MentalModeler v0.2

Steven Gray, Alexander Metzger,
Steven Scyphers, and Antonie Jetter

MentalModeler v0.2

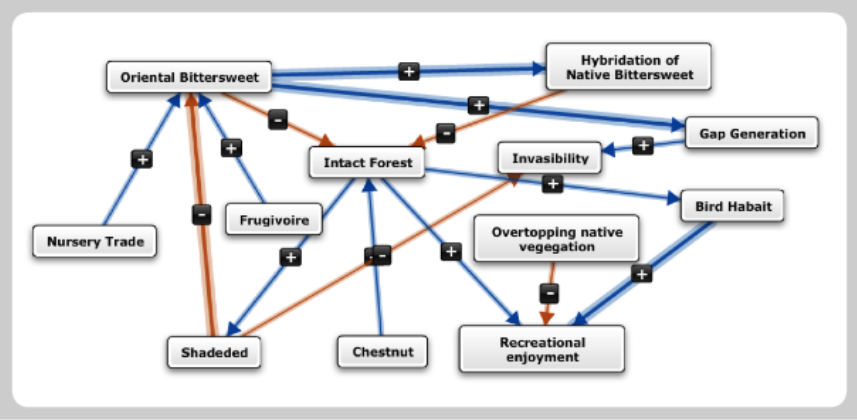
www.mentalmodeler.org

MentalModeler | 01 HOME | 02 DOWNLOAD | 03 WHAT IS FCM? | 04 RESOURCES | 05 ABOUT

01 HOME

What is *Mental Modeler*?

Mental Modeler is modeling software that helps individuals and communities capture their knowledge in a standardized format that can be used for scenario analysis.



Based in Fuzzy-logic Cognitive Mapping (FCM), users can easily develop semi-quantitative models of environmental issues, social concerns or social-ecological systems in *Mental Modeler* by:

- Defining the important components of a system
- Defining the relationships between these components
- Running "what if" scenarios to determine how the system might react under a range of possible changes.

MentalModeler v0.2

Design Goals:

- Represent and standardize stakeholder knowledge and values in resource decision-making
- Provide flexibility and ease in the modeling process
- Create datasets which can compare and combine stakeholder understanding and values
- Create datasets which can be integrated with expert knowledge, scientific datasets, and used to test co-developed hypotheses
- Increase understanding of the structure and function of social-ecological systems

MentalModeler v0.2

Design Goals:

- Represent and standardize stakeholder knowledge and values in resource decision-making
- Provide flexibility and ease in the modeling process
- Create datasets which can compare and combine stakeholder understanding and values
- Create datasets which can be integrated with expert knowledge, scientific datasets, and used to test co-developed hypotheses
- Increase understanding of the structure and function of social-ecological systems

MentalModeler v0.2

Design Goals:

- Represent and standardize stakeholder knowledge and values in resource decision-making
- Provide flexibility and ease in the modeling process
- Create datasets which can compare and combine stakeholder understanding and values
- Create datasets which can be integrated with expert knowledge, scientific datasets, and used to test co-developed hypotheses
- Increase understanding of the structure and function of social-ecological systems

MentalModeler v0.2

Design Goals:

- Represent and standardize stakeholder knowledge and values in resource decision-making
- Provide flexibility and ease in the modeling process
- Create datasets which can compare and combine stakeholder understanding and values
- Create datasets which can be integrated with expert knowledge, scientific datasets, and used to test co-developed hypotheses
- Increase understanding of the structure and function of social-ecological systems

MentalModeler v0.2

Design Goals:

- Represent and standardize stakeholder knowledge and values in resource decision-making
- Provide flexibility and ease in the modeling process
- Create datasets which can compare and combine stakeholder understanding and values
- Create datasets which can be integrated with expert knowledge, scientific datasets, and used to test co-developed hypotheses
- Increase understanding of the structure and function of social-ecological systems

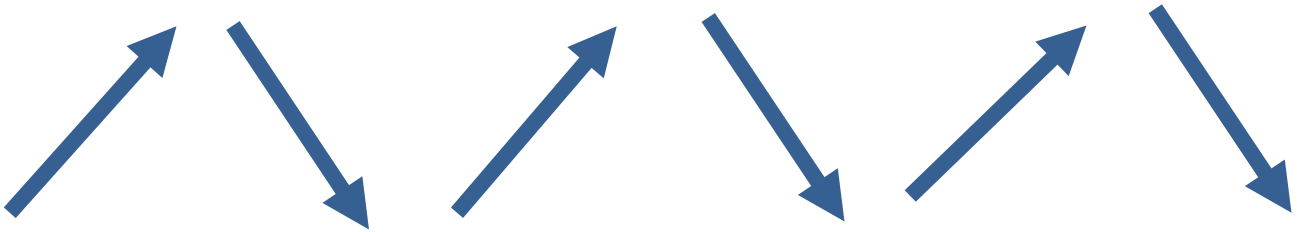
Two ways this is intended to be useful:

1. Research context: Understand how the structure and function of individual and group understanding varies reliably with different value orientations, attitudes and behaviors.

2. Planning context: Share, construct, and revise knowledge about a system to promote learning and adaptability among different experts or stakeholders

Two ways this is intended to be useful:

1. Research context: Understand how the structure and function of individual and group understanding varies reliably with different value orientations, attitudes and behaviors.



2. Planning context: Share, construct, and revise knowledge about a system to promote learning and adaptability among different experts or stakeholders

Outline

- **Overview of Fuzzy-logic Cognitive Mapping**
  - Fuzzy Numbers and Fuzzy Sets
  - Cognitive Mapping
  - Doing the calculations the old fashioned way:
    - Structural Metrics
    - Functional Metrics
- **Introduction to *Mental Modeler***
  - *Case study of Collaborative Modeling for Citizen Scientists*
- **New Analytical Capabilities coming soon!**
  - Integrating MMP files into R
- **Building a Model**
  - *How do stakeholders view the relationship between logging, economic development and wildlife habitat?*

Outline

- **Overview of Fuzzy-logic Cognitive Mapping**
  - Fuzzy Numbers and Fuzzy Sets
  - Cognitive Mapping
  - Doing the calculations the old fashioned way:
    - Structural Metrics
    - Functional Metrics
- **Introduction to *Mental Modeler***
  - *Case study of Collaborative Modeling for Citizen Scientists*
- **New Analytical Capabilities coming soon!**
  - Integrating MMP files into R
- **Building a Model**
  - *How do stakeholders view the relationship between logging, economic development and wildlife habitat?*

What is a FCM?

Fuzzy-logic Cognitive Mapping

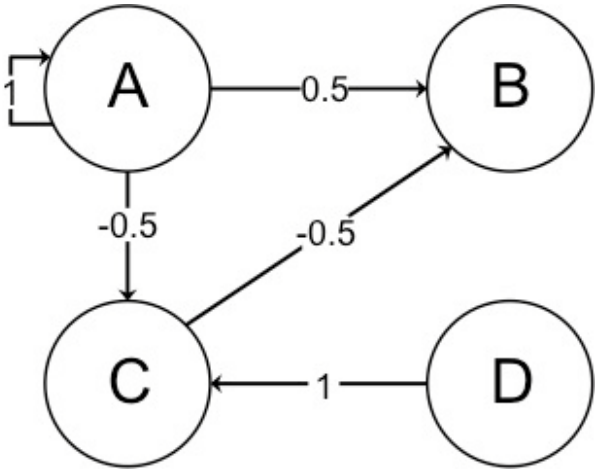
A **Fuzzy cognitive map** is a cognitive map within which the relations between the elements (e.g. concepts, events, project resources) of a "mental landscape" can be used to compute the "strength of impact" of these elements.

Fuzzy cognitive maps are signed fuzzy digraphs.

Spreadsheets or tables are used to map FCMs into matrices for further computation

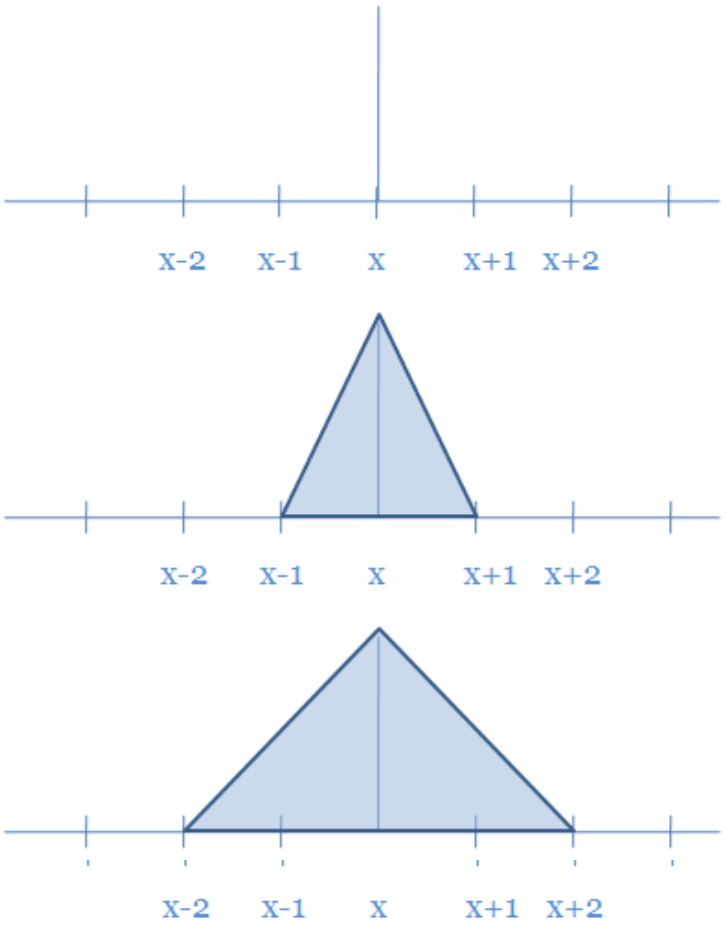
Reliant on fuzzy logic AND cognitive mapping

