HYDROLOGICS

Advancing the management of water resources

Undergraduate Course in Computer Aided Negotiation of Water Resources Disputes

Megan W. Rivera
Daniel P. Sheer
Andrew J. Miller

Presenter
Megan W Rivera
January 27, 2009

HydroLogics, Inc.
Office Locations

10440 Shaker Dr., Ste. 104
Columbia, MD 21046
410-715-0557

811 Mordecai Dr., Ste. 200
Raleigh, NC 27604
919-856-1288

Outline

- How this course came to be
- What happened this semester
- The future of the course
- Why is this worth doing

HYDROLOGICS

Course Origins: An Academic-Industry Partnership

Megan Rivera

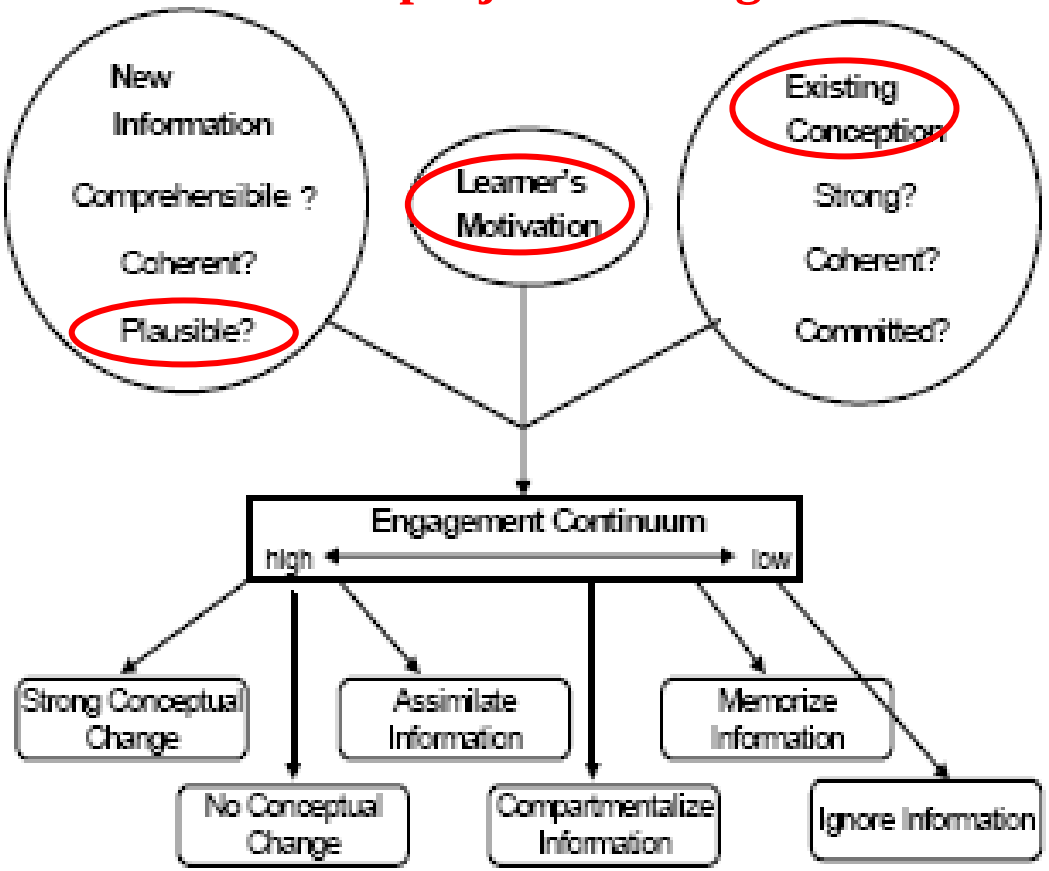
Dan Sheer

Andy Miller

HYDROLOGICS

Background in Engineering Education

Power of student-driven projects dealing with real world problems



HYDROLOGICS

Engineering Professor at the City College of New York

- Very limited in ability to bring student-driven projects dealing with real-world problems to the classroom
  - No “real world” experience
  - Research: scalar dispersion in wave-current boundary layers
  - Tenure track demands

