

Challenges and Opportunities in Operationalizing Coupled Human and Natural Systems Research in the Chesapeake Bay Watershed

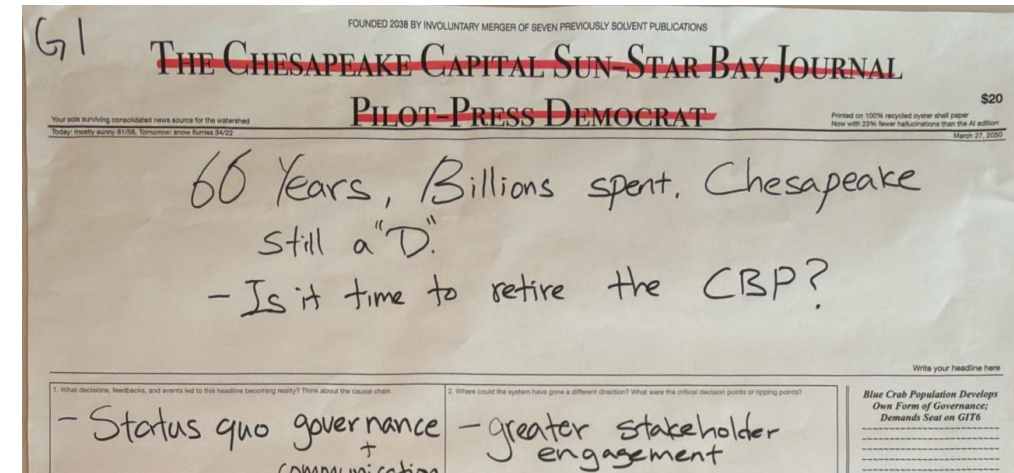
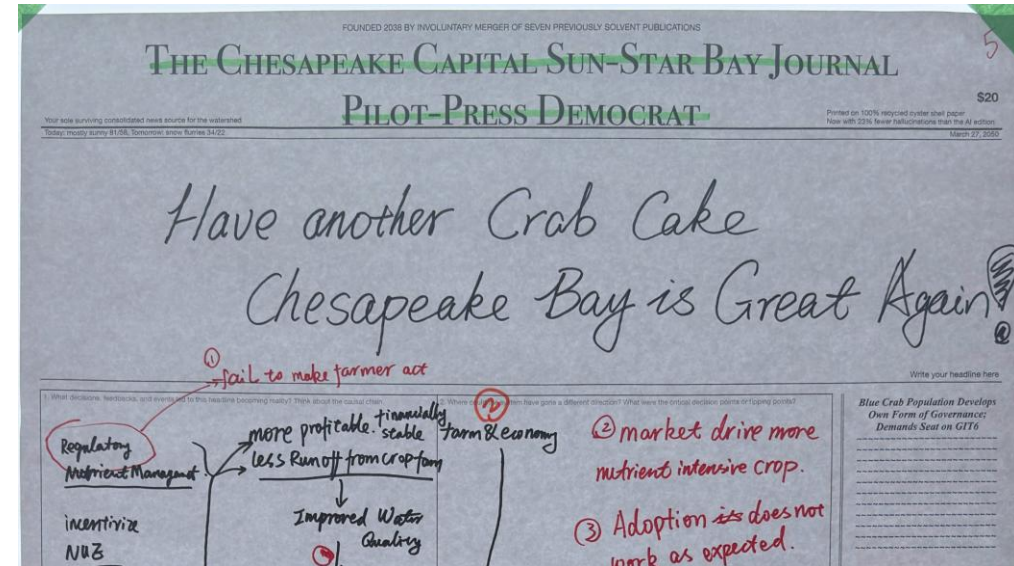


STAC Workshop Report
March 26-27, 2026
Annapolis, MD



STAC Publication 26-005

Headlines from 2050 (also March 26 & 27, 2026)



Patrick Bitterman

Assistant Professor, Department of Geography
Kent State University

Sept 15, 2026 // STAC meeting

www.patrickbitterman.com
pbitterm@kent.edu



Lessons from our NSF-funded project:

Directional asymmetry in modeling and monitoring

WHAT “WE” MODEL WELL

Human decisions

- Land use change
- BMP implementation
- Point source controls

Environmental outcomes

- Nutrient loading
- Water quality
- Habitat condition

WHAT WE'RE (GENERALLY) MISSING

How do environmental conditions lead to Δ in...

- ↪ behavioral response?
- ↪ political support?
- ↪ institutional adaptation?
- ↪ investment decisions?

Signals exist, but are punctuated, dispersed, context-dependent

Workshop objectives

1. **Synthesize** the current state of applied CHANS science and its **relevance** to addressing challenges in the Chesapeake Bay ecosystem

2. **Map** feedbacks and **identify** gaps

3. **Assess** CHANS applications (i.e., where can this be used?)