Bart Kosko
Professor, USC



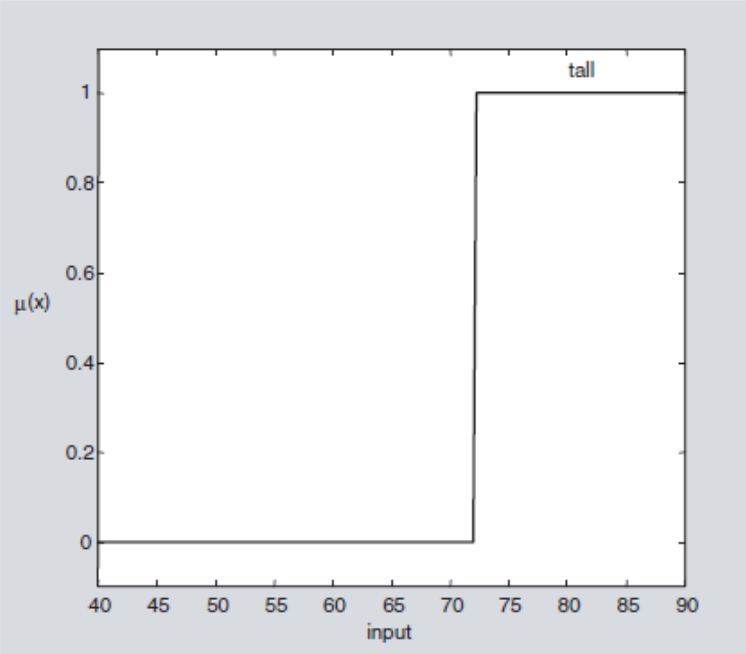
Fuzzy Set Theory

- *Fuzzy Number*
  - *Number ‘x’*
  - *Near ‘x’*
  - *Almost ‘x’*



Fuzzy Set Theory

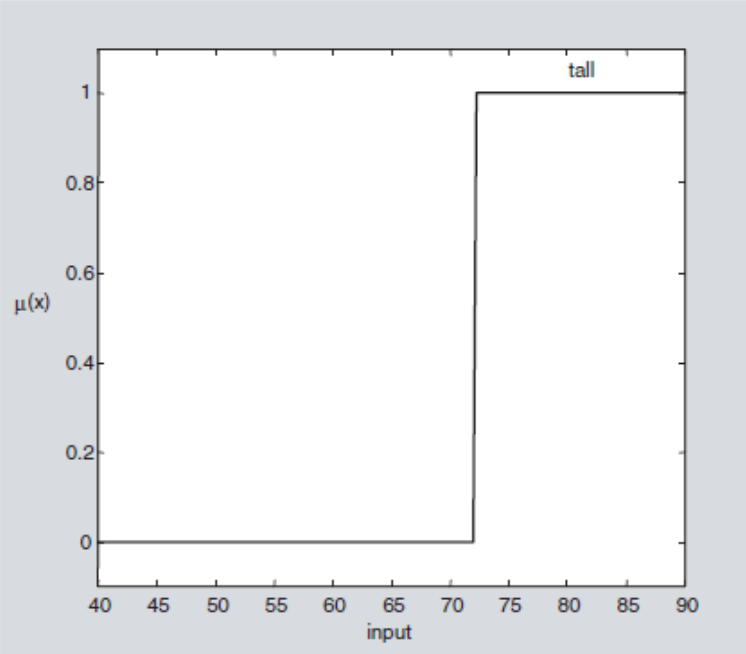
A fuzzy set A in U may be represented as a set of ordered pairs. Each pair consists of a generic element x and its grade of membership function; that is



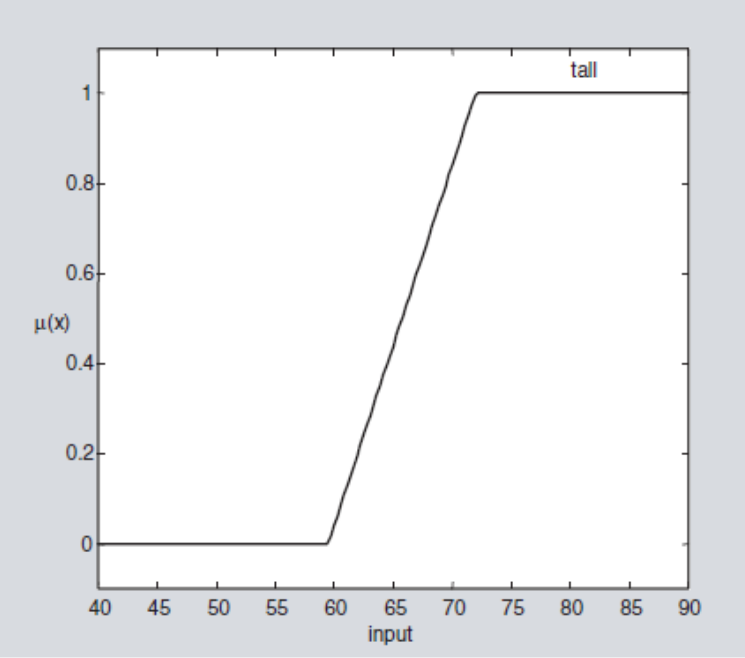
(a) Crisp membership function

Fuzzy Set Theory

A fuzzy set A in U may be represented as a set of ordered pairs. Each pair consists of a generic element x and its grade of membership function; that is



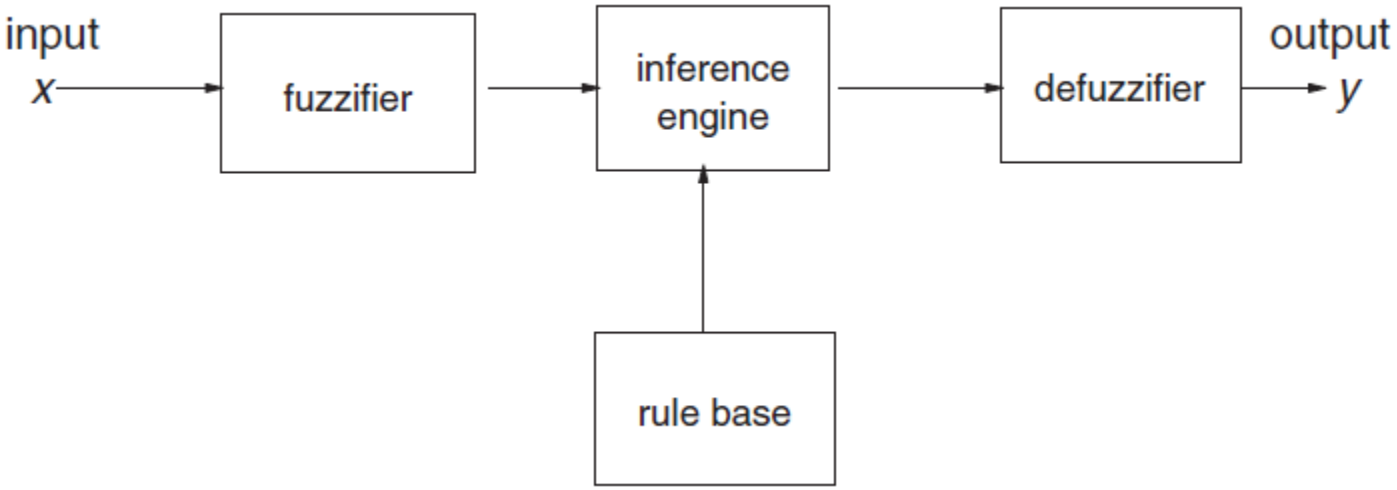
(a) Crisp membership function



(b) Fuzzy membership function

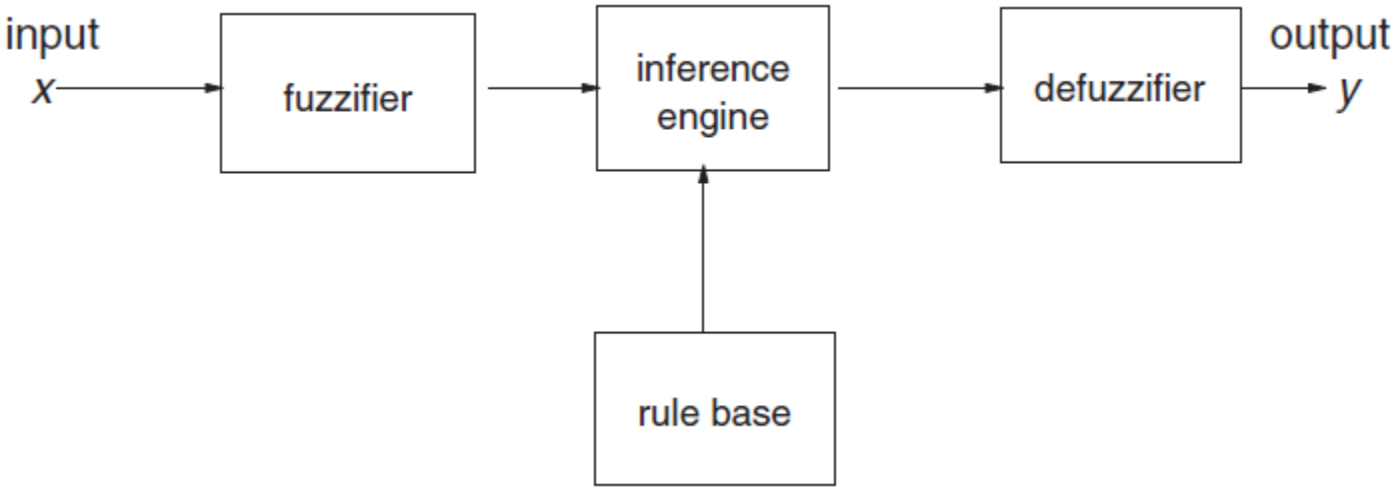
Fuzzy Set Theory

- *Fuzzy set operations = OR, AND, NOT*
- *Establishes a rule-based interference system:*