HYDROLOGICS

Joined HydroLogics in 2006

- Finally, something worth teaching!
  - Got the “real world” experience I was lacking
  - Water Resources Management
    - Important problems
    - Stakes often high
    - Interdisciplinary
  - Computer Aided Dispute Resolution particularly “juicy”…

HYDROLOGICS

One of the “Fathers” of CADRe

- Part of joint ICPRB/JHU study led to a novel solution for water supply on the Potomac River
  - Utilities knew they didn’t have enough water
  - Corps of Engineers proposed 16 reservoirs, eventually narrowed down to 6
  - Public opposition, funding problems led to stalemate

HYDROLOGICS

Breaking the Impasse

- ICPRB and JHU: optimization model showed few reservoirs needed ***IF*** the water suppliers coordinated their operations
- *The water utilities were skeptical*
- ICPRB/JHU switched to simulation and gaming to broker agreements
- Built trust and a system of cooperation that continues today
- Shared Vision Planning & Computer Aided Negotiation

Slide shamelessly stolen from Mark Lorie's presentaion to the class

CAN process has been used by HydroLogics for over 20 years

- Kansas Water Office
- Southern Nevada Water Authority
- South Florida Water Management District
- Delaware River Basin Commission

HYDROLOGICS

Desire to Teach

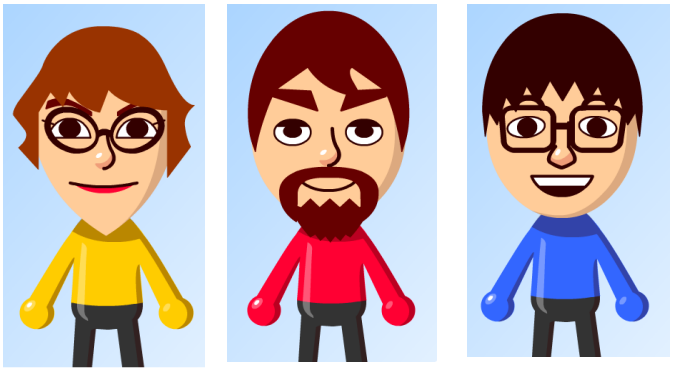
- Based heavily on his own experience as a student (DoGEE grad)
- Willing to invest company (including his own) time and resources

HYDROLOGICS

Department of Geography & Environmental Systems at UMBC Was Ideal for Pilot

- Also a DoGEE grad
- A number of relevant, interdisciplinary programs
  - field headquarters of the Baltimore Ecosystem Study (BES), one of two urban sites in NSF's Long-Term Ecological Research (LTER) network
  - Center for Urban Environmental Research and Education
  - "Water in the Urban Environment," NSF IGERT (Integrative Graduate Education and Research Traineeship) program

We found some support to get started



National Science Foundation
WHERE DISCOVERIES BEGIN

Course, Curriculum, and Laboratory Improvement (CCLI)

HYDROLOGICS

Outline

- How this course came to be
- What happened this semester
- The future of the course
- Why is this worth doing

HYDROLOGICS

This semester: the good, the bad, the oysters

- The players
- The project
- The process
- The product

HYDROLOGICS

The Players

- Instructor: me
- TA: Sam Lebherz
- Expert Panel: Environmental Economist, Biologist, Lawyer
- Guest Speakers: Water manager, Army Corps (SVP), DRBC lawyer, Mediator, Modeler (LP)

HYDROLOGICS

The Players

- 13 exceptional undergraduate students
  - Strong academically
  - Junior and senior standing
  - Very interdisciplinary: chemical engineering, psychology, history, hydrology, environmental studies, biology, etc.

HYDROLOGICS

The Project: Delaware River Basin

- NYC built 3 large reservoirs in the headwaters of the DRB in the 1950s
- As part of the Supreme Court Decree allowing the interbasin transfer:
  - NYC can take an average of 800 mgd, to be reset each June 1
  - NYC must make releases from its reservoirs to support 1750 cfs every day at the state line

HYDROLOGICS

The Project: Delaware River Basin

- The drought of the 1960s made it very clear that these volumes could not be supported
  - Subsequent “Good Faith Agreements” provide a schedule for “shorting” NYC and downstream target based on amount of water in the reservoirs