4. **Develop** recommendations

Some common frameworks

...for reasoning about human-environment interactions

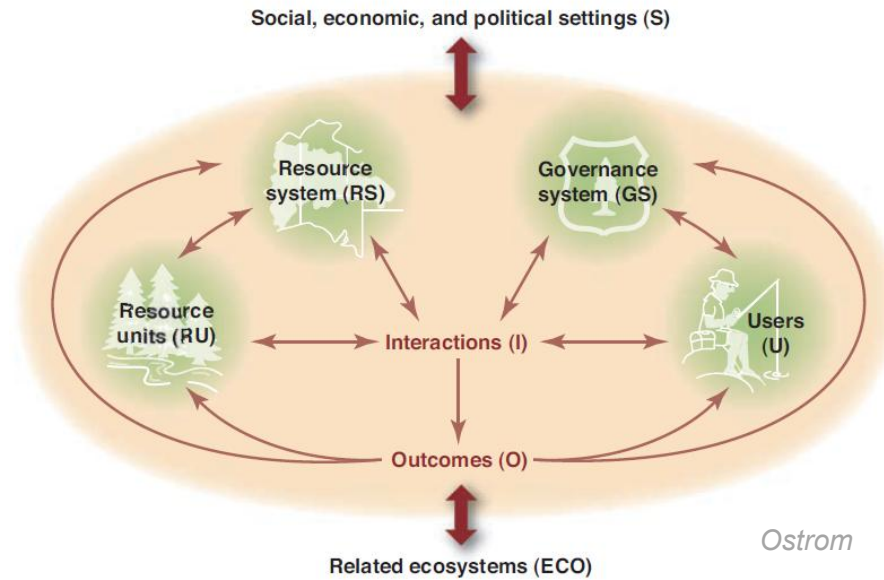
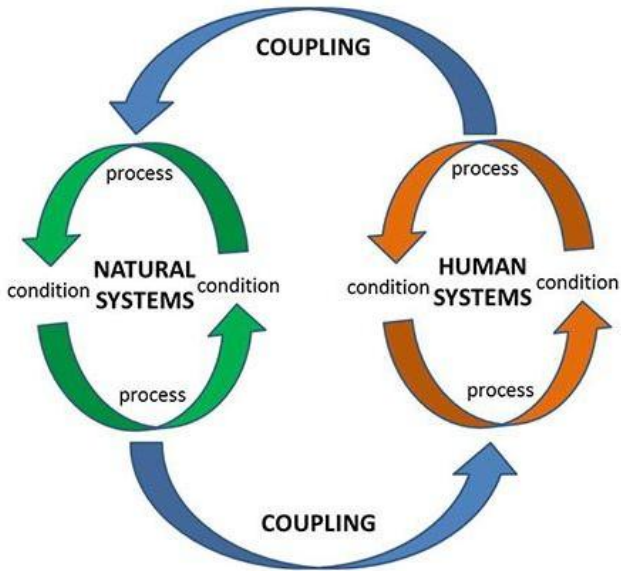
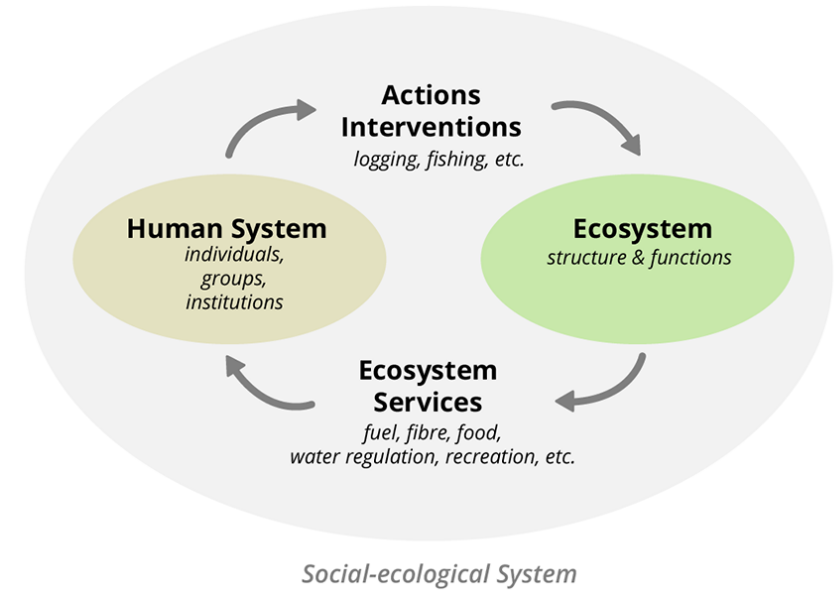


Fig. 1. The core subsystems in a framework for analyzing social-ecological systems.



<https://saras-institute.org/social-ecological-systems/>

Human activity is **NOT**
separate from
ecosystem

Environmental change
results from social
processes

Problems transcend *traditional*
disciplines

Workshop background

5 key properties of Coupled Human And Natural Systems

Nonlinearity



Small changes,
disproportionate
effects

Feedback loops



Outcomes
reshape
conditions that
produced them

Heterogeneity



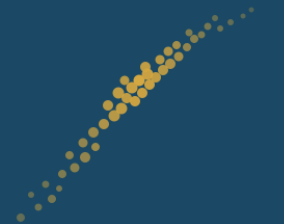
Responses vary
across actors,
places, and scales

Adaptation & memory



Actors anticipate,
learn, and change
behavior over
time

Emergence



System-level
patterns arise
from interactions
of individuals

But why now (or, why back in March)???

