

1. Purpose/objective

NOAA supports a broad product suite that provides information for decision-makers dealing with Lake Erie Harmful Algal Bloom (HAB) issues. The National Centers for Coastal Ocean Science (NCCOS) Lake Erie HAB-Forecast System (HAB-FS) is comprised of a seasonal outlook and twice-weekly bulletins during bloom season. The goal of this transition is to establish an initial operating capability for twice-weekly bulletin, that provides information on the current size density and location of the HAB as well as a 72 hr forecast of these parameters, at the Center for Operational Products and Services (CO-OPS) in 2016, with full operational capability as a HAB-Operational Forecast System (HAB-OFS) by the bloom season in summer 2017 (June 1). This transition plan documents the steps necessary to achieve that objective without additional resources to base budgets. There are also related observations/data streams that will require a long term plan for funding to support the sustainment of operational requirements of the Lake Erie HAB forecast system.

2. Business case

2.1. User: The traditional user community that sets the requirements for the NCCOS experimental Lake Erie bulletin is comprised of state agencies, largely in Ohio. Ohio EPA typically brokers information flow to the public water treatment facilities, while the Ohio Sea Grant/Stone Laboratory is a key conduit for broader/public information coordination. The products also have some utility for the recreational/tourism sectors, and in the last year the Ohio Department of Health has taken on a greater role with respect to recreational advisories. The bulletins are available to the general public via a listserv, which currently has >1600 subscribers.

2.2. User requirements: The fundamental requirement is to provide advance notice of potential threats to public water supplies. Both the seasonal outlook (not to be transitioned) and the bulletins meet the defined needs, at different temporal scales. Stakeholders have indicated they need to know where the bloom is, how big it is and where the bloom is going. They have requested satellite imagery, wind information, and current information, as well as a bulletin forecast in an easy to use format that is smart-phone friendly. To make effective water treatment decisions, Lake Erie water quality managers require as fine a forecast resolution (both in space and time) that NOAA can produce, as well as a forecast that addresses the entire vertical profile of the water column (since the water intakes are subsurface). The forecast system is thus typically delivered twice weekly on Mondays and Thursdays mornings, a schedule based on operational constraints such as satellite imagery availability, and the twice-weekly frequency has been demonstrated as sufficient to meet user needs. There are also user-requested model enhancements such as toxin information which could be incorporated later in an operations-to-research-to-operations loop.

2.3. Current demonstration system: The demonstration HAB-FS product suite is comprised of a rolling seasonal outlook (with the final seasonal prediction typically released at a media event in the first week of July), and a twice-weekly bulletin issued during the HAB season-- essentially, from the first week of July until the bloom dissipates for the season (typically October). Only the twice-weekly bulletin would be transitioned to CO-OPS, with NCCOS retaining production of the

seasonal outlook. Bulletin production relies on satellite imagery (derived cyanobacterial index), hydrodynamic models (particle transport), and in situ observations (winds, water temperature, and cell counts). The data components are described in more detail in section 3 below. The information is currently disseminated via an email list that informs subscribers that a new bulletin has been posted to the NOAA Lake Erie HAB OFS website.

Additionally, GLERL produces a hydrodynamic model that projects Lake Erie HAB bloom transport and concentration. That model is also in an experimental/demonstration status, and has been proposed (via RTAP) to transition in out-years as an enhancement to the HAB-OFS.

2.4. Justification for transition: The 2014 water crisis in Toledo has been a galvanizing event for HAB forecasting in Lake Erie. There continues to be high visibility and interest in Lake Erie HAB forecasting products, including Congressional interest. Besides public drinking water concerns, there is a substantial tourism industry in Lake Erie, and HABs have the potential to lead to beach closures, effects on fishing/boating, and other recreational activities.

The NCCOS bulletins have been produced in demonstration mode since 2009, and have proven utility. Given this demonstrated reliance for decision making, it is critical that the bulletins be transitioned to operations to ensure a commitment to deliver them in a manner that is sustained, systematic, reliable, and robust as supported by funding, infrastructure and expertise.