HYDROLOGICS

The Project: Delaware River Basin

Problem of Incentives

- Subsequent "Good Faith Agreements" provide a schedule for "shorting" NYC and downstream target based on amount of water in the reservoirs
- NYC can take an average of 800 mgd, to be reset each June 1
- NYC must make releases from its reservoirs to support 1750 cfs every day at the state line

HYDROLOGICS

The Project: Delaware River Basin

Some of the stakeholders

- NYC-water supply
- NYS-cold water fisheries, liveries, flooding
- PA-lake recreation, liveries, flooding
- NJ-salinity at drinking water intakes, shad fisheries, Northern NJ water supply
- DE-oyster beds, endangered wedge mussels, floodplain ecosystems

HYDROLOGICS

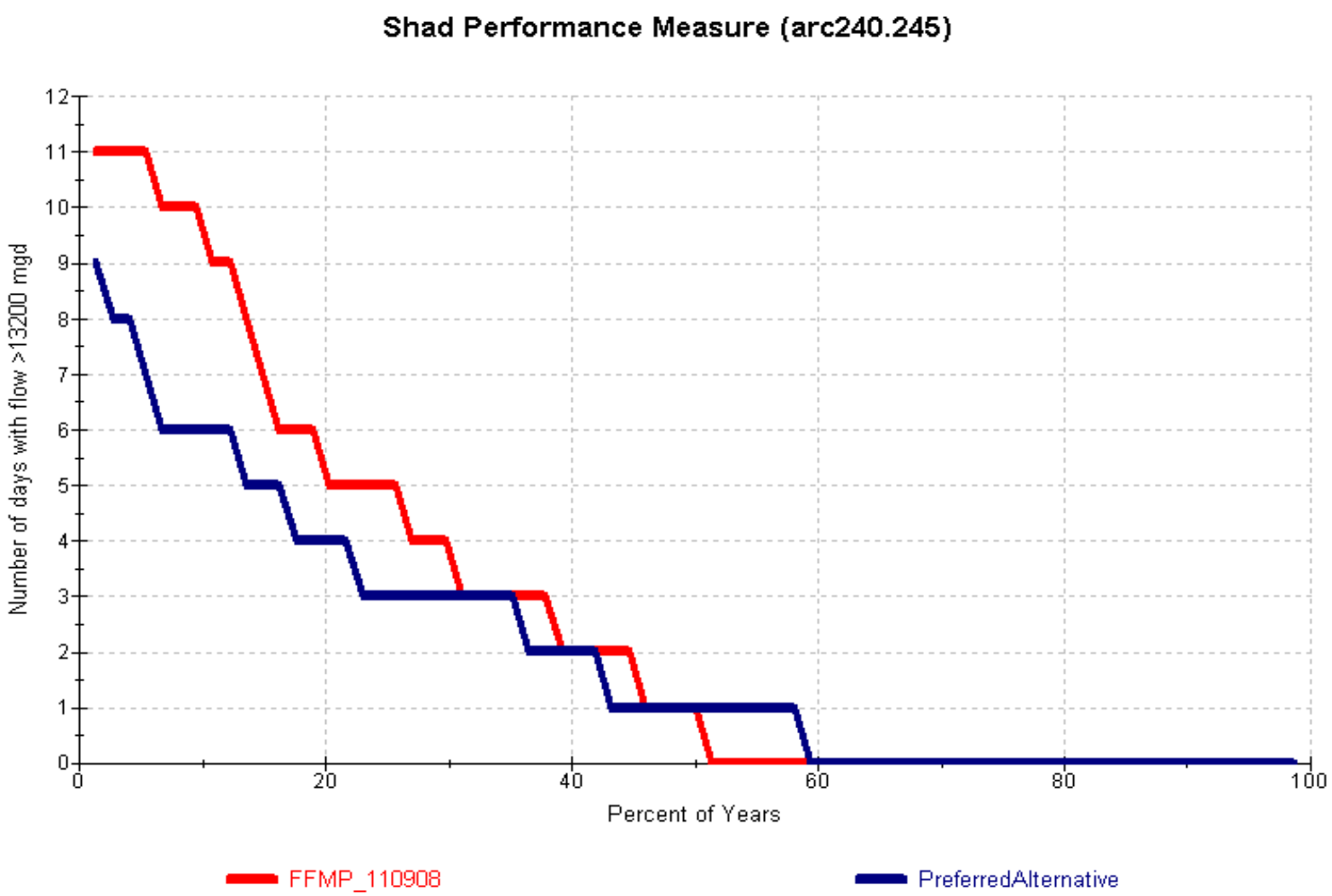
The Process: Computer Aided Negotiations