Fuzzy Set Theory

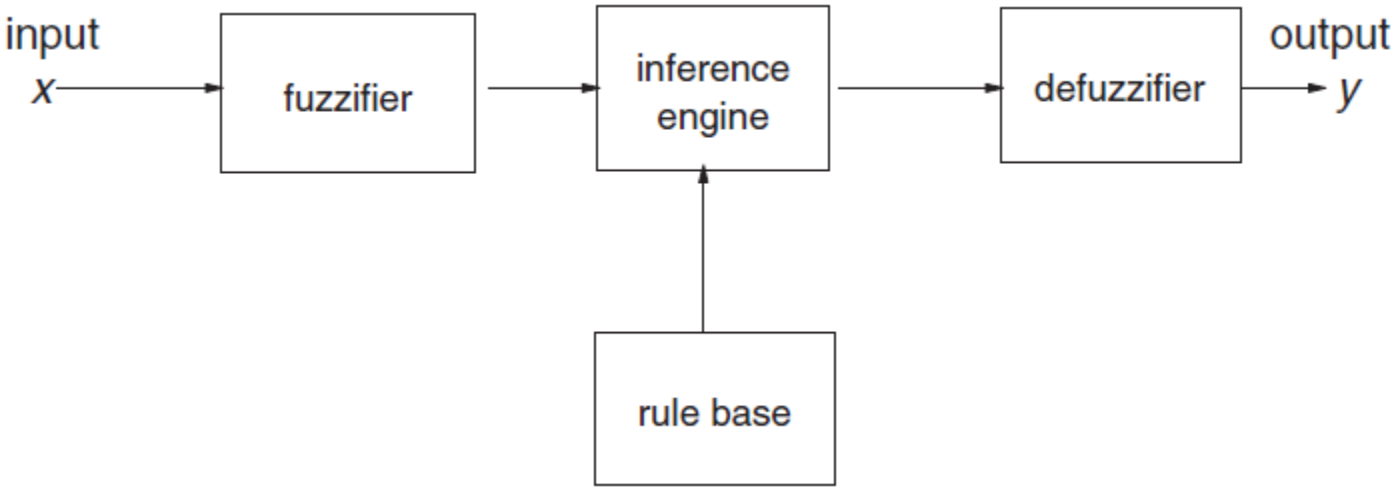
- *Fuzzy set operations = OR, AND, NOT*
- *Establishes a rule-based interference system:*



If apples are green **AND** small **THEN** Not ready to eat

Fuzzy Set Theory

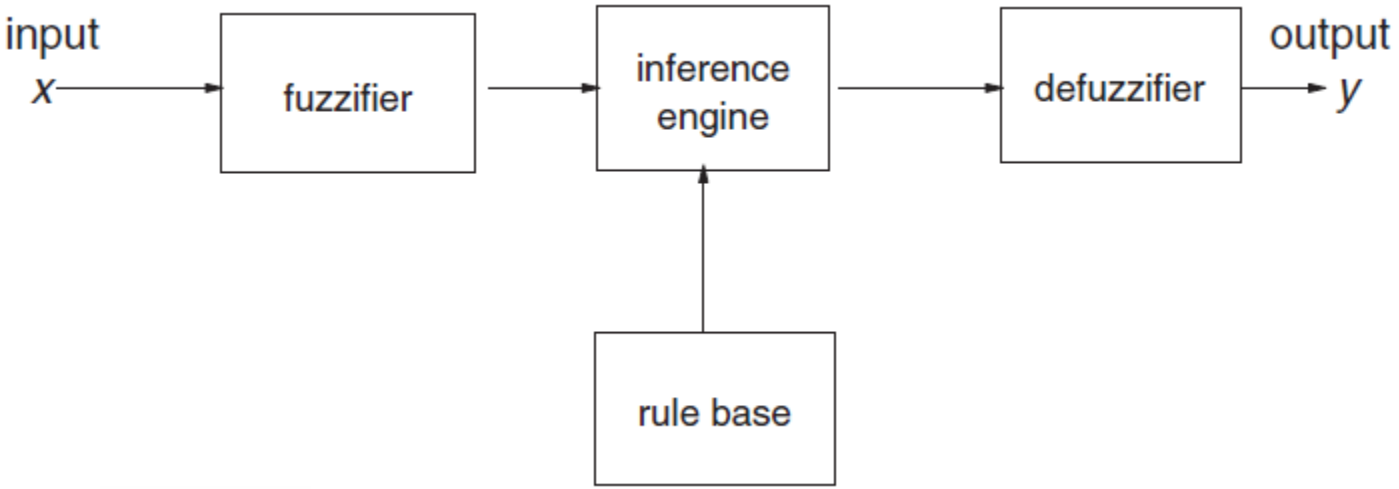
- *Fuzzy set operations = OR, AND, NOT*
- *Establishes a rule-based interference system:*



If apples are red **AND** large **THEN** Ready to eat

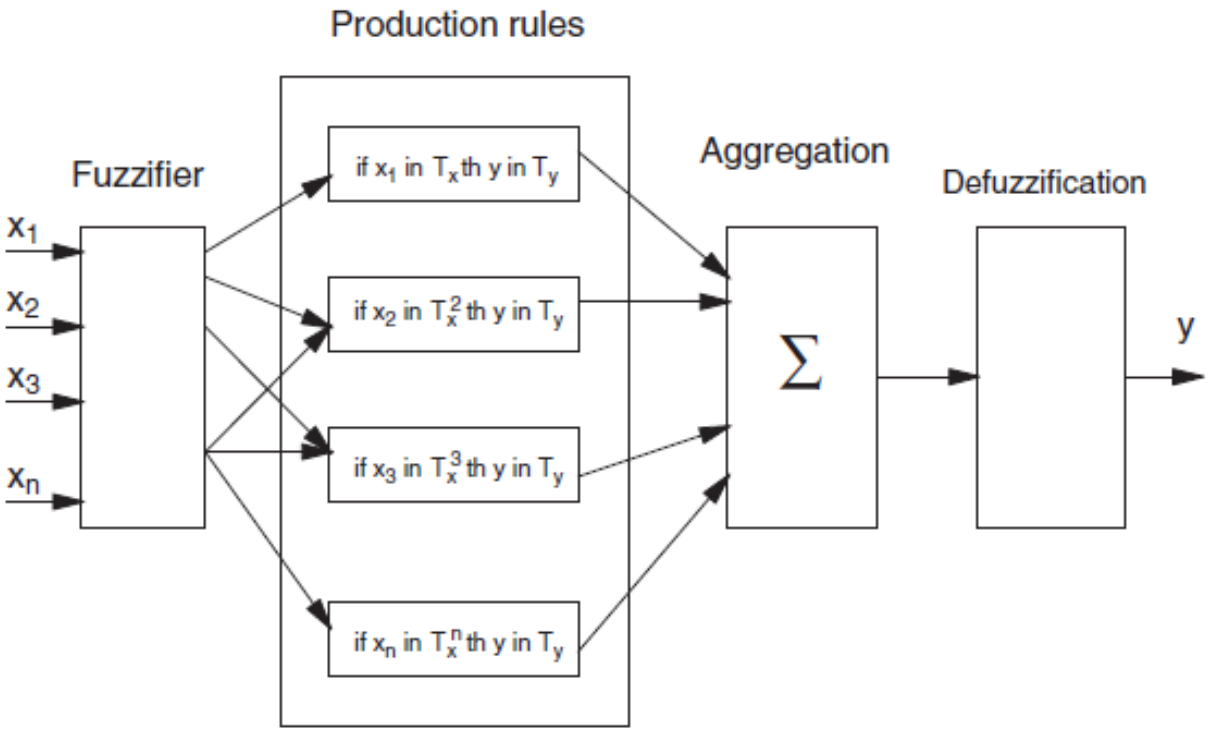
Fuzzy Set Theory

- *Fuzzy set operations = OR, AND, NOT*
- *Establishes a rule-based interference system:*



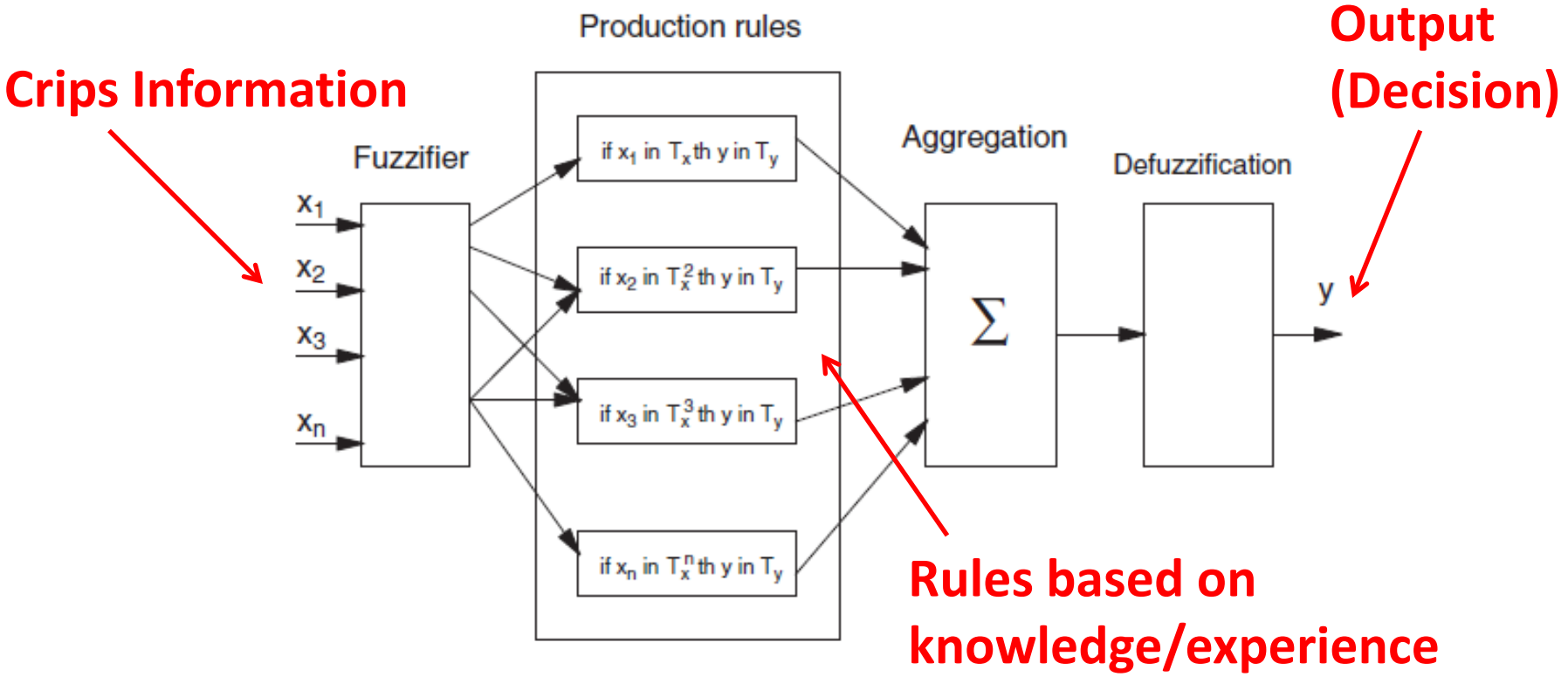
Fuzzy Set Theory

- *Fuzzy set operations = OR, AND, NOT*
- *Establishes a rule-based interference system:*