3. Capabilities and functions

3.1. Current capabilities: The NCCOS bulletin is constructed from satellite data, modeled current data, and in situ observations (temperature, wind, and cell counts), produced as a PDF (see Appendix 1 for process), and distributed via an email listserv and HTTP (note, NCCOS uses this mechanism to distribute both the rolling seasonal forecast and the twice weekly bulletin). The demonstration process is documented by a Standard Operating Procedure. The system is currently at Readiness Level 7 (as defined in NAO 216-105): Prototype system, process, product, service or tool demonstrated in an operational or other relevant environment (functionality demonstrated in near-real world environment; subsystem components fully integrated into system). As the system is still in demonstration mode, ancillary activities (technical advice for stakeholders, user-requested enhancements, etc.) are a seamless part of the extant procedures.

It is important to note that the twice-weekly bulletins are part of a larger Lake Erie HAB product suite supported across multiple line offices (NOS and OAR/GLERL, with additional interest from NWS), and that NCCOS provides a number of informal products and technical advice to stakeholders beyond simply producing the bulletin. The 2015 bloom season highlighted the need to provide a coherent and consistent NOAA-wide voice in disseminating Lake Erie HAB information, and product delivery and stakeholder interactions for the bulletin need to be evaluated and coordinated in this larger context.

3.2. Operational description: CO-OPS has prepared a conceptual information flow for the Lake Erie HAB-OFS (Figure 1), executed primarily through an Arc-GIS and hardware infrastructure to

handle end-to-end lifecycle of HAB-OFS products, with supporting software systems (GNOME) for particle tracking modeling. The specific roles and responsibilities for observations, model guidance, dissemination and stakeholder interactions will be outlined in a separate CONOPS document.

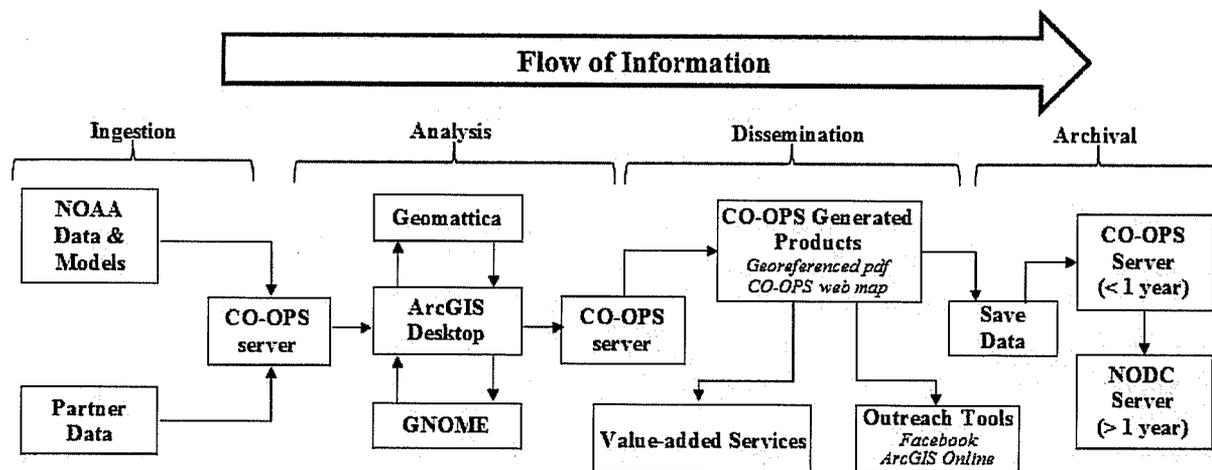


Figure 1. A conceptual flow of information for an ArcGIS-based HAB-OFS infrastructure (Davis, 2014). Updates and efficiencies achieved during transition may alter this workflow.