1. Develop performance measures – displays that compare alternatives for a management objective

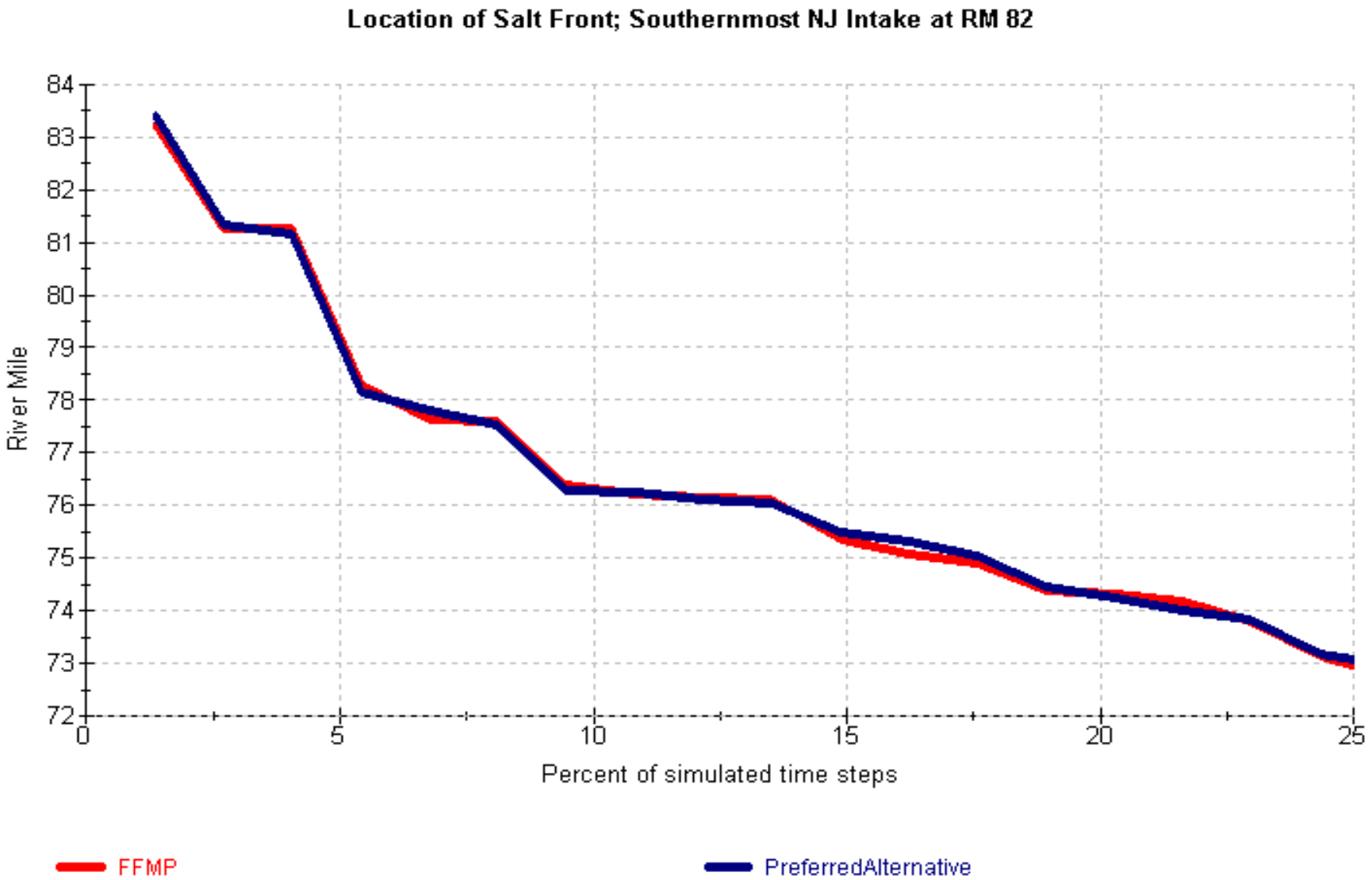
Why are PMs so important

- Without PMs parties tend to focus on abstract portions of rules (e.g. the minimum flow requirement, the level of the summer pool rule curve, water in upstream reservoirs is bad)
- With PMs parties can focus on overall outcomes
- Creating PMs forces parties to think about what they really care about and how to measure it