...a human-environment-sized gap

2023

CESR Report

Implementation and response gaps point to structural problems in *how the management system handles environment → human feedbacks*

2024

Beyond 2025 Report

Called for *integrating social science into a systems-based approach* to understanding decision-making across scales

2024-

STAC Social Science Workgroup (SSWG)

Standing Workgroup established *to integrate social science perspectives into CBP's work*

2025

Watershed Agreement

Commits to *integrating social science holistically* and to adaptive management informed by the best available science

Workshop roadmap

Two days, four breakout sessions (plus some other stuff too)

Day 1

Session 1

MAP

Systems mapping of
focal sub-systems,
forward and feedback
pathways



Session 2

TEST

Shock propagation
and gap analysis on
Session 1 maps



Session 3

DIAGNOSE

Challenges and
Opportunities:
barrier-opportunity
pairs



Session 4

PRESCRIBE

Develop actionable
recommendations
for integrating socio-
environmental
thinking

Two modes of recommendations

#1. Actionable, substantive recommendations



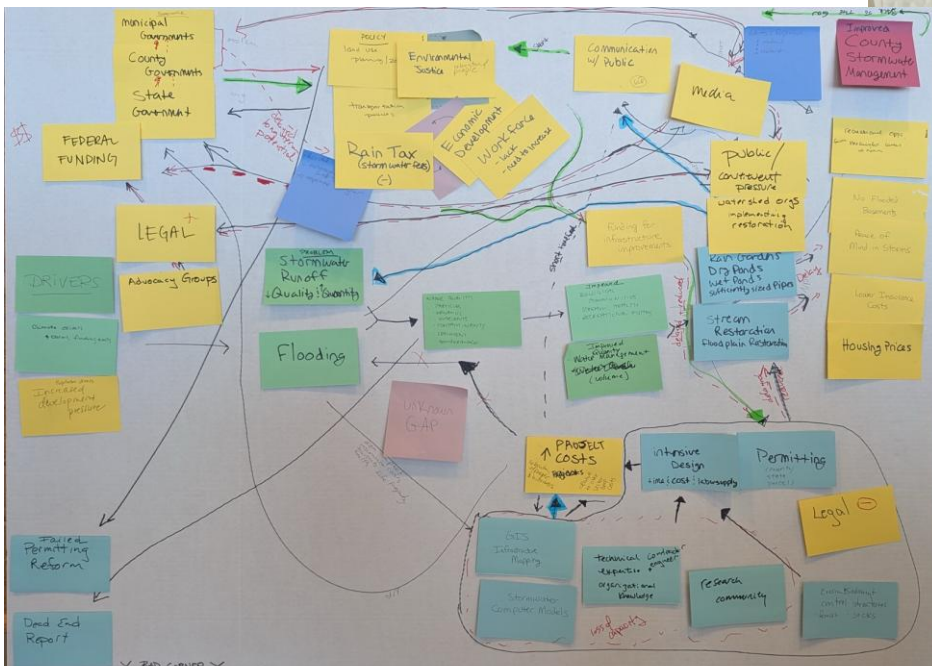
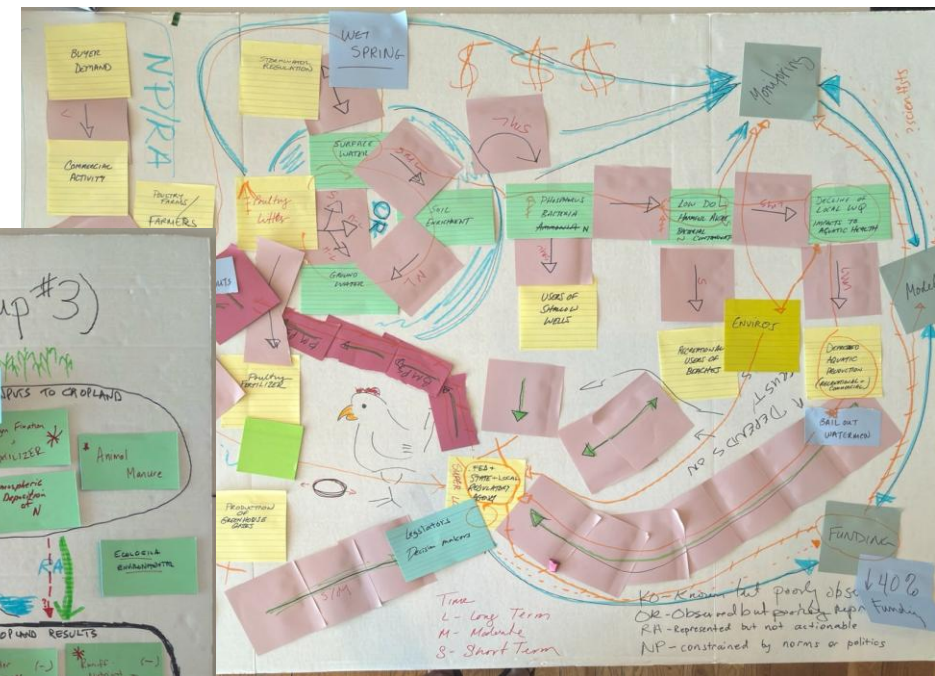
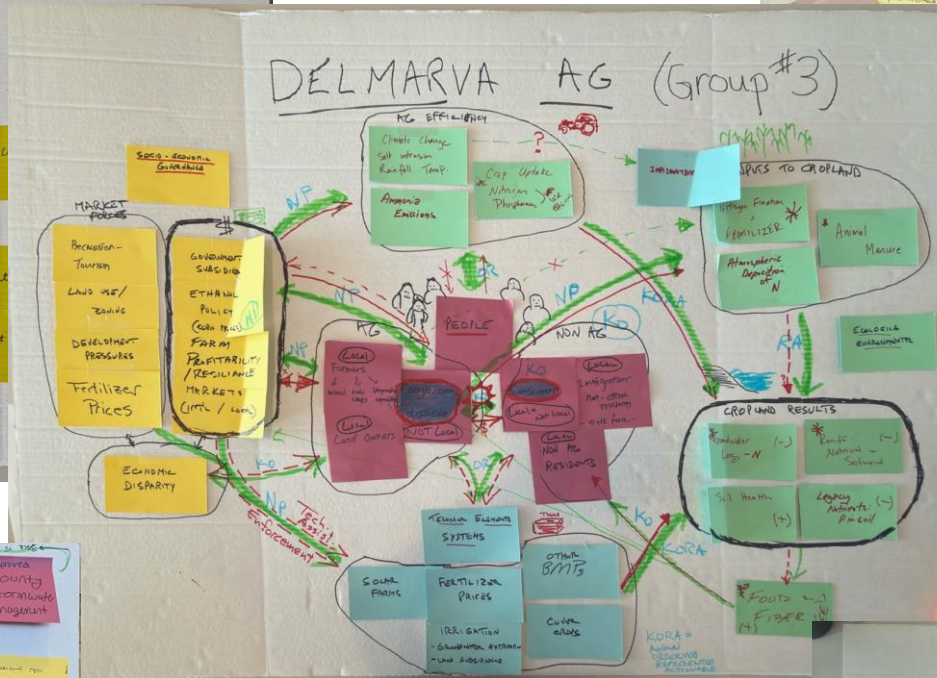
Two modes of recommendations