Fuzzy Set Theory

- *Fuzzy set operations = OR, AND, NOT*
- *Establishes a rule-based interference system:*



Fuzzy-logic Cognitive Mapping

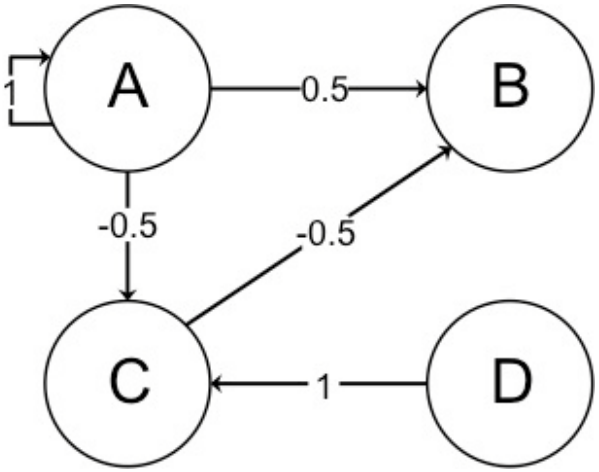
A **Fuzzy cognitive map** is a cognitive map within which the relations between the elements (e.g. concepts, events, project resources) of a "mental landscape" can be used to compute the "strength of impact" of these elements.

Fuzzy cognitive maps are signed fuzzy digraphs.

Spreadsheets or tables are used to map FCMs into Matrices for further computation

Reliant on fuzzy logic AND cognitive mapping

Bart Kosko
Professor, USC



Concept or Cognitive Mapping?

In 1943 Kenneth Craik wrote *The Nature of Explanation*. In this book he laid the foundation for the concept of mental models, that the mind forms models of reality and uses them to predict similar future events

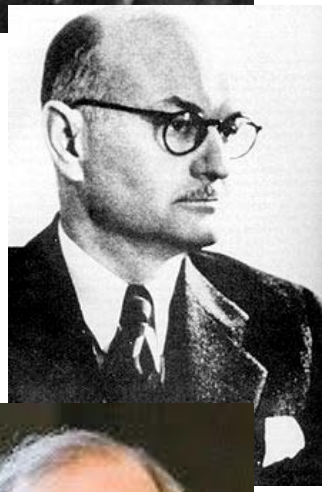
Concept or Cognitive Mapping?

In 1943 Kenneth Craik wrote *The Nature of Explanation*. In this book he laid the foundation for the concept of mental models, that the mind forms models of reality and uses them to predict similar future events

Introduced by Edward Tolman in 1948, cognitive map is a type of mental representation which serves an individual to acquire, code, store, recall, and decode information about the relative locations and attributes of phenomena in their everyday or metaphorical spatial environment

Concept or Cognitive Mapping?

In 1943 Kenneth Craik wrote *The Nature of Explanation*. In this book he laid the foundation for the concept of mental models, that the mind forms models of reality and uses them to predict similar future events

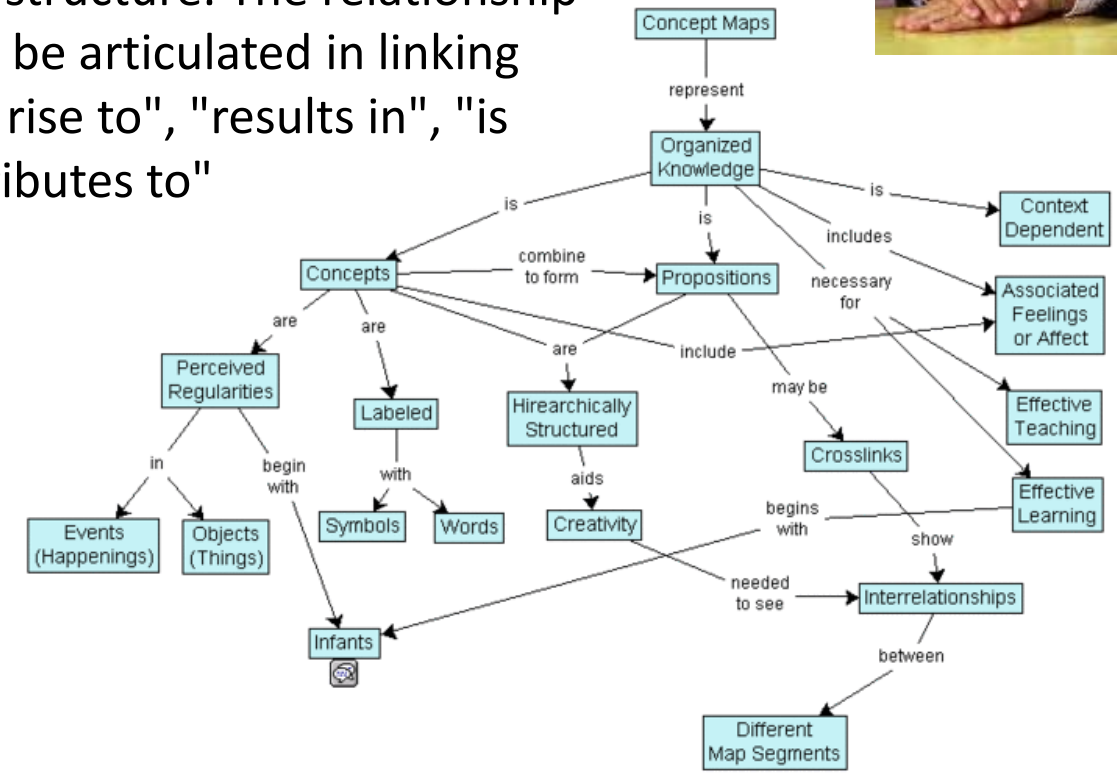


Introduced by Edward Tolman in 1948, cognitive map is a type of mental representation which serves an individual to acquire, code, store, recall, and decode information about the relative locations and attributes of phenomena in their everyday or metaphorical spatial environment

Robert Axelrod (1976) was the first to use the term in reference to the content and structure of individuals' minds, thereby shifting its applied meaning from referring to a map that is cognitive, to a map of cognition (Doyle and Ford 1999)

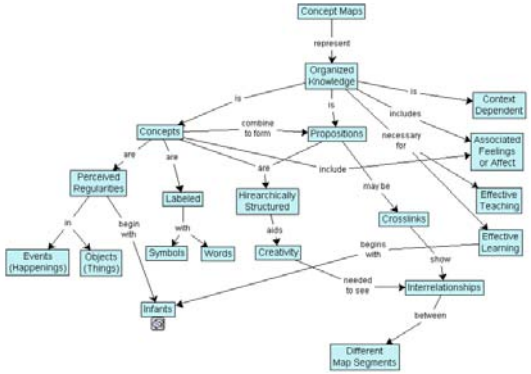
Concept or Cognitive Mapping?

A **concept map** is a diagram showing the relationships among concepts. It is a graphical tool for organizing and representing knowledge.
Concepts, usually represented as boxes or circles, are connected with labeled arrows in a downward-branching hierarchical structure. The relationship between concepts can be articulated in linking phrases such as "gives rise to", "results in", "is required by," or "contributes to"



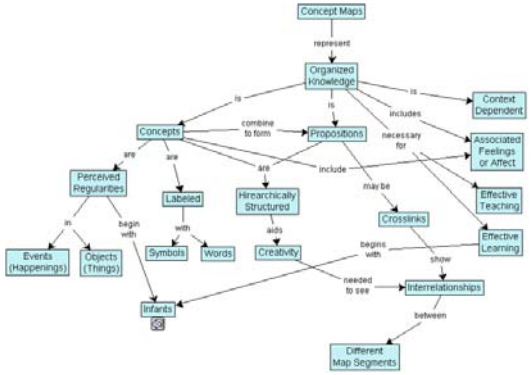
Brining it all together: Fuzzy-logic Cognitive Mapping (FCM)

Explicit representation of an internal mental model of relationships between concepts constructed over time…

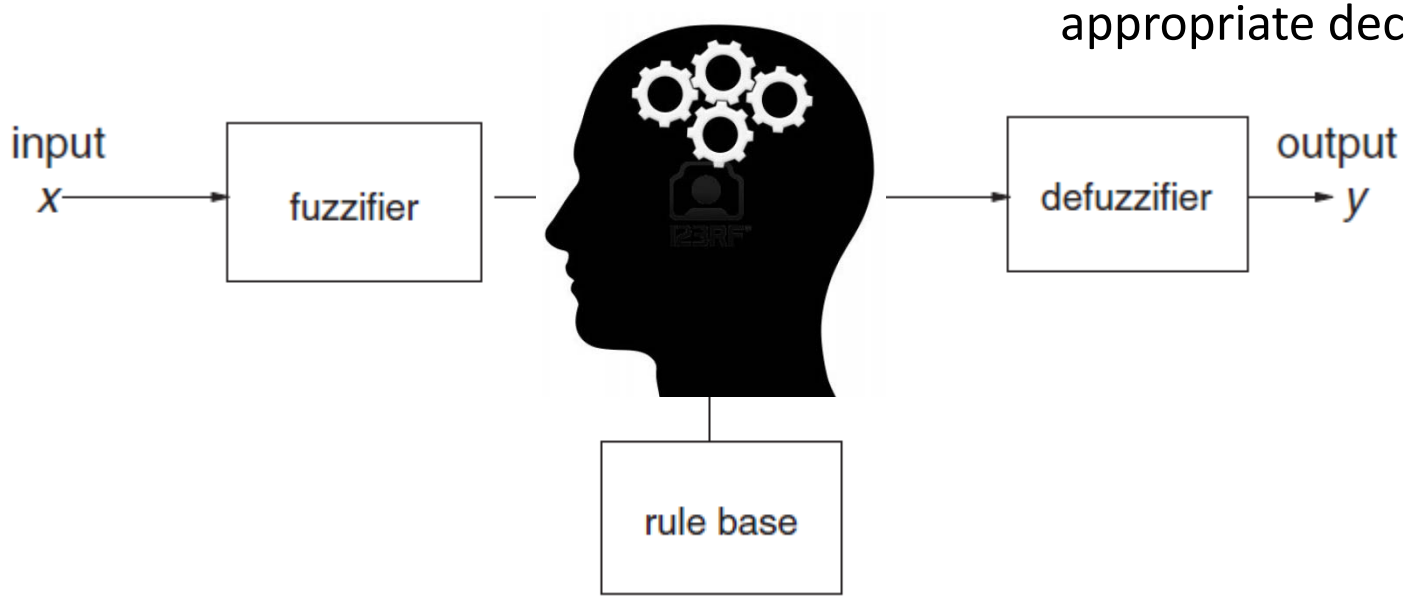


Brining it all together: Fuzzy-logic Cognitive Mapping (FCM)