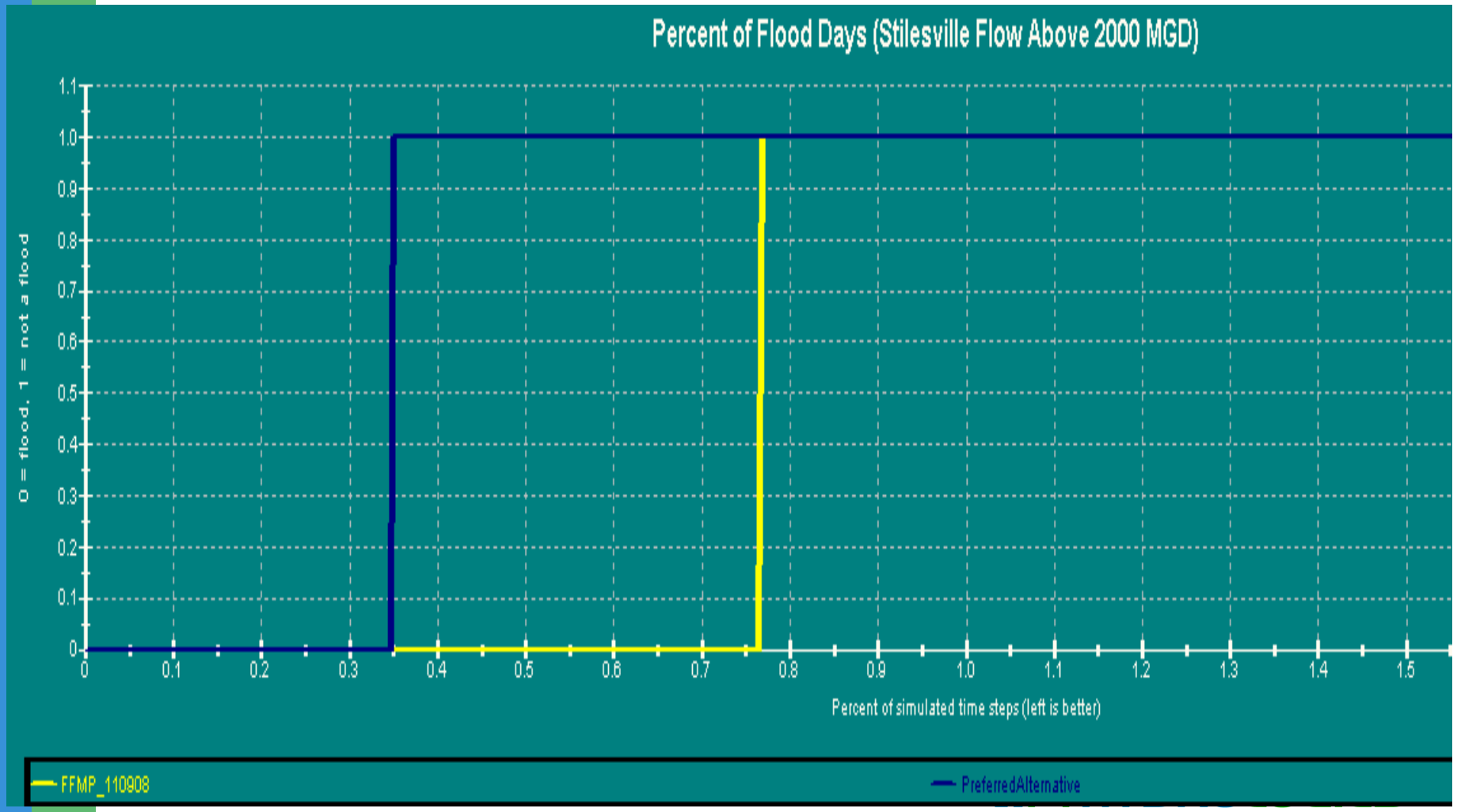
Number of Days with Flows Exceeding Velocity Threshold for Shad Spawning