#2. The repeatable practice coupled-systems-thinking (methodological recs)



This workshop as one illustrative example

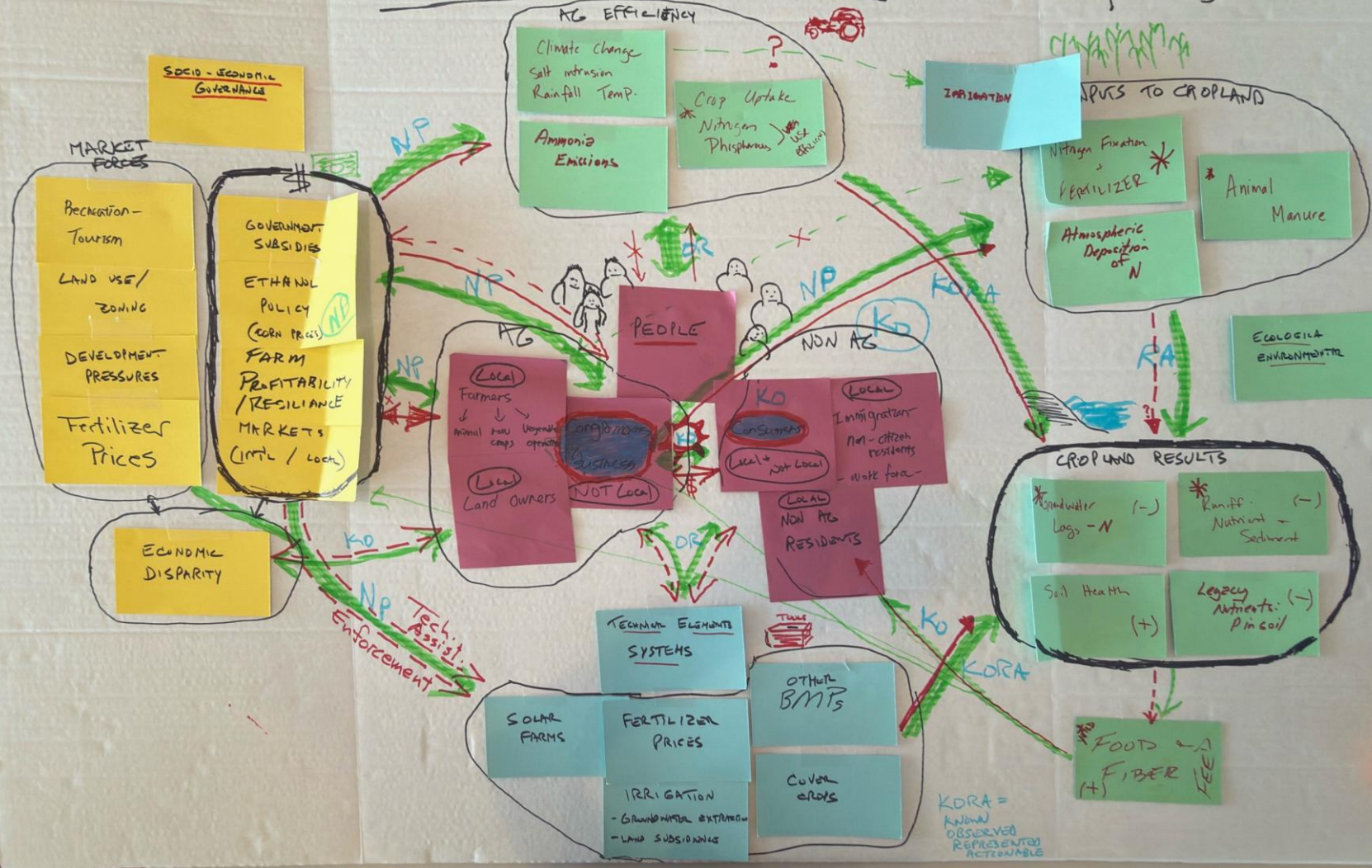
or, evidence of how CHANS-thinking can be implemented in the CBW