Given that NCCOS will retain the seasonal Lake Erie HAB outlook, there will be greater opportunity for subject matter interactions (consultations as well as potential joint staffing and/or shared responsibilities) between offices than there has been in HAB forecasts that have been transitioned previously (Gulf of Mexico for Florida and Texas). That type of close collaboration would provide for greater opportunities for planning and implementing product enhancements (operations-to-research-to operations loop) or other types of operational support.

3.3. *Data collection and management:* The system currently relies on satellite imagery -- primarily MODIS, though Sentinel-3/Ocean and Land Colour Instrument is expected to come online during FY16. Image processing and algorithm applications have been done in NCCOS historically, and NCCOS has discussed with NESDIS the potential for them to assume that processing responsibility. The in situ observations come from a variety of sources, including OAR's Great Lakes Environmental Research Lab (GLERL), the National Weather Service weather forecast offices in Cleveland and Detroit, and state/academic partners. It is expected that the Lake Erie HAB-OFS will rely on the continuous and reliable delivery of observations and model input data as outlined in the table below.

Data Type	Data Provider(s)	Funding Type	Criticality
Satellite Imagery (MODIS)	NESDIS	Base	critical
Phytoplankton community	OAR/GLERL	GLRI/Research Mandate	validation

composition and enumeration	Ohio EPA	State mandate	
Toxins (particulate and dissolved microcystins)	OAR/GLERL	GLRI/Research Mandate	helpful
	Ohio EPA	State mandate	
Extracted chlorophyll, phycocyanin.	OAR/GLERL	GLRI/Research Mandate	helpful
Observed winds	NOS/CO-OPS	Base	critical
	NWS/ASOS	Base	
	OAR/GLERL	GLRI/Research Mandate	
Forecasted winds	NWS	Base	critical
Forecasted wind uncertainty	NWS	Base	helpful
Observed water temperature	NOS/CO-OPS	Base	helpful
	OAR/GLERL	GLRI	
Nowcast/Forecast surface currents	NOS/CO-OPS	Base	critical

4. Transition activities

The transition implementation has been designed around advancing Readiness Levels. Specific steps in each phase are outlined in Appendix 2.

4.1. Phase 1: November 2015-July 2016. Prepare extant system for transfer.

System status: RL 7. Prototype system, process, product, service or tool demonstrated in an other relevant environment (NCCOS).

Phase goal: RL 7. Modification of system processes for use in operational environment (CO-OPS).

Interim deliverables:

- transition meeting (February 2016),
- updated written user requirements (February 2016),
- NCCOS SME brief providing summary of demonstration forecast skill to CO-OPS/OD Chief (FY 2016)

4.2. Phase 2: July 2016-November 2016. Establish and test initial operating capability at CO-OPS by the end of the 2016 bloom season (e.g. bulletin production in parallel at CO-OPS and NCCOS).

System status: RL 7.

Phase goal: RL 8. Finalized system, process, product, service or tool tested, and shown to operate or function as expected within user's environment; user training and documentation completed; operator or user approval given.

Interim deliverables:

- CO-OPS production of bulletins during the 2016 bloom season in parallel (by the end of June 2016).
- NCCOS will continue to distribute the bulletin through extant mechanisms during the 2016 bloom season, ingesting bulletins produced by CO-OPS as appropriate.

4.3. Phase 3: November 2016-November 2017. CO-OPS system is fully operational.

System status: RL 8.

Phase goal: RL 9. System, process, product, service or tool deployed and used routinely.

Final deliverables:

- CO-OPS HAB Full Time Analysts:
 - maintain documentation (standard operating procedures),
 - perform regular skill assessments, and
 - test product enhancements.
- CO-OPS production of semi-weekly bulletins during the bloom season, with NCCOS in an advisory capacity.
- NCCOS and CO-OPS will have established through the CONOPS how to distribute the full suite of products (e.g. both the weekly and seasonal forecasts, which are currently distributed through a single mechanism but will not both transfer to CO-OPS).