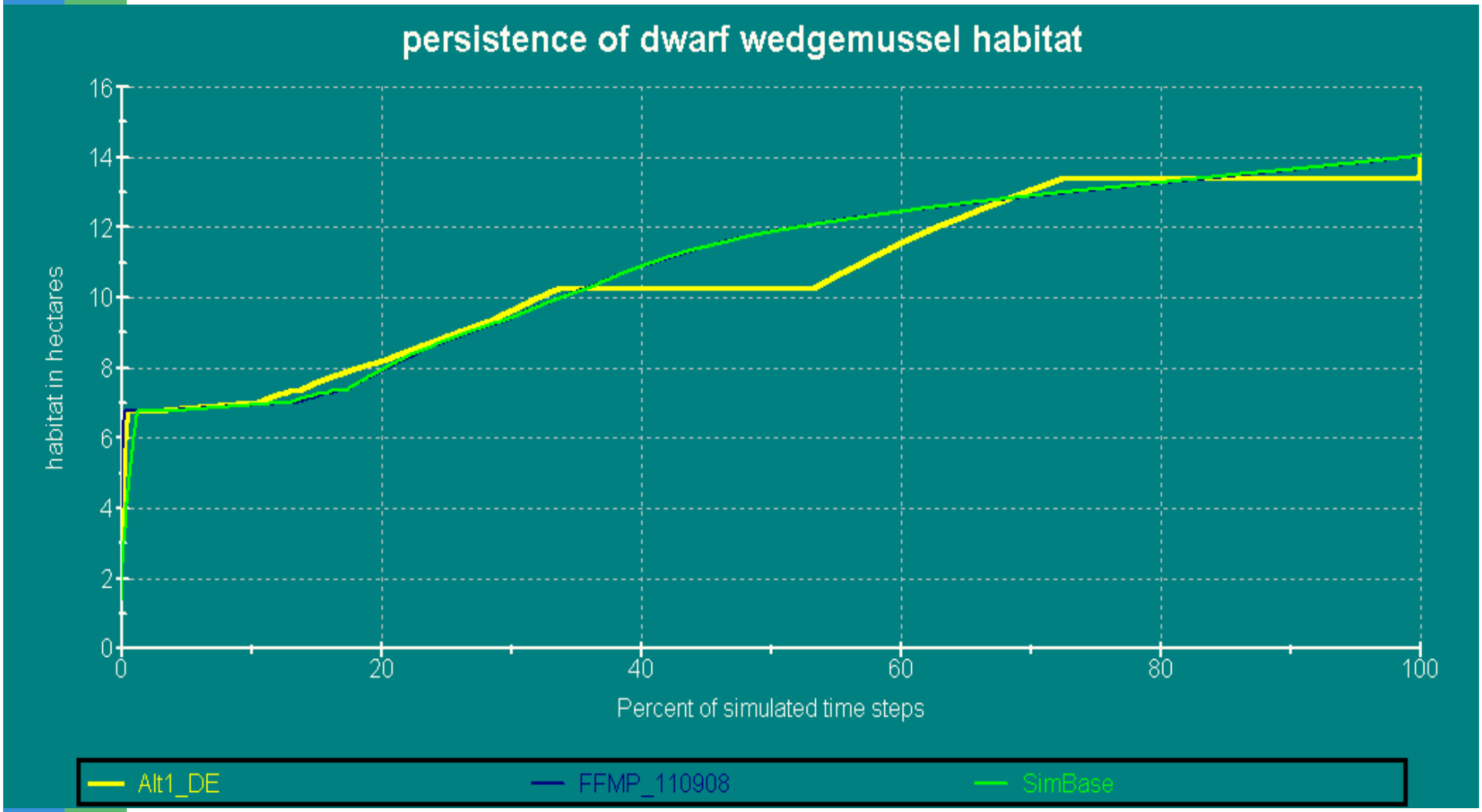
Frequency of Days that Salt Front is Close to NJ Water Intake