~63 participants
5 in-person groups;
1 virtual group



DELMARVA AG (Group #3)



Some generalizable findings

1. **People** are at the center
2. Diagnostic overlay (**blue labels**) indicates constraints are **social and political**
3. Emergent group behavior: Group 3 created label "KORA": known, observed, represented, actionable – but only for **technical** links
4. Policy shock broke **social** feedbacks, not ecological linkages
5. Failure pathway (due to shock) was almost always **institutional**, not ecological

(more)
Headlines
from the future

FOUNDED 2038 BY INVOLUNTARY MERGER OF SEVEN PREVIOUSLY SOLVENT PUBLICATIONS

THE CHESAPEAKE CAPITAL SUN-STAR BAY JOURNAL

PILOT-PRESS DEMOCRAT

Your sole surviving consolidated news source for the watershed
Today: mostly sunny 81/58, Tomorrow: snow flurries 34/22

Printed on 100% recycled oyster shell paper
Now with 23% fewer hallucinations than the AI edition
March 27, 2050

\$20

Write your headline here

1. What decisions, feedbacks, and events led to this headline becoming reality? Think about the causal chain.

2. Where could the system have gone a different direction? What were the critical decision points or tipping points?

3. What new risks or unintended consequences emerged? What did people not see coming?

4. Looking back from 2050: what would you most want to go back to 2026 and start studying or monitoring?

**Blue Crab Population Develops
Own Form of Governance;
Demands Seat on GITO**

Blue Crab Population Develops Own Form of Governance; Demands Seat on GITO

**Bay Bridge Tunnel Completes
Fourth Bore; Toll Now \$847**

Bay Bridge Tunnel Completes Fourth Bore; Toll Now \$847

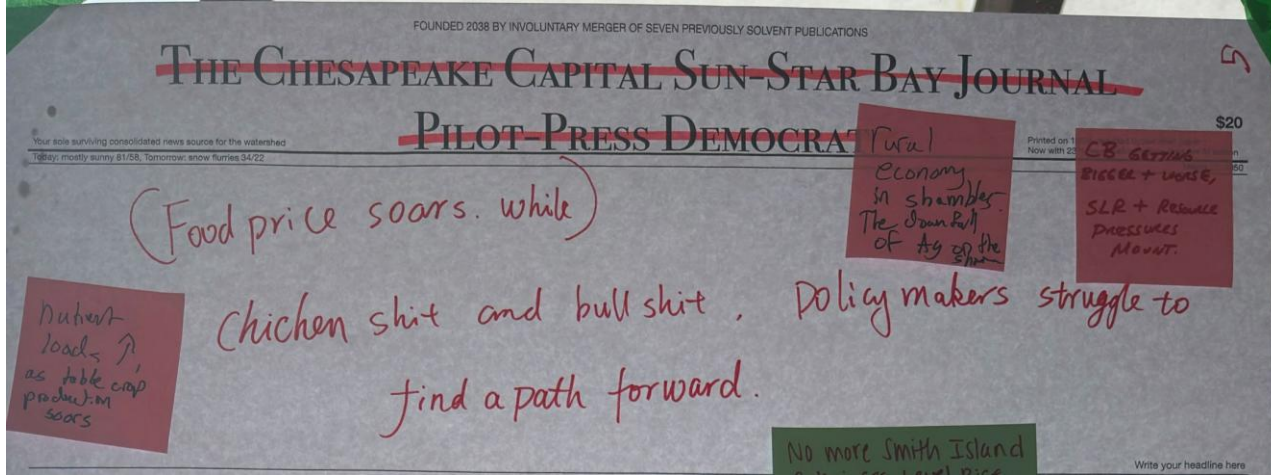
**Old Bay Shortage Enters Third
Month, MD Governor Activates
National Guard in response**