5. Schedule and deliverables

The decision gates for the Lake Erie HAB transition are designed around moving to the next higher Readiness Level (RL). Since the forecast is already in RL 7, transition of the Lake Erie HAB forecast system also includes a brief that demonstrates that the forecast system meets defined and peer reviewed skill criteria. Finally, since the transition follows CO-OPS' internal project management paradigm, we include the close-out brief for the project as a decision gate. The transition gate will also serve as an opportunity for the approval authorities to request updates to the transition plan as needed.

Date	Gate	Presented by	Approval authority
FY 2016	Forecast system meets defined and peer reviewed skill criteria	NCCOS SME	CO-OPS (OD Chief), NCCOS (TBD)
July 2016	Extant system prepared for transfer (modification of	NCCOS SME and analyst	CO-OPS (OD chief, OD/PMAB chief) and

	extant RL7)		NCCOS (CCMA director, CCMA/COAST chief)
November 2016	Establish and test initial operating capability at CO-OPS (achieve RL8)	NCCOS analyst and CO-OPS HAB product coordinator	CO-OPS (OD chief, OD/PMAB chief) and NCCOS (CCMA director, CCMA/COAST chief)
July 2017	Formal closure of internal CO-OPS project management with respect to the planning and resources for the transition phase.	CO-OPS HAB product coordinator	CO-OPS' Executive Leadership Team (ELT)
November 2017	CO-OPS system is mission proven in an operational environment (RL9)	CO-OPS HAB product coordinator	CO-OPS director, NCCOS director

6. Roles and responsibilities for transition

NCCOS provides subject matter expertise for the Lake Erie HAB bulletin, and R&D for HAB forecast development based on operational and user needs. For transition, NCCOS is responsible for packaging its extant processes for use in an operational environment, producing the bulletin for the 2016 season, training CO-OPS staff on bulletin production, and determining when CO-OPS has acquired sufficient skill to take over primary bulletin production. NCCOS is also responsible for developing model improvements to support future transitions.

CO-OPS runs NOAA's only operational HAB forecasts (Gulf of Mexico for Florida and Texas), and is one of the NOAA data providers for the Lake Erie HAB bulletin. For transition, CO-OPS is responsible for building its HAB-OFS infrastructure, providing infrastructure details to NCCOS to ensure components to be transferred are system-compatible, obtaining training from Lake Erie HAB SMEs on the forecast system, and developing required supporting documentation such as standard operating procedures.

GLERL conducts research (field observations and modeling) on HABs in Lake Erie and throughout the Great Lakes. The field observations (specifically chlorophyll, phycocyanin, phytoplankton community composition and enumeration, particulate and dissolved microcystins and observed winds and water temperature) are important for model validation, understanding bloom dynamics and toxicity, and for future bulletin enhancements to meet operational and user needs. GLERL's FVCOM HAB particle model is slated (through FY17 RTAP funding) to replace the transport module (GNOME) in the current bulletin.

Responsibilities for specific transition actions are outlined in Appendix 2. Carolyn Lindley, OD/PMAB branch chief, is the resource manager responsible for ensuring transition activities occur within CO-OPS and working with NCCOS to resolve issues that may arise during transition. Greg Piniak, CCMA/COAST branch chief, is the transition project lead for NCCOS.

7. Budget overview

7.1. Cost of current system: The extant data streams are disparate-- and somewhat difficult to amortize, given that some components are essentially operational by other entities (e.g. satellite data acquisition), or supported by a mix of reimbursable funding (e.g. GLERL's Great Lakes Restoration Initiative HABs monitoring project) that is not guaranteed in the long term and GLERL base budget for long-term Great Lakes observations. GLERL's FY15 cost to support the bulletin was \$218K (1FTE [\$161K] funded from GLERL base and \$57K in shiptime and sample collection and analysis funded through the Great Lakes Restoration Initiative). NCCOS's FY15 labor for bulletin production was \$81K (0.75 FTE, spread over two Federal and two contract staff), with an additional \$386K (2.67 FTE, spread over four Federal and three contract staff) on ancillary bulletin activities (troubleshooting, evaluating model performance, interacting with stakeholders, and longer-term Lake Erie HAB R&D refinements) and approximately \$30K annually on infrastructure (software costs, storage, etc.) that support bulletin production.