Explicit representation of an internal mental model of relationships between concepts constructed over time…



…that applies a set of associative rules thought to be similar to the ways in which individuals are able to make context appropriate decisions

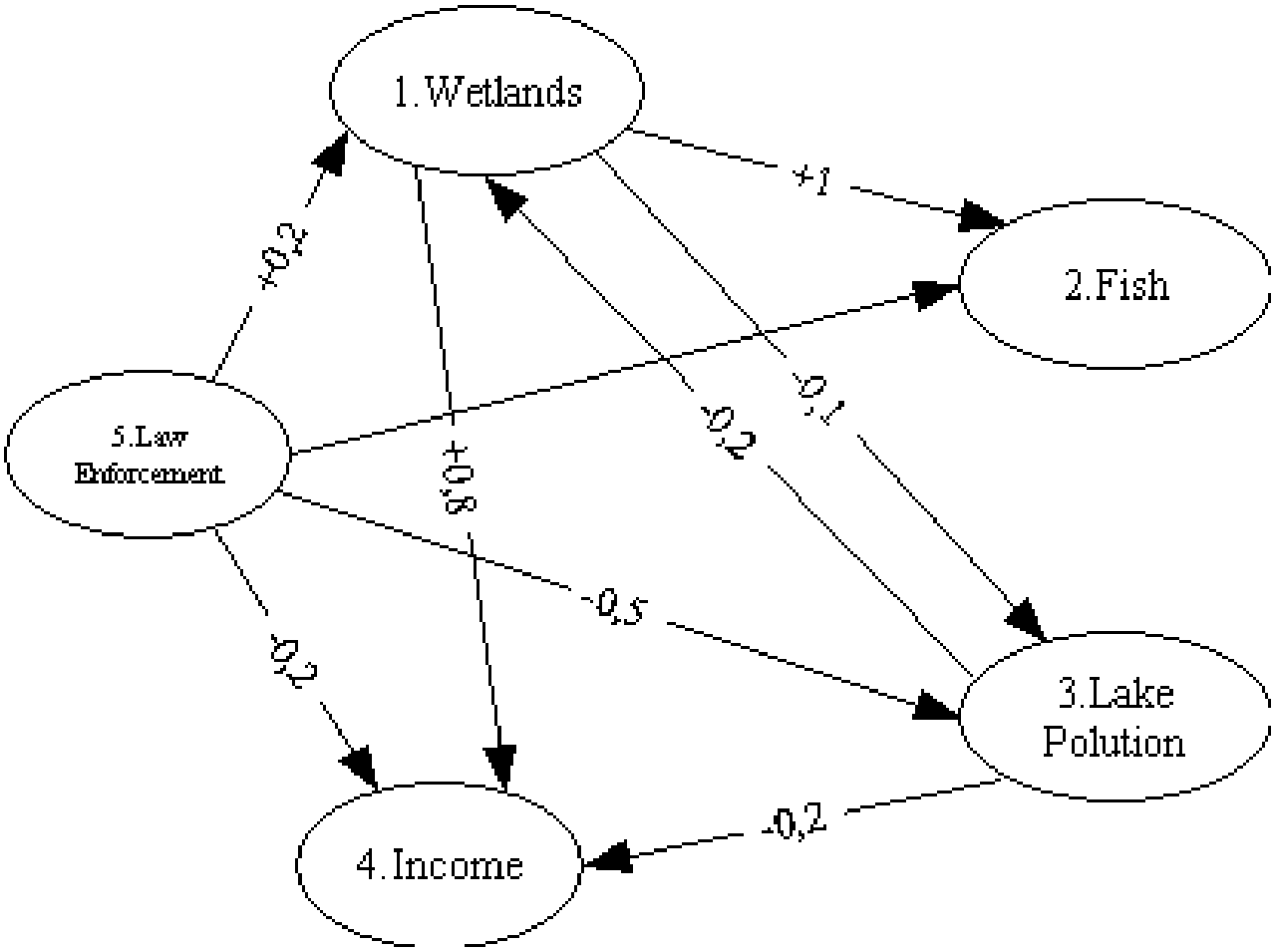


How to construct a FCM?

Brining it all together: Fuzzy-logic Cognitive Mapping (FCM)

- A **Fuzzy cognitive map** is a special kind of cognitive/concept map within which the components and relationships between the components are defined in specific ways.
  - **Components** in a fuzzy-logic cognitive map need to be defined as things that can go increase or decrease (like precipitation, animal populations, satisfaction, hunger, or traffic)
  - **Relationships** in an fuzzy-logic cognitive map have 2 main characteristics: (a) the direction of a relationship (which way the arrow is pointing) and (b) the degree of influence one component can have on another (positively or negatively) parameterized between a fuzzy set from 0 and 1.

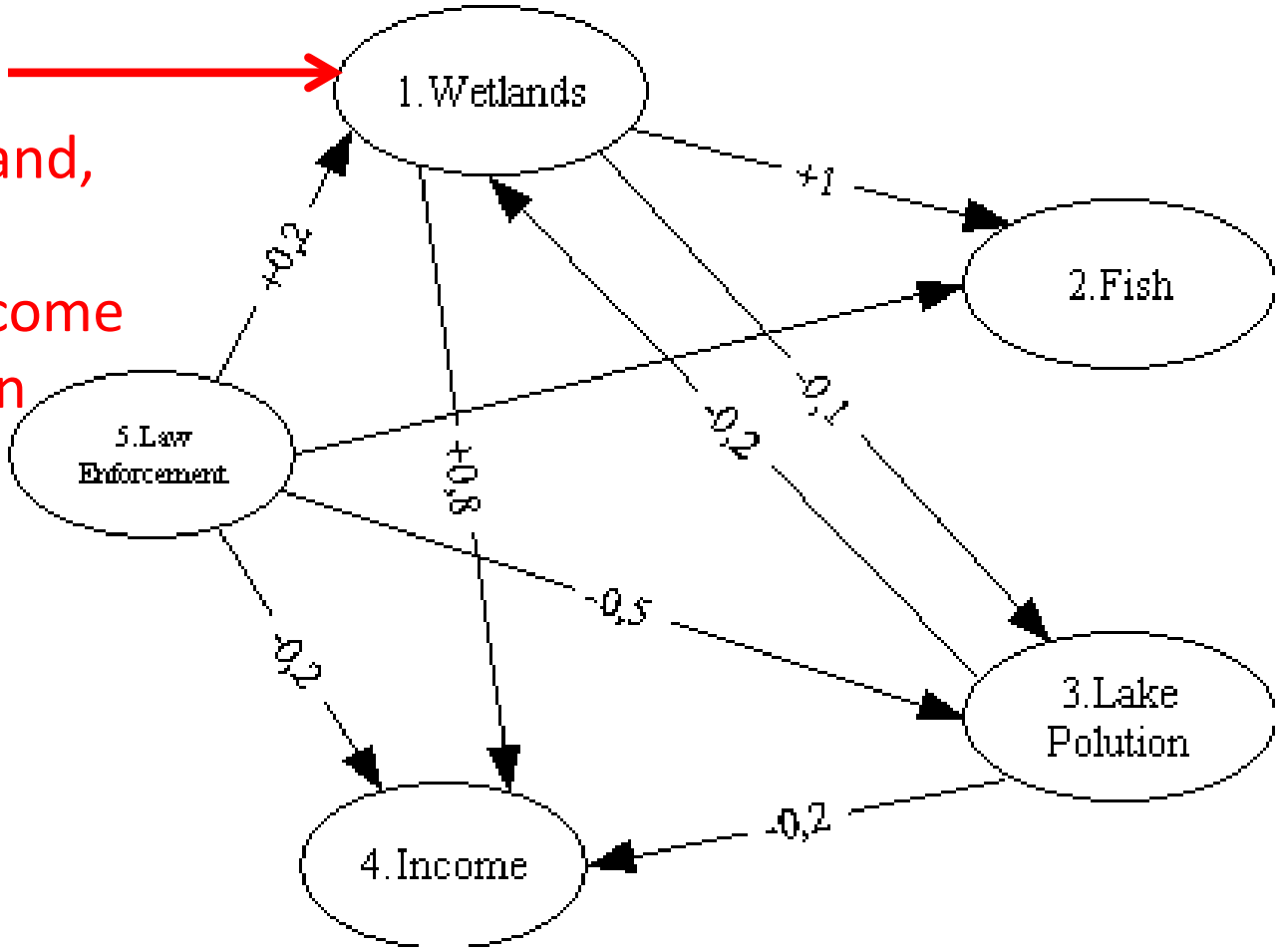
Example


1.Wetlands
2.Fish
3.Lake Polution
4.Income
5.Law Enforcement
+1
+0,2
-0,1
-0,2
+0,8
-0,5
0,2
-0,2

Example

Components

The amount of wetland, the amount of law enforcement and income can all go up or down



