #: 14**
Product Description	Visualizaton of nutrient levels - maps with nutrient layers in areas of concern.	
User Need | Source	Inter-annual and seasonal assessments of off-shore vs. nearshore sources of nutrients	K06
Technical Requirements (have)		
Technical Requirements (need)	Nutrient measurement capability on buoys. Talk to Ru at UNH, Hanson at URI.	
Feasibility		**DIFFICULT**
Notes		

Category: Historical		**Project #: 15**
Product Description	Historical archive and synthesis of available model output, HAB patterns, toxicity counts.	
User Need | Source	Historical synthesis of the frequency (monthly, seasonal & inter-annual), duration and spatial occurrence of HABs	K06
Technical Requirements (have)	Have data, model output, historical analysis (research papers, reports, etc)	
Technical Requirements (need)	Work with HAB researchers to rebuild stories of past HAB events in useable format for end users (managers, scientists). May already have done this. Would need to be credited and developed carefully with scientists.	
Feasibility		**MEDIUM**
Notes		

Other user needs not identified as web products		
Product Description | Ref #	In-situ remote HAB detection from buoys with data reported in real-time (MBARI ESP project)	**16**
User Need | Source	Environmental Sample Processor detects presence of target species in real time via RNA analysis.	E06
Notes	In NERACOOS CSC proposal for HAB investigation	
Product Description | Ref #	Improvements in biotoxin detection	**17**
User Need | Source	Improve biotoxin detection methods that are field-based, reliable and affordable.	E02, E06, B07
	Whole scallop aquaculture - improve testing methods	B07
Product Description | Ref #	Investigate ability to depurate shellfish to remove toxin	**18**
User Need | Source	Toxin depuration rates	
Notes	DMR is planning to investigate this in 2007-2008	B07

Sources of user needs used to develop potential products

M07 - Workshop on Coastal Managers Needs for Coastal and Ocean Observations for Inundation – MACOORA, Baltimore, MD November 2006

- 2-day user needs workshop focused on identifying the needs of coastal managers in the MACOORA region for estuarine and coastal observations products and tools for planning and managing coastal inundation, including the effects of both storm surge and sea level rise.
    - 70+ representatives from federal, state and local governments, research community, and private sector representing Mid-Atlantic region (including CT, MA and RI).

K06 - Synthesis of Coastal Managers Needs for Ocean Observing Products and Services – The Keeley Group – September 2006.

Synthesizing user needs from the following sources:

- Workshops:
    - Managing Nitrogen Impacts in the Gulf of Maine – 2001
    - Gulf of Maine Coastal Monitoring Strategy – 2002
    - Northeast Coastal Indicators Workshop – 2004
    - Gulf of Maine Summit – 2004
- Proceedings:
    - Alaska User Needs Assessment, May, 2004
    - Coastal and Ocean Observing System User Requirements: An Examination of User Surveys. (Boyd 2000)
    - Improving Methods and Indicators for Evaluating Coastal Water Eutrophication: A Pilot Study in the Gulf of Maine. NOAA/CICEET (Bricker, Lipton, Mason, Dionne, Keeley, Latimer, Pennock 2005)
    - Recommendations to the US Commission on Ocean Policy. 2004 (Coastal States Organization.)
    - SECOORA Ocean Observing Market Analysis; Appendix A Compendium of Needs Assessment Documents. (Eslinger 2004)
    - Great Lakes Observing System. Public Survey. August 2005.
    - More Effectively Using Observing, Monitoring, Research and Education Infrastructure. California and the World Ocean Conference Proceedings (Keeley, Gregorio, Bailey 2002)
    - Ocean Observing and Coastal Managers Users Needs. Coastal States Organization/Anchorage Alaska Annual Meeting. (Keeley 2003)
    - Great Lakes Coastal Managers User Needs Focus Group. NOAA & Coastal States Organization – Chicago, Illinois (Keeley 2005)
    - Southeast Coastal Managers User Needs Focus Group NOAA & Coastal States Organization – Jacksonville, Florida (Keeley 2004)
    - Nutrients and Coastal Managers Needs. NOAA Eutrophication Workshop – Patuxent Maryland. (Keeley 2002)
    - Information Needs for Fishery Management in Maine. Gulf of Maine Modeling Workshop – Portland, Maine (Mercer 2002)
    - NOAA National Ocean Service Requirements for the integrated Ocean Observing System: Case Study for Coastal Management. (Mitreteck Systems 2005)
    - A Demonstration of the Alaska Ocean Observing System in Prince William Sound: Alaska Ocean Observing Workshop. (Schoch, McCammon 2005)
    - A User Assessment of Coastal Ocean Observation Systems in the Gulf of Mexico. (Thurlow, Kruse, Bierling 2004) Texas Sea Grant Program/Texas A&M University System

- State Coastal Observations and Monitoring Needs: Results of a Survey to Assess Coastal Management Needs. (Urban Harbors Institute 2004) Coastal States Organization/SEACOOS Outreach and Education Work Group
- Improving Links Between Science and Coastal Management: Results of a Survey to Assess Science and Technology Needs. (Urban Harbors Institute. 2004) Coastal States Organization/NOAA - Cooperative Institute for Coastal and Estuarine Technology
- Summary of Needs from CeNCOOS Stakeholders. (Watson 2004)
- Additional notes from personal communication and informal meetings with stakeholders in NE region

E02 - ECOHAB/GLOBEC Gulf of Maine Modeling Workshop – June 2002

- Management and scientific informational needs for harmful algal bloom and fisheries forecasting in the Gulf of Maine - A framework for moving toward an operational capability
  - Workshop sponsored by CSCOR to facilitate the transfer of model-based research products into the hands of managers and stakeholders for environmental decision-making. Over 30 participants from state and local governments, research community representing ME, MA, NH and the Maritimes. (Including WHOI, NOAA, MA DMF, ME DMR, DFO, NMFS, MWRA, UMaine, UMass)

E06 - ECOHAB User Needs workshop – December 2006

- Third of three scheduled workshops under ECOHAB project. Focused on gathering User needs workshop with
- 30+ representatives from state and local governments, research community representing ME, MA, NH and the Maritimes. (Including WHOI, NOAA, MA DMF, ME DMR, NMFS, MWRA, UMaine, UMass)

N05 - Storm Surge Tools and Information: A User Needs Assessment - NOAA Coastal Services Center 2005

- Interviews were conducted with key professionals from NOAA, FEMA, professional associations, state and local governments, nongovernmental organizations, and private sector.
- On-line needs assessment sent to 552 professionals and distributed through Association of State Floodplain Mangers (ASFPM) and regional NWS Weather Forecast Offices. 254 responses received
- Focus Group Sessions for 61 individuals representing 10 states held in CT, MA and FL.

GoMOOS Annual Survey 2005, 2007

- 2005 Survey – 455 participants
- 2007 Survey – 300 participants (1 week remaining in survey)