7.2. Cost of transition: In addition to the extant base expenditures in NCCOS and CO-OPS, NCCOS has invested \$150K in FY15 funds for new contract staff to assist in the automation of NCCOS system processes to run in the CO-OPS operational environment, and to potentially assist in parallel operations in NCCOS and CO-OPS during the 2016 bloom season. In addition, NCCOS spent \$4K in FY16 travel funds for an in-person meeting in February 2016 to update stakeholder requirements and finalize plans for running products in parallel with CO-OPS during the 2016 bloom season.

7.3. Cost of operational system: The operational system must include collection and analysis of field data to detect the bloom, develop a mixing forecast, predict bloom decline and validate the bloom forecast. It also includes model output data for transport forecasts. This forecast system leverages wind, water temperature and water level and currents data collected by NOS/CO-OPS and NWS for core mission operations. GLERL's Great Lakes vessel operations are also leveraged to support the Lake Erie sample collection necessary to support the bulletin. Furthermore, it leverages model output data from models operated and maintained by NOS/CO-OPS and NOS/OR&R, IT infrastructure maintained by CO-OPS, and satellite imagery collected by NESDIS/Coastwatch for core mission operations.

The operational system, like the demonstration system, however, will incur additional costs associated with specific analysis that support bulletin forecast generation. The labor cost for processing satellite imagery specifically for use in the bulletin forecast will be approximately \$2K as incurred by either NCCOS (or potentially NESDIS in the future) each year (note that cost is for extant imagery, leverages a substantial investment of infrastructure and labor in both NCCOS and NESDIS, and does not account for algorithm refinement or new data streams. The end-to-end cost is likely more on the order of \$100k-\$200k. If NESDIS ultimately does the processing rather than NCCOS, an updated cost estimate can be included). The cost for collecting cell counts, optical chlorophyll data, and toxin data will be approximately \$244K (\$69K shiptime, sample collection and analysis and 1.0 FTE [\$175K]) incurred by GLERL, via Great Lakes Restoration Initiative funding or GLERL base funds for long-term observations as described above with increases for salary, vessel support and sample collection and analysis.

GLERL's specific responsibilities in supporting the Lake Erie bulletin will be to sample western Lake Erie bi-weekly in June then weekly from July – October. GELRL currently visits eight sites and will continue to do so for the foreseeable future. However, site location may change depending on future bloom dynamics and needs of the operational HAB bulletin. From the surface water collected at each site, two primary parameters will be measured, algal pigments (e.g. chlorophyll *a*, a universal pigment to estimate algal biomass; and phycocyanin, an accessory pigment specific to cyanobacteria) and the primary cyanotoxin of concern in Lake Erie, microcystins. Chlorophyll *a* and phycocyanin will assist in the annual model skill assessment and particulate (i.e intracellular) microcystins and dissolved microcystins will be analyzed within 48 hours of collection and those data will be distributed to CO-OPS for inclusion in the Bulletin. Samples will be collected and preserved for phytoplankton community composition and enumeration and wind speed/direction and water temperature will be recorded at each station. These additional parameters will also be helpful in the annual model skill assessment. To develop and disseminate forecast bulletins for Lake Erie HAB, CO-OPS will also spend \$125K (1.33 FTE) each year on labor.

8. Impacts of transition

8.1. *Budget spend plan*

From 2010-2013, the development and production of the Lake Erie bulletin was supported as a component of a larger reimbursable project funded by NASA (~\$300K/yr for the overall project), supplemented by NCCOS base funds for Federal labor. NCCOS has base-funded all of its Lake Erie HAB efforts since FY13. As noted above, the entirety of the transition effort is being funded from NCCOS and CO-OPS base resources. NCCOS is funding the transition effort out of a discretionary fund the NCCOS director set aside for ecological forecasting roadmap transition activities. GLERL base funds supported the Federal labor associated with the field collections and sample analysis, as part of a larger NOAA Lake Erie HAB observations program initially funded in 2010 under the auspices of the Great Lakes Restoration Initiative.