Percent of Days with Flooding



Quantity of Wedge Mussel Habitat



The CAN Process

1. Develop performance measures
2. Reach consensus on
   - the scientific data to be used in evaluating alternatives
   - scientific methods and assumptions to be used
   - the nature of alternatives to consider and how to structure the evaluations

HYDROLOGICS

The CAN Process

1. Develop performance measures
2. Reach consensus on
   - the scientific data to be used in evaluating alternatives
   - scientific methods and assumptions to be used
   - the nature of alternatives to consider and how to structure the evaluations
3. Create and evaluate alternatives in a collaborative setting with other stakeholders

HYDROLOGICS

We used the DRBC's model

- Prepared students to use the model with four group exercises
- Available on a server
- Students used the model to develop alternatives, which were made available to other states
- We used the model in our CAN session
- Demo the model…

HYDROLOGICS

The Product: Alternate Operations that All States Agreed to (almost)

- Two states wanted to continue negotiating
  - Suggested some of the additional recreation revenue be used to support oyster and mussel studies
  - Both felt confident agreement would be reached (rather than continue with current operations)

HYDROLOGICS

The Product: Much was learned by all (I think)

- Assessment will be finished at the end of February
- All groups worked on modeling when they didn't have to (and at end of the semester)
- Every student participated in the CAN sessions
- Many aspects of process reflected those with actual stakeholders (not clear on own PMs, let alone others', until well into modeling; many of the PMs were not in conflict; spent bulk of time on one or two measures; etc.)

HYDROLOGICS

Not without its frustrations

- Expert panel not used very much
- Most students felt they need more guidance in PM development
- Adapting DRBC model
- Time to learn to use model (well spent?)