Old Bay Shortage Enters Third Month, MD Governor Activates National Guard in response

**Annapolis Tourist Asks "What's
a Watershed?" for 4 millionth
time; Gift Shop Adds FAQ Kiosk**

Annapolis Tourist Asks "What's a Watershed?" for 4 millionth time; Gift Shop Adds FAQ Kiosk

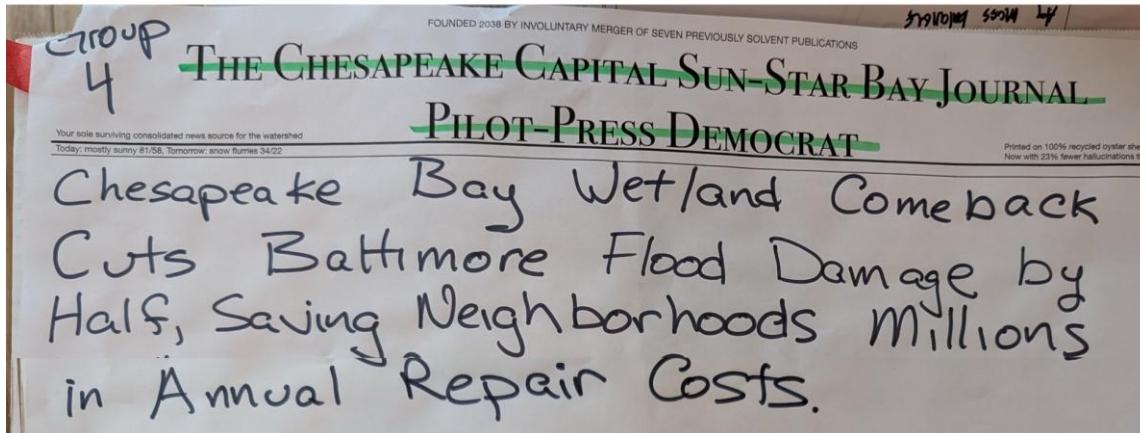
(Write your own funny ones below)



Centrality of social systems

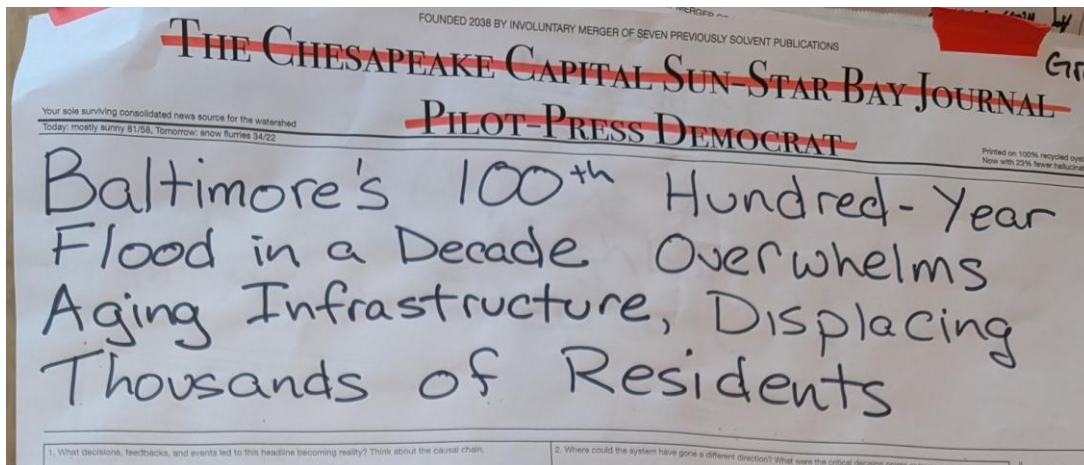
Participants wrote about...

- People
- Institutions
- Politics



And not (so much) about...

- TN loads
- BMP efficiencies
- Atmospheric deposition



Recommendations

Substantive and methodological

Substantive recommendations (group outputs)