8.2. *Risks and mitigation*

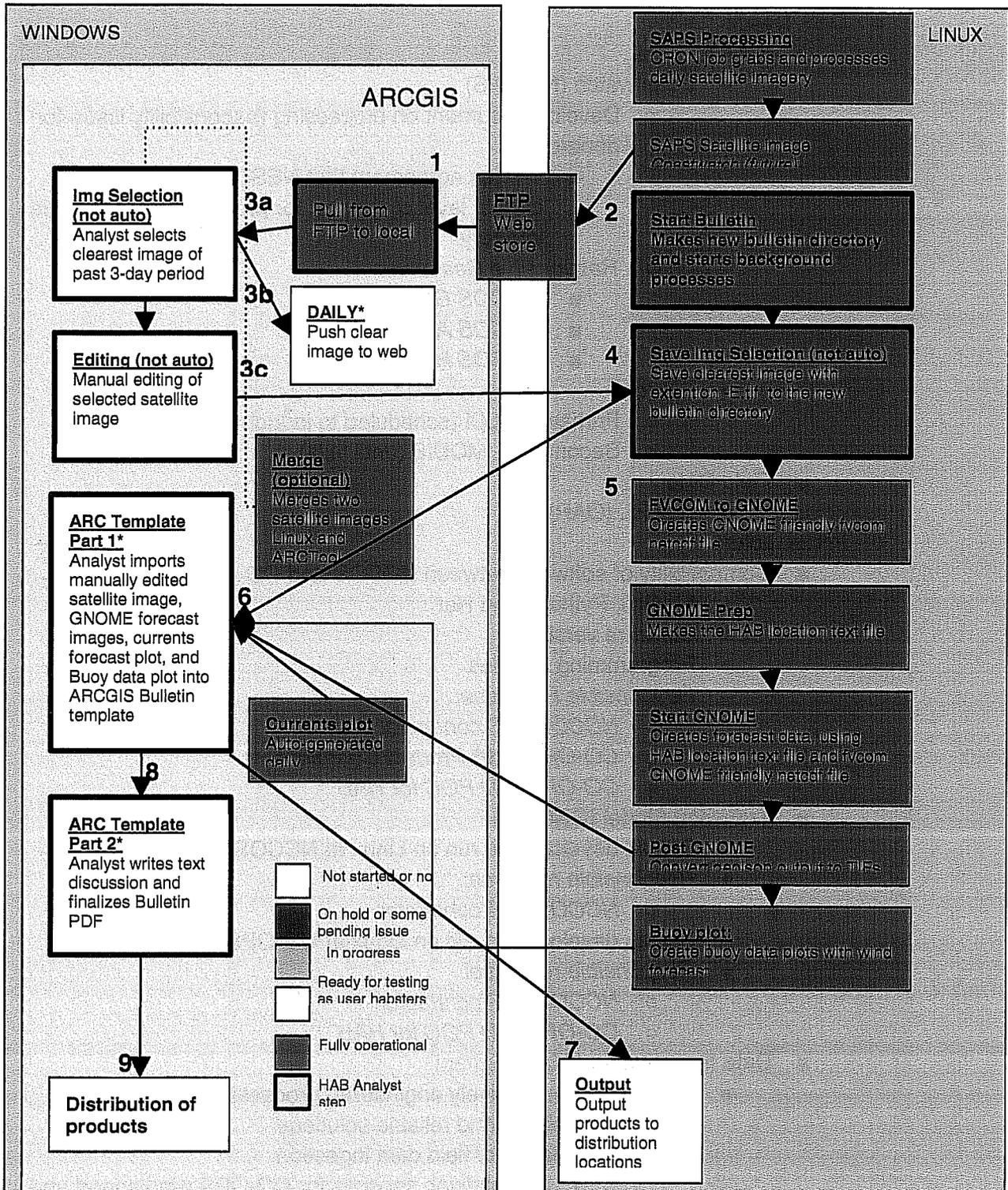
OR-#	Organizational risks (OR)	Mitigation (M)	Probability	Impact
OR-1	Delays to CO-OPS GIS Architecture project stall development of ESRI ArcGIS-based software and hardware infrastructure to handle the end-to-end lifecycle of HAB-OFS products.	Create multi-phase plan for developing new HAB-OFS infrastructure, independent from, but complementary to the CO-OPS GIS Architecture project.	Low	Medium
OR-2	Offices involved in the transition do not provide enough staff time and resources to execute the transition steps.	Leverage Resource Managers, NOS Priorities Roadmap and EFR leadership to assure full participation.	Low	High
OR-3	Delays to improvements of the GIS infrastructure that the Gulf of Mexico HAB-OFS relies upon (in turn affecting the amount of time that CO-OPS has to staff Erie)	Prioritize implementing improvements that have a more significant impact on efficiency first. Leverage CO-OPS Director, NOS Priorities Roadmap and EFR leadership to identify and	Medium	High