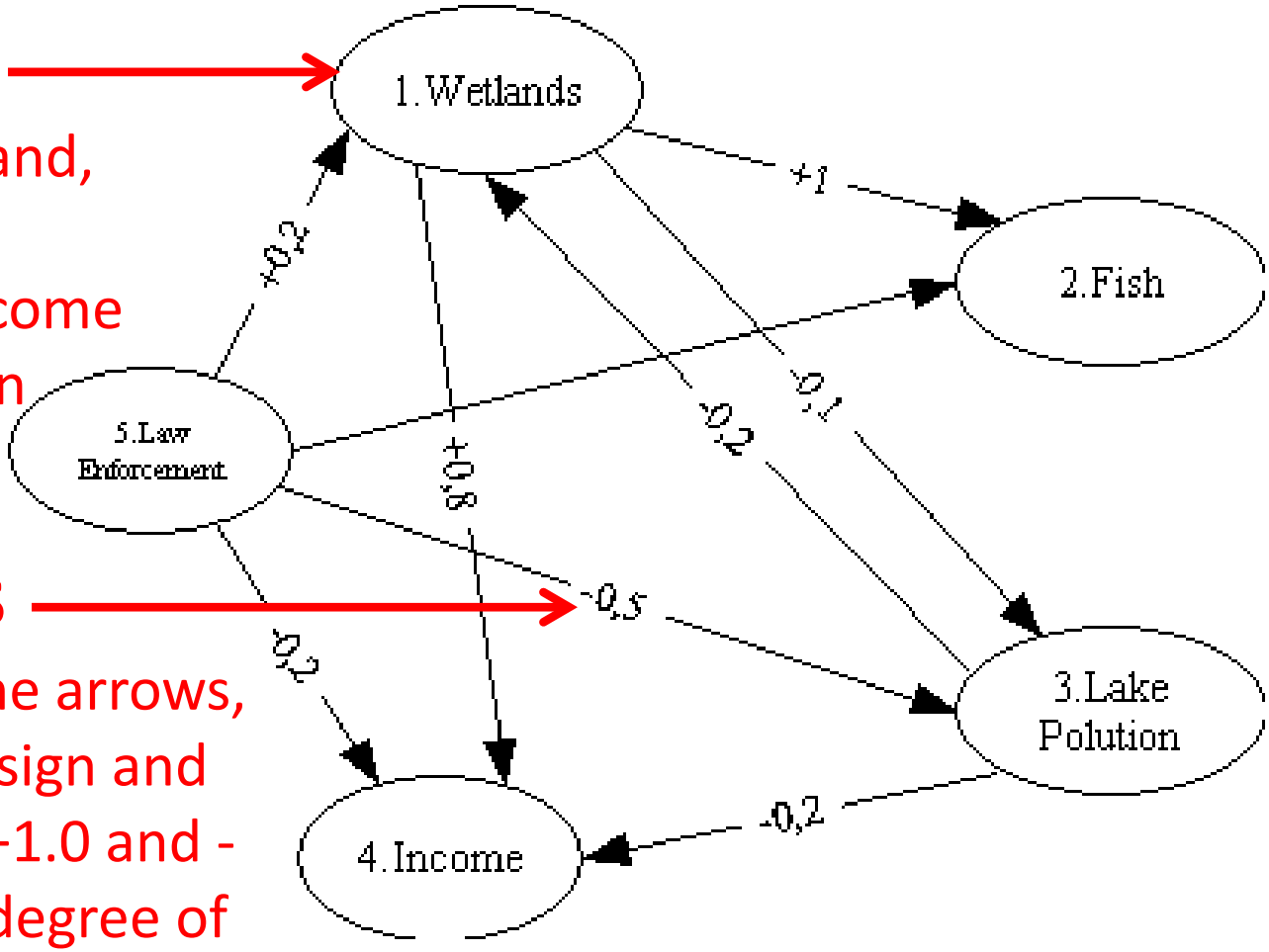
Example

Components

The amount of wetland, the amount of law enforcement and income can all go up or down

Relationships

These direction of the arrows, positive or negative sign and numbers (between +1.0 and -1.0) all indicate the degree of influence one component can have on another

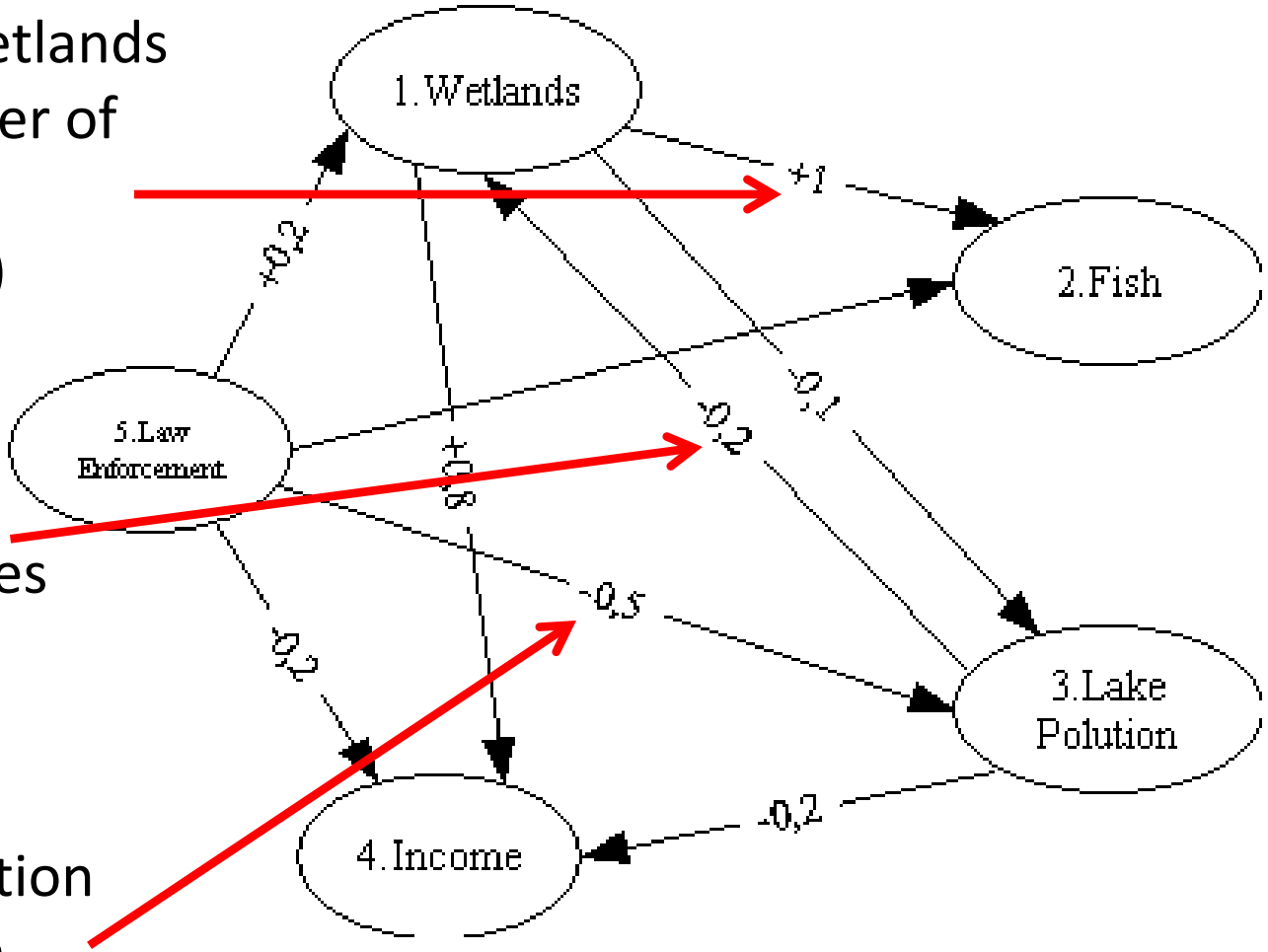


Thinking about relationships

As the amount of wetlands increases, the number of fish increases a lot (indicated by the +1)

As lake pollution increases, the amount of wetlands decreases slightly (-0.2)

As law enforcement increases, lake pollution decreases a medium amount (+0.5)



Thinking about relationships

Remember, the direction of the arrow indicates the direction of increase or decrease. The number value included on the arrow could be anything between +1 (as one component goes up the other component increases a lot) to -1 (as one component goes up the other component decreases a lot)

Thinking about relationships

Remember, the direction of the arrow indicates the direction of increase or decrease. The number value included on the arrow could be anything between +1 (as one component goes up the other component increases a lot) to -1 (as one component goes up the other component decreases a lot)

These number values on the lines could even be qualitatively defined and then later translated into quantitative values:

increases a lot	= +1
increases	= +0.5
increases a little	= +0.25
decreases a little	= -0.25
decreases	= -0.5
decreases a lot	= -1

Rule of Thumb for Relationships

When determining the relationships between components in an FCM always ask yourself 2 questions:

1. When this component increases, does the other component increase or decrease?
2. Is it a high increase/decrease, medium increase/decrease or low increase/decrease?

How can you analyze an FCM?

What are they good for?

- Calculating Structural Network Metrics

  --Measuring and representing knowledge (and variation)

  --Determining driving variables and sensitive variables and common belief structures

What are they good for?

- Calculating Structural Network Metrics

  --Measuring and representing knowledge (and variation)

  --Determining driving variables and sensitive variables and common belief structures

- Calculating Scenario (Functional) Analysis

  -- Understanding how stakeholders anticipate the impacts of environmental change

  -- Decreasing uncertainty associated with environmental change

Knowledge Structure

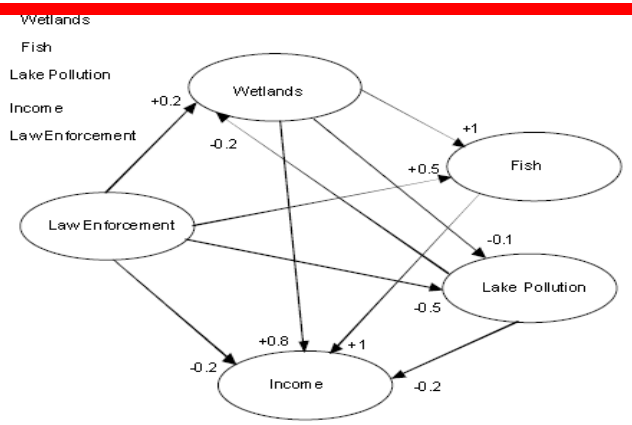


Fig. 3. Example fuzzy cognitive map.