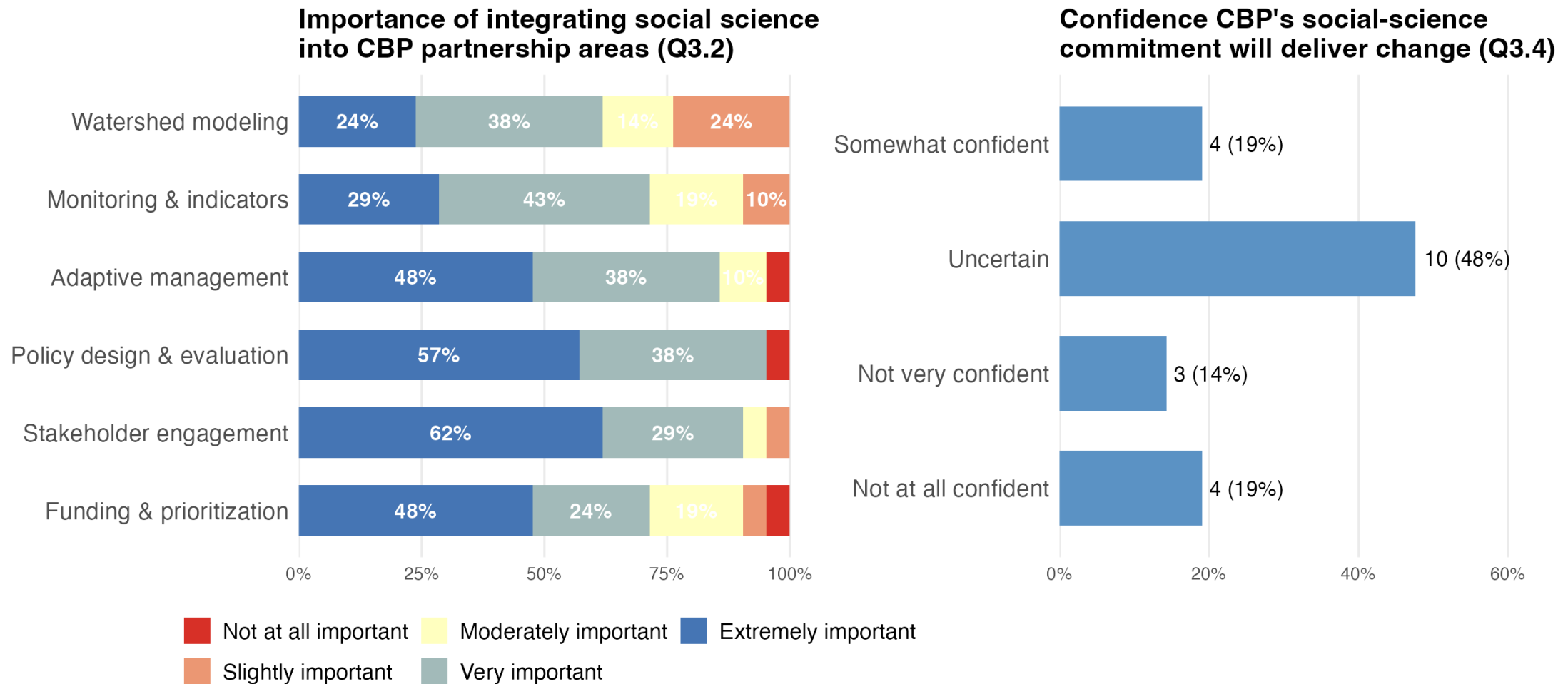
1. **Trust infrastructure:** build agency-producer & community-state relationships *before* BMPs (G1, G2)
2. **Pre-positioned project libraries:** ready-to-deploy designs to exploit short post-event/funding windows (G4)
3. **Locally-led capacity + flexible BMP frameworks** at the sub-watershed scale (e.g., locally-set nutrient-efficiency targets instead of one statewide number) (G3)
4. **Institutionalize CHANS competency inside existing CBP structures** (GITs/SSWG/LGAC/STAC) (all groups)
5. **Priority science gaps:** include behavioral-response modules in the watershed model; trust/capacity/civic indicators; IEK/LEK integration (G6)

Day 2, Session 4 participant guide Group: 4

Recommendation 2 *Stormwater +*

Problem statement
3-4 sentences: what specific feedback, gap, or barrier does this address? Link to your Day 1 map and Session 3 analysis. <i>Lack of predictive planning to be prepared for an event (research, decision support, planning)</i> <i>Implementing organizations too rigid (state agencies, bureaucracy)</i> <i>- project timescales too long</i> <i>- better aligned research + predictive modeling for decision support - funding allocated to this.</i>
Proposed action
What, specifically, should be done? By whom? At what scale? Be concrete. Test: "Integrate social data into the modeling system" is not a recommendation. "Develop a behavioral response module for the CBP watershed model that represents farmer BMP adoption as a function of economic incentives, information access, and observed environmental conditions" piloted in 2-3 sub-watersheds is. <i>- integrate social, economic science modeling to optimize restoration activities</i> <i>- pre-planning & permitting projects so there is a library of shovel ready projects with input from local community and subject matter experts</i>
Implementation pathway
Near-term (within 6 months): what could start now? <i>planning opportunities communicated, optimized + prioritized for sharing across state agencies, NGOs.</i> <i>plan communications - pre-design the narrative. - towards public private partnerships</i> Medium-term (1-3 years): development and piloting <i>build library of projects, w/ input from local community and subject matter experts</i> Long-term target state: what does success look like? <i>develop workforce - (engineering, construction early career sciences).</i> Which CBP structures could house this? (GITs, workgroups, STAC, modeling team)
Risks & dependencies
What could prevent this from working? Political feasibility? Resources? Risk of co-option? <i>A lot of proactive work for funding that may not appear. Hope fatigue</i>
How would you know it's working?
Success indicators? What evidence would trigger revision or abandonment? <i>plans exist when opportunity arises, projects happen & science better informs mgmt over long term</i> <i>* Next 100-yr flood doesn't take out Ellicott City</i>

Post-workshop evaluation → how do we deliver?