		provide additional project resources to assist where possible.		
OR-4	No funding available for Lake Erie HAB-OFS O&M.	NCCOS assists by providing resources/staff to support the HAB-OFS during the Lake Erie HAB season (June until end of HAB).	Low	High
OR-5	Loss of trained HAB-OFS analyst from team delays project while a replacement is trained for 3-6 months.	Leverage Resource Managers, NOS Priorities Roadmap and EFR leadership to identify and provide additional project resources to assist where possible. Identify FTE subject matter expert to ensure continuity of operations. Improve efficiency of HAB-OFS product generation to reduce training time necessary.	Medium	High
OR-6	Workload required to deliver Lake Erie HAB-OFS is greater than estimated during the Demo phase.	Include conservative estimates in plans. Document time and resources required during parallel testing and adjust operational requirements accordingly. Work with Resource Managers to realign workload to complete the project.	Low	High
OR-7	No long-term solution is found to replace the reimbursable funding that currently supports in situ observations at GLERL.	If GLRI funding is not renewed, GLERL will support the collection of a core set of observations in the western basin of Lake Erie that are leveraged for the bulletin.	High	Medium
OR-8	NESDIS does not pick up operational processing of OLCI imagery	NCCOS does the processing	Low	Low
OR-9	Limited observations available for validation or in areas with specific user requirements or in areas where blooms do not typically form	Leverage GLOS (IOOS) for any available observations in the Great Lakes. Develop relationships with agencies in other jurisdictions (e.g., New York, Canada, etc) to incorporate any relevant data they have.	High	Medium

9. References

Davis, E. (2014). Final evaluation and recommendation to CO-OPS for next-generation HAB-OFS framework. Unpublished manuscript, National Oceanic and Atmospheric Administration, National Ocean Service, Center for Operational Oceanographic Products and Services.

Appendix 1. Work flow for demonstration Lake Erie HAB-FS twice-weekly bulletins, with automation status as of 1 July 2016.



Appendix 2. Implementation details for transition schedule and deliverables outlined in section 5 above.

Phase 1: November 2015-July 2016. Preparation for transfer.

- Data Needs
 - Satellite Data
 - Coastwatch (NESDIS)
 - Develop document on processing responsibility issue for decision
 - Written agreement that NESDIS will provide a certain level of support for processing the satellite imagery
 - *Responsible Resource:*
 - *NCCOS GIS contractor*
 - *NCCOS Analyst*
 - *NCCOS HAB SME*
 - Source
 - Primary - OLCI (scheduled to launch by FY16)
 - Secondary - MODIS (until fails)
 - Field Data
 - GLERL (OAR)
- Infrastructure
 - Compatibility of software between NCCOS and CO-OPS
 - ArcGIS, Python, Red Hat
 - Software versions
 - Programming libraries
 - *Responsible Resource:*
 - *NCCOS GIS contractor*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
 - Transport Model (GNOME)
 - Scripts developed to run on Linux at NCCOS
 - *Responsible resource:*
 - *NCCOS GIS contractor*
 - Scripts developed to run on Linux at CO-OPS
 - *Responsible resource:*
 - *NCCOS GIS contractor*
 - *CO-OPS ISD POC for HAB*
 - Data Ingestion and Management
 - Upgrade from creatively engineered processing steps to more automated, robust, and reliable solutions
 - Automation of field data ingestion
 - Scripts/web services for CO-OPS wind speed and water temperature data