Cognitive Maps collected can then be translated into a matrix format for analyses

	1.Amount of wetland	2. Fish Population	3. Pollution	4. Livelihood	5. Laws
1. Amount of wetland	0	1	-0.1	0.8	0
2. Fish Population	0	0	0	1	0
3. Pollution	-0.2	-1	0	-0.2	0
4. Livelihood	0	0	0	0	0
5. Laws	0.2	0.5	-0.5	-0.2	0

Mental Model Structural Measurement	Description of Measure and Cognitive Inference
N (Concepts)	Number of variables included in model; higher number of concepts indicates more components in the mental model (Özesmi and Özesmi 2004)
N (Connections)	Number of connections included between variables; higher number of connections indicates higher degree of interaction between components in a mental model (Özesmi and Özesmi 2004)
N (Transmitter)	Components which only have "forcing" functions; indicates number of components that effect other system components but are not affected by others (Eden et al.1992)
N (Receiver)	Components which have only receiving functions; indicates the number of components that are affected by other system components but have no effect (Eden et al.1992)
N (Ordinary)	Components with both transmitting and receiving functions; indicates the number of concepts that influence and are influenced by other concepts (Eden et al.1992)

	1.Amount of wetland	2. Fish Population	3. Pollution	4. Livelihood	5. Laws
1. Amount of wetland	0	1	-0.1	0.8	0
2. Fish Population	0	0	0	1	0
3. Pollution	-0.2	-1	0	-0.2	0
4. Livelihood	0	0	0	0	0
5. Laws	0.2	0.5	-0.5	-0.2	0

$$\mathrm{od}(v_i) = \sum_{k=1}^{N} \bar{a}_{ik}$$

$$\mathrm{id}(v_i) = \sum_{k=1}^{N} \bar{a}_{ki}$$

Mental Model Structural Measurement	Description of Measure and Cognitive Inference
Centrality	Absolute value of either (a) overall influence in the model (all + and – relationships indicated, for entire model) or (b) influence of individual concepts as indicated by positive (+) or negative (-) values placed on connections between components; indicates (a) the total influence (positive and negative) to be in the system or (b) the conceptual weight/importance of individual concepts (Kosko 1986a). The higher the value, the greater is the importance of all concepts or the individual weight of a concept in the overall model
C/N	Number of connections divided by number of variables (concepts). The lower the C/N score, the higher the degree of connectedness in a system (Özesmi and Özesmi 2004)
Complexity	Ratio of receiver variables to transmitter variables. Indicates the degree of resolution and is a measure of the degree to which outcomes of driving forces are considered. Higher complexity indicates more complex systems thinking (Eden et al.1992; Özesmi and Özesmi 2004)
Density	Number of connections compared to number of all possible connections. The higher the density, the more potential management polices exist (Özesmi and Özesmi 2004; Hage and Harary 1983)
Hierarchy Index	Index developed to indicate hierarchical to democratic view of the system. On a scale of 0-1, indicates the degree of top-down down (score 1) or democratic perception (score 0) of the mental model (McDonald 1983)

$$D = \frac{C}{N(N-1)}$$

$$h = \frac{12}{(N-1)N(N+1)} \sum_i \left[\frac{\mathrm{od}(v_i) - \left(\sum \mathrm{od}(v_i)\right)}{N} \right]^2$$

Comparison of Structures

Stakeholder Group	Harvesters	Pre and Post Harvest	Managers	Scientists	Environmental NGO	Community Map
Maps (N)	9	4	5	6	3	27
Number of Variables	16.2(3.0)	12.8(2.1)	15.4(5.8)	19.2(1.71)	19.7(5.5)	27
Number of Transmitter	6.33(3.08)	2.75(1.71)	5.8(3.27)	6.33(1.75)	7.67(3.51)	6
Number of Receiver	1.44(0.88)	2(1.41)	0.8(0.45)	2.33(1.87)	1.67(0.58)	1
Number of Ordinary	8.55(3.16)	8(3.47)	8.8(3.90)	10.33(3.72)	10.67(4.50)	20
Number of Connections	26.22(7.70)	22.5(13.80)	25(13.80)	27.33(7.60)	40.67(19.00)	117
C/N	1.65(0.30)	1.66(1.24)	1.42(0.23)	1.41(0.30)	2.56(1.02)	4.34
Complexity (R:D)	0.34(0.40)	0.38(0.49)	0.27(0.22)	0.50(0.58)	0.17(0.29)	0.17
Density	0.11(0.02)	0.14(0.01)	0.11(0.04)	0.09(0.02)	0.12(0.08)	0.17

Values in Mean (SD)

Gray, S., Chan, A., Clark, D., and R.C. Jordan. 2012 Modeling the integration of stakeholder knowledge in social-ecological system decision-making: Benefits and limitations to knowledge diversity. *Ecological Modeling* 229, 88-96.

Comparison of Structures

Stakeholder Group	Harvesters	Pre and Post Harvest	Managers	Scientists	Environmental NGO	Community Map
Maps (N)	9	4	5	6	3	27
Number of Variables	16.2(3.0)	12.8(2.1)	15.4(5.8)	19.2(1.71)	19.7(5.5)	27
Number of Transmitter	6.33(3.08)	2.75(1.71)	5.8(3.27)	6.33(1.75)	7.67(3.51)	6
Number of Receiver	1.44(0.88)	2(1.41)	0.8(0.45)	2.33(1.87)	1.67(0.58)	1
Number of Ordinary	8.55(3.16)	8(3.47)	8.8(3.90)	10.33(3.72)	10.67(4.50)	20
Number of Connections	26.22(7.70)	22.5(13.80)	25(13.80)	27.33(7.60)	40.67(19.00)	117
C/N	1.65(0.30)	1.66(1.24)	1.42(0.23)	1.41(0.30)	2.56(1.02)	4.34
Complexity (R:D)	0.34(0.40)	0.38(0.49)	0.27(0.22)	0.50(0.58)	0.17(0.29)	0.17
Density	0.11(0.02)	0.14(0.01)	0.11(0.04)	0.09(0.02)	0.12(0.08)	0.17

Values in Mean (SD)

Number of components and type of components

Comparison of Structures

Stakeholder Group	Harvesters	Pre and Post Harvest	Managers	Scientists	Environmental NGO	Community Map
Maps (N)	9	4	5	6	3	27
Number of Variables	16.2(3.0)	12.8(2.1)	15.4(5.8)	19.2(1.71)	19.7(5.5)	27
Number of Transmitter	6.33(3.08)	2.75(1.71)	5.8(3.27)	6.33(1.75)	7.67(3.51)	6
Number of Receiver	1.44(0.88)	2(1.41)	0.8(0.45)	2.33(1.87)	1.67(0.58)	1
Number of Ordinary	8.55(3.16)	8(3.47)	8.8(3.90)	10.33(3.72)	10.67(4.50)	20
Number of Connections	26.22(7.70)	22.5(13.80)	25(13.80)	27.33(7.60)	40.67(19.00)	117
C/N	1.65(0.30)	1.66(1.24)	1.42(0.23)	1.41(0.30)	2.56(1.02)	4.34
Complexity (R:D)	0.34(0.40)	0.38(0.49)	0.27(0.22)	0.50(0.58)	0.17(0.29)	0.17
Density	0.11(0.02)	0.14(0.01)	0.11(0.04)	0.09(0.02)	0.12(0.08)	0.17

Values in Mean (SD)

Complexity is a measure of the amt of Receiver to Driver components and indicates the degree of resolution in the model

Comparison of Structures

Stakeholder Group	Harvesters	Pre and Post Harvest	Managers	Scientists	Environmental NGO	Community Map
Maps (N)	9	4	5	6	3	27
Number of Variables	16.2(3.0)	12.8(2.1)	15.4(5.8)	19.2(1.71)	19.7(5.5)	27
Number of Transmitter	6.33(3.08)	2.75(1.71)	5.8(3.27)	6.33(1.75)	7.67(3.51)	6
Number of Receiver	1.44(0.88)	2(1.41)	0.8(0.45)	2.33(1.87)	1.67(0.58)	1
Number of Ordinary	8.55(3.16)	8(3.47)	8.8(3.90)	10.33(3.72)	10.67(4.50)	20
Number of Connections	26.22(7.70)	22.5(13.80)	25(13.80)	27.33(7.60)	40.67(19.00)	117
C/N	1.65(0.30)	1.66(1.24)	1.42(0.23)	1.41(0.30)	2.56(1.02)	4.34
Complexity (R:D)	0.34(0.40)	0.38(0.49)	0.27(0.22)	0.50(0.58)	0.17(0.29)	0.17
Density	0.11(0.02)	0.14(0.01)	0.11(0.04)	0.09(0.02)	0.12(0.08)	0.17

Values in Mean (SD)

Density is a measure of potential change within the system

Comparison of Structures

Stakeholder Group	Harvesters	Pre and Post Harvest	Managers	Scientists	Environmental NGO	Community Map
Maps (N)	9	4	5	6	3	27
Number of Variables	16.2(3.0)	12.8(2.1)	15.4(5.8)	19.2(1.71)	19.7(5.5)	27
Number of Transmitter	6.33(3.08)	2.75(1.71)	5.8(3.27)	6.33(1.75)	7.67(3.51)	6
Number of Receiver	1.44(0.88)	2(1.41)	0.8(0.45)	2.33(1.87)	1.67(0.58)	1
Number of Ordinary	8.55(3.16)	8(3.47)	8.8(3.90)	10.33(3.72)	10.67(4.50)	20
Number of Connections	26.22(7.70)	22.5(13.80)	25(13.80)	27.33(7.60)	40.67(19.00)	117
C/N	1.65(0.30)	1.66(1.24)	1.42(0.23)	1.41(0.30)	2.56(1.02)	4.34
Complexity (R:D)	0.34(0.40)	0.38(0.49)	0.27(0.22)	0.50(0.58)	0.17(0.29)	0.17
Density	0.11(0.02)	0.14(0.01)	0.11(0.04)	0.09(0.02)	0.12(0.08)	0.17

Values in Mean (SD)

Scientists see the more components in the system, more complexity in the system, but less amount of room for change