Caveats: small n, self-selected group, we missed a lot of (most) local stakeholders in our recruitment efforts

Methodological recommendations

(or, institutionalizing the process/practice while balancing resource realities)

1. Recurring CHANS-based facilitation should be a STAC-advised practice, not a one-off workshop
2. The partnership should develop & maintain standing pool of facilitators and conveners skilled in coupled-systems methods, with **STAC defining the competencies the role requires and advising on curriculum**. CHANS work should feed structured products back into modeling, monitoring, and indicator design
3. Practitioner representation must be intentionally designed, not just “invited.” STAC should advise on group composition based on convening purpose
4. The partnership should establish a defined intake process for the outputs of CHANS-based work. What happens (or should happen) to our **structural recommendations**?
5. STAC should explicitly steward “systems-thinking-with-heterogeneous-actors” as a method in its workshop portfolio
6. STAC, the Social Science Workgroup, and the modeling team should jointly define a structured handoff process between the outputs of convenings and the modeling and monitoring systems

Back to the headlines...

All CB states met 2045 goals and the watershed is thriving

Gap between what participants hope for and what they are concerned about is a function of institutions, trust, and resources.

Not just nutrients

61

FOUNDED 2038 BY INVOLUNTARY MERGER OF SEVEN PREVIOUSLY SOLVENT PUBLICATIONS

~~THE CHESAPEAKE CAPITAL SUN-STAR BAY JOURNAL~~

~~PILOT PRESS DEMOCRAT~~

\$20

Your site surviving consolidated news source for the watershed
Today: mostly sunny 81/55, Tomorrow: snow flurries 34/22

Printed on 100% recycled oyster shell paper
Now with 23% fewer hallucinations than the AI edition
March 27, 2050

60 Years, Billions spent. Chesapeake
Still a "D".
- Is it time to retire the CBP?

Write your headline here

1. What decisions, feedbacks, and events led to this headline becoming reality? Think about the causal chain.

- Status quo governance + communication

2. Where could the system have gone a different direction? What were the critical decision points or tipping points?

- greater stakeholder engagement

Blue Crab Population Develops
Own Form of Governance;
Demands Seat on GIT6



NSF award #2009248: CNH2-L: Modeling the dynamics of human and estuarine systems with regulatory feedbacks

Workshop Steering Committee

Not shown: Theo Lim, Christine Kirchhoff, Amy Handen, Denice Wardrop, Gary Shenk (pre-retirement)



Bonus

In the near term...

1. document the workshop method as a repeatable protocol, drawing on the materials in the Appendices, so that a second convening does not begin from scratch (MR5)
2. advise partnership leadership on the timing and focal question of a second convening, so that it informs an upcoming decision point (e.g., quarterly progress meeting, milestone review) and informs the practitioner and local-stakeholder representation that this first workshop lacked (MR1, MR3)
3. define the competencies this work requires of a facilitator, and seed a pool by pairing experienced facilitators with new recruits at that convening, treating facilitation as a skill to be deliberately developed (MR2)
4. open a discussion with partnership leadership about where the outputs of this work should be received and acted on, and how they should feed the modeling, monitoring, and indicator systems (MR4, MR6)

Objectives

- **Synthesize the current state of applied CHANS science and its relevance to addressing challenges in the Chesapeake Bay ecosystem.** This objective will largely focus on the CBW but will also draw upon research and successful management actions in other watersheds. Participants will consider how CHANS frameworks can address persistent challenges while identifying opportunities to improve resilience and sustainability. We will focus on practical, solutions-oriented applications that align with the CBP's goals, with special focus on implementation and response gaps as laid out in the 2023 STAC report⁵.
- **Map feedbacks and identify gaps.** We will highlight key gaps between how the Chesapeake Bay system functions and how it is currently managed, with a particular emphasis on nonpoint source pollution and the limitations of current adaptive management, monitoring, and modeling efforts. This includes exploring and mapping disconnects between policy objectives and ecological realities, as well as identifying areas where knowledge, models, or monitoring are insufficient. Understanding these gaps is critical for bridging the divide between scientific understanding and practical application.
- **Assess CHANS applications.** In breakout groups, participants will evaluate the potential of CHANS research to enhance policies and management practices. Participants will consider how coupled systems frameworks can address persistent challenges, such as implementation and response gaps, while identifying opportunities to improve resilience and sustainability. This exploration will focus on practical, solutions-oriented applications that align with the CBP's goals and the Watershed Agreement.
- **Develop recommendations.** The workshop will generate actionable recommendations for incorporating CHANS insights into the CBP's adaptive management framework and decision-making processes. This will involve proposing strategies, pilot projects, and tools to better integrate human-environment feedbacks into management practices. The recommendations will be tailored to address specific challenges in the CBW and guide future research and policy efforts.