- Infrastructure
 - Hydrodynamic model (National Operational Coastal Model)
 - Scripts from LEOFS to HAB-OFS running as expected
 - *Responsible Resource:*
 - NCCOS GIS contractor (FY16 only)
 - CO-OPS HAB Product Coordinator
 - CO-OPS ISD POC for HAB
 - Transport model (GNOME)
 - Scripts to Linux server running as expected
 - *Responsible Resource:*
 - NCCOS GIS contractor (FY16 only)
 - CO-OPS HAB Product Coordinator
 - CO-OPS ISD POC for HAB
 - Data Ingestion and Management
 - Data ingestion scripts running as expected
 - *Responsible Resource:*
 - NCCOS GIS contractor (FY16 only)
 - CO-OPS HAB Product Coordinator
 - CO-OPS ISD POC for HAB
 - Satellite data processing
 - Cyanobacteria Index/concentration calculation
 - GIS scripts functioning as expected
 - *Responsible Resource:*
 - NCCOS GIS contractor (FY16 only)
 - CO-OPS HAB Product Coordinator
 - CO-OPS ISD POC for HAB
 - Image Editing
 - GIS scripts are functioning as expected
 - *Responsible Resource:*
 - NCCOS GIS contractor (FY16 only)
 - CO-OPS HAB Product Coordinator
 - CO-OPS ISD POC for HAB
- Data Distribution
 - Website and listserv
 - Imagery and Bulletin
 - Files with data, imagery, and bulletin
 - How to update the website on completion of the bulletin (automated)
 - *Responsible Resource:*
 - CO-OPS HAB Product Coordinator
 - CO-OPS ISD POC for HAB
 - Back-up
 - COOP server solution

- *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
 - Archive
 - Storage at CO-OPS identified
 - Data to create bulletin for assessment (field data, edited satellite imagery, other associated metadata) for at least one year
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
 - *CO-OPS Technical Director (to help archive agreements/revise policy)*
 - Bulletin formally archived at NCEI
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
 - Training Needs
 - Initial Training of CO-OPS Part Time analysts
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *NCCOS Analyst*
 - *CO-OPS Full and Part-Time Analysts*
 - Documentation
 - Initial Standard Operating Procedures developed
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS Full Time Analysts*

Phase 3: November 2016-November 2017.

- Compatibility of Software between NCCOS and CO-OPS
 - ArcGIS, Python, Red Hat
 - Software versions
 - Programming libraries
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
- Transport Model (GNOME)
 - Scripts running on Linux at CO-OPS
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
- Data Ingestion and Management
 - Data ingestion scripts running as expected
 - *Responsible Resource:*

- *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
- Satellite data processing
 - Cyanobacteria Index/concentration calculation
 - GIS scripts functioning as expected
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
- Hydrodynamic Model (National Operational Coastal Model)
 - NOS FVCOM LEOFS used for FY17 bloom season
 - GIS scripts functioning as expected
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
- Image Editing
 - GIS scripts are functioning as expected
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
- Data Distribution
 - Website and listserv
 - Successful demonstration with FY17 bloom season
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
 - Back-up
 - COOP solution implemented
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
- Archive
 - Archive solution at CO-OPS implemented and demonstrated effective for FY17 bloom season
 - Bulletin formally archived at NGDC
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *CO-OPS ISD POC for HAB*
- Training needs
 - Final trainings completed for CO-OPS Analysts
 - *Responsible Resource:*
 - *CO-OPS HAB Product Coordinator*
 - *NCCOS Analyst*
 - *CO-OPS Full Time Analysts*
 - *CO-OPS Part Time Analysts*