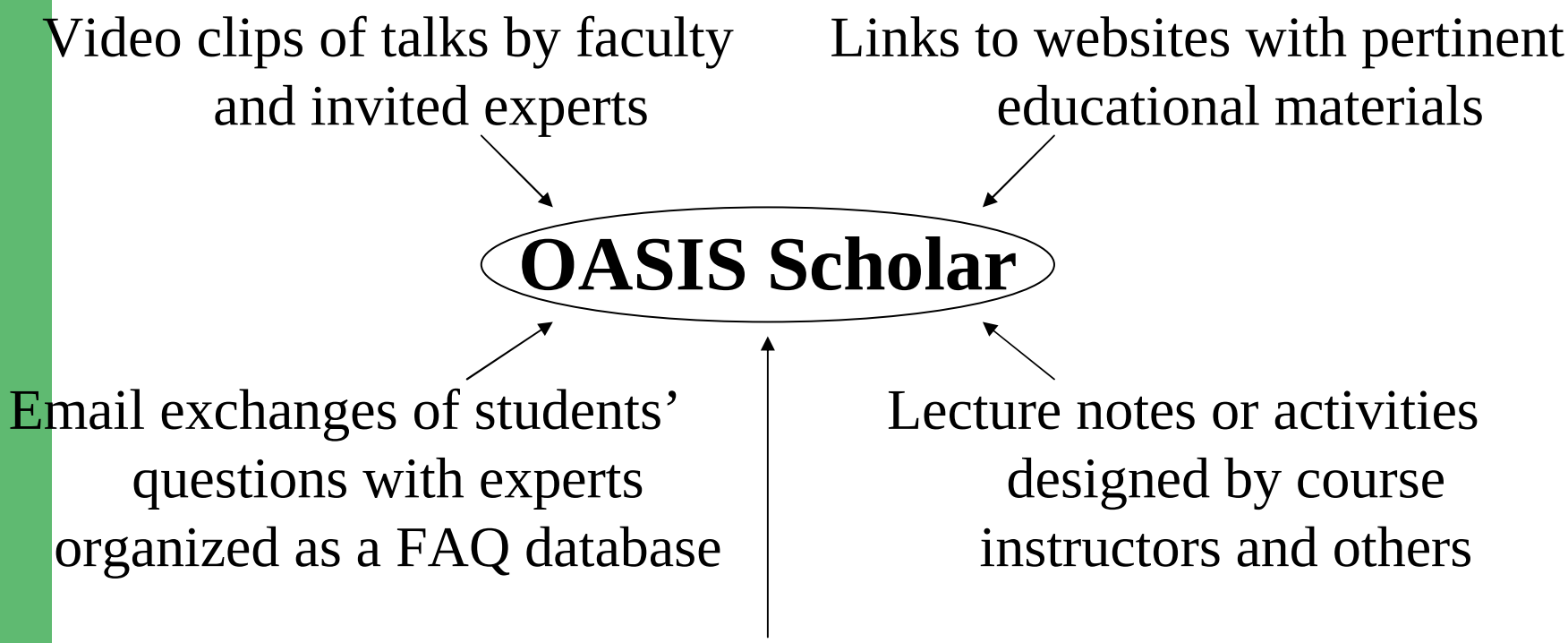
HYDROLOGICS

Outline

- How this course came to be
- What happened this semester
- The future of the course
- Why is this worth doing

HYDROLOGICS

Expanding archive of course materials



HYDROLOGICS

Expansion

- Year 1: UMBC, create OASIS Scholar
- Year 2:
  - George Mason (Engineering department)
  - University of Texas, Austin (LBJ School of Public Affairs)
  - University of Lethbridge (Geology/Earth Science)
- Pieces could be used in many different ways
- Eventually: enough support for anyone (myself four years ago)

HYDROLOGICS

Outline

- How this course came to be
- What happened this semester
- The future of the course
- Why is this worth doing

HYDROLOGICS

Why it should be taught: Changing the World

- Provide students with first-hand experience in balancing multiple objectives and negotiating disputes
- Facilitate students' understanding of and appreciation for the role of science and technology in solving complex problems in public policy

HYDROLOGICS

Why it should be taught: Changing the World

policy-makers who understand the potential of cutting-edge science and technological tools to inform decision-making

lawyers who have a new model for negotiations of long-standing disputes

scientists who can bring the results of their studies to pressing societal issues and design future studies with the needs of these issues in mind

- Facilitate students' understanding of and appreciation for the role of science and technology in solving complex problems in public policy

HYDROLOGICS

Why it should be taught: Learn a lot…

Increase student mastery of content and procedural knowledge in:

Hydrology	Physics	Ecology
Mediation/Conflict resolution		Public policy
Economics	Multi-objective analysis	Law
Computer programming		Mathematics
Statistics and data analysis		Synthesis

HYDROLOGICS

Why it should be taught: …Learn it well

Aspects of Meaningful STEM education

Component	Description
Relevant	Engaging in complex, interdisciplinary, real-world problems
Conceptually connective	Activating the individual student's existing knowledge-base (derived from the current course, previous courses, and out-of-class experience) and promoting assimilation or conceptual change[1]
Problem-driven	Problem-driven rather than content-driven syllabus. In this model, the motivation for learning the supporting content is clear[2]
Meta-cognitive	Promote awareness by student of his/her own learning process (Bransford and Donovan, 2005; Lin and Lehman, 1999).

[1] Bransford and Donovan (2005), Dole and Sinatra (1998), Gentner and Gentner (1983), Osman and Hannafin (1994), Posner, et al. (1982), Strike and Posner (1985)
[2] Duch,et al., 2001; Forsythe, 2002; National Research Council, 1996

HYDROLOGICS

Why it should be taught: …Learn it well

Aspects of Meaningful STEM education

Component	How component is addressed in CAN course
Relevant	Case study of actual water dispute
Conceptually connective	Student-directed learning process -- the pace and path of content introduction. Much of the information will be accessed through OASIS Scholar, instructor, and experts by students *as needed to move forward with their problem-solving*
Problem-driven	
Meta-cognitive	Explicit discussion on their responsibility to self-teach, which requires knowledge of learning style; blog entries

Also, methods from engineering design courses, case-study based courses in economics and elsewhere, and hybrid courses

HYDROLOGICS

Why it should be taught: Recruit!

- Attract and retain students to STEM fields, including those from underrepresented groups
- Possibility of liberal arts undergraduates considering STEM graduate programs
- This seems unlikely to show up with UMBC cohort

HYDROLOGICS

Why should it be taught: It’s really fun

Go to demonstration of the model

HYDROLOGICS