Knowledge Function

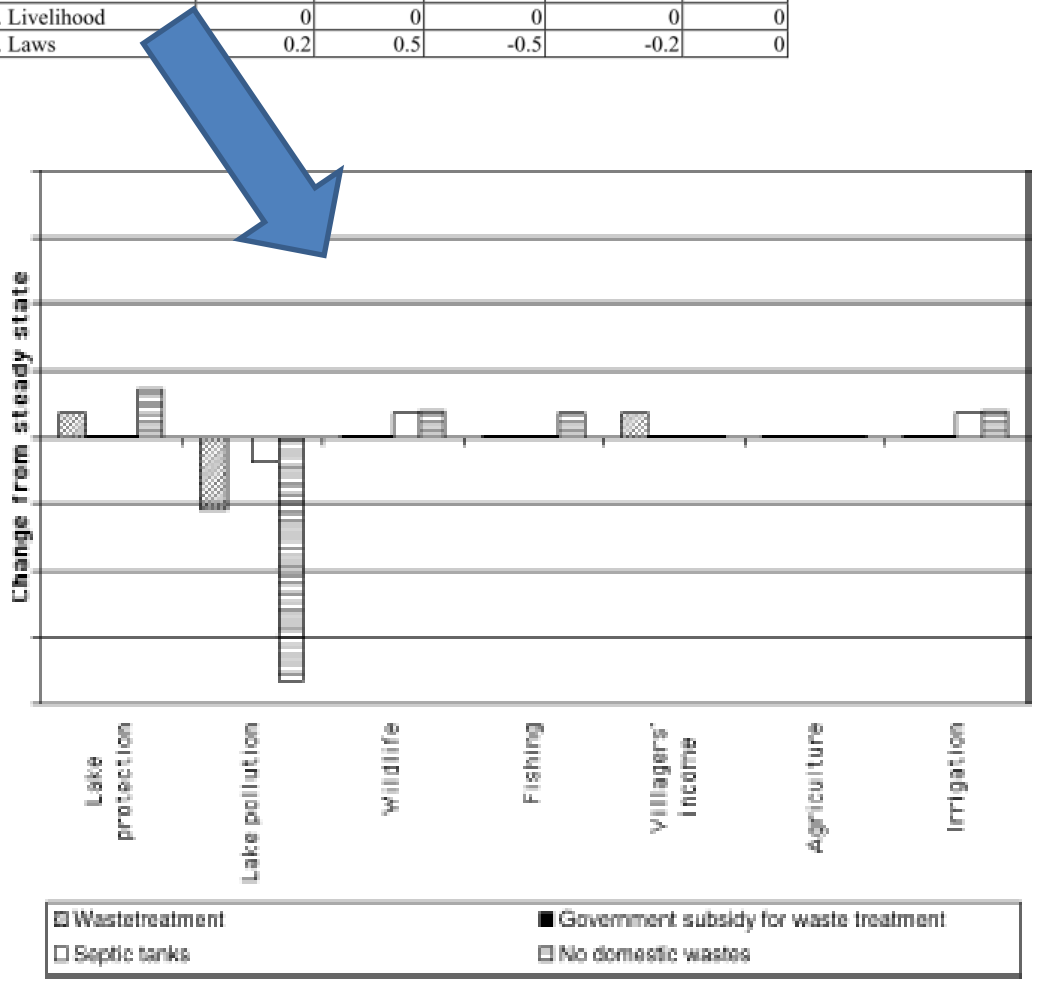
	1.Amount of wetland	2. Fish Population	3. Pollution	4. Livelihood	5. Laws
1. Amount of wetland	0	1	-0.1	0.8	0
2. Fish Population	0	0	0	1	0
3. Pollution	-0.2	-1	0	-0.2	0
4. Livelihood	0	0	0	0	0
5. Laws	0.2	0.5	-0.5	-0.2	0

x [1,1,1,1,1,….]

Scenario State

- -- Steady State

Relative Change

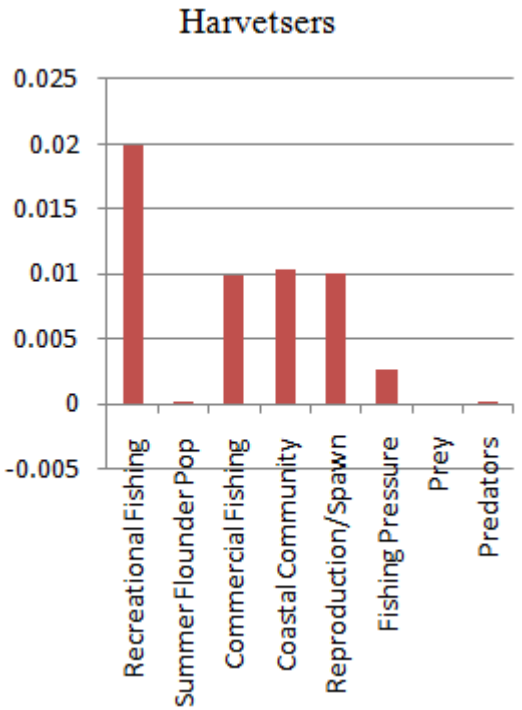


Components in the FCM can be increased or decreased to understand how the system would react under a range of policy, social, or environmental changes (Kosko 1986)

Comparison of Function

Scenario: Increase Summer Flounder Population

Increase in recreational and commercial fishing, coastal community, fishing pressure and reproduction/spawn

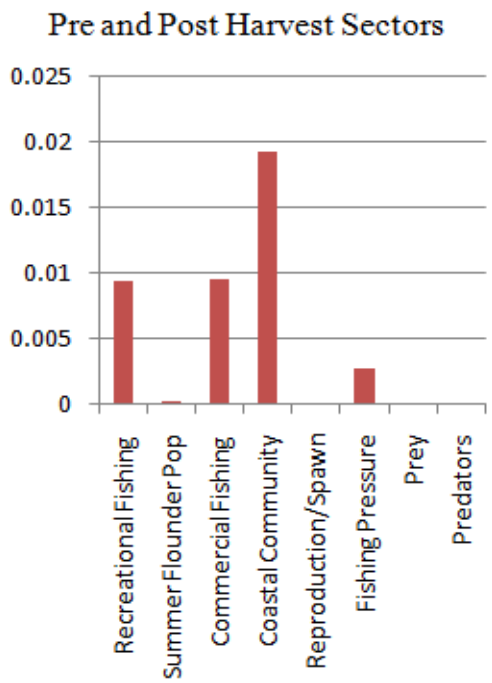


Comparison of Function

Scenario: Increase Summer Flounder Population

Increase in recreational and commercial fishing, coastal community, fishing pressure and reproduction/spawn

Increase in recreational and commercial fishing, and coastal community



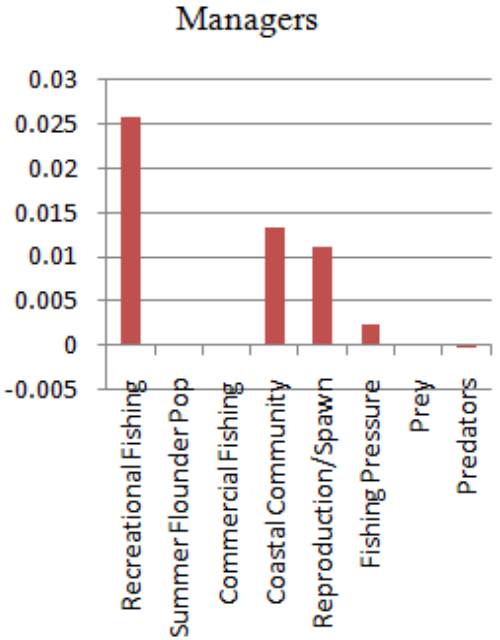
Comparison of Function

Scenario: Increase Summer Flounder Population

Increase in recreational and commercial fishing, coastal community, fishing pressure and reproduction/spawn

Increase in recreational and commercial fishing, and coastal community

Increase in recreational fishing, coastal community, reproduction/spawn, and fishing pressure



Comparison of Function

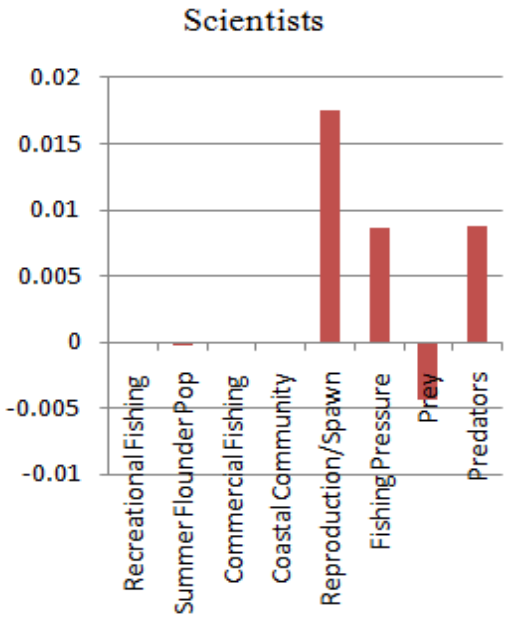
Scenario: Increase Summer Flounder Population

Increase in recreational and commercial fishing, coastal community, fishing pressure and reproduction/spawn

Increase in recreational and commercial fishing, and coastal community

Increase in recreational fishing, coastal community, reproduction/spawn, and fishing pressure

Increase in reproduction/spawn, fishing pressure, and predators, and Decrease in prey



Comparison of Function

Scenario: Increase Summer Flounder Population

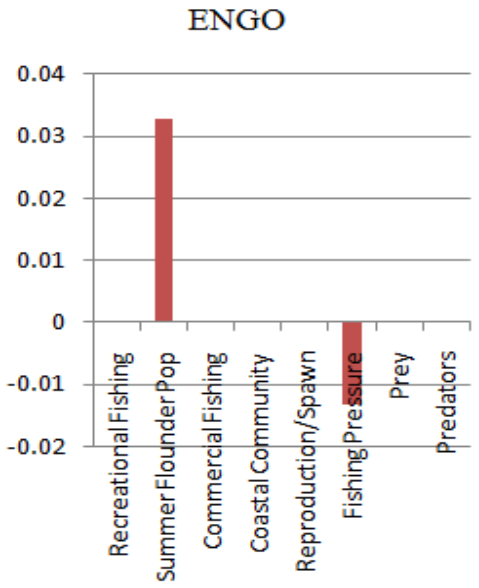
Increase in recreational and commercial fishing, coastal community, fishing pressure and reproduction/spawn

Increase in recreational and commercial fishing, and coastal community

Increase in recreational fishing, coastal community, reproduction/spawn, and fishing pressure

Increase in reproduction/spawn, fishing pressure, and predators, and Decrease in prey

Increase in summer flounder population and Decrease in fishing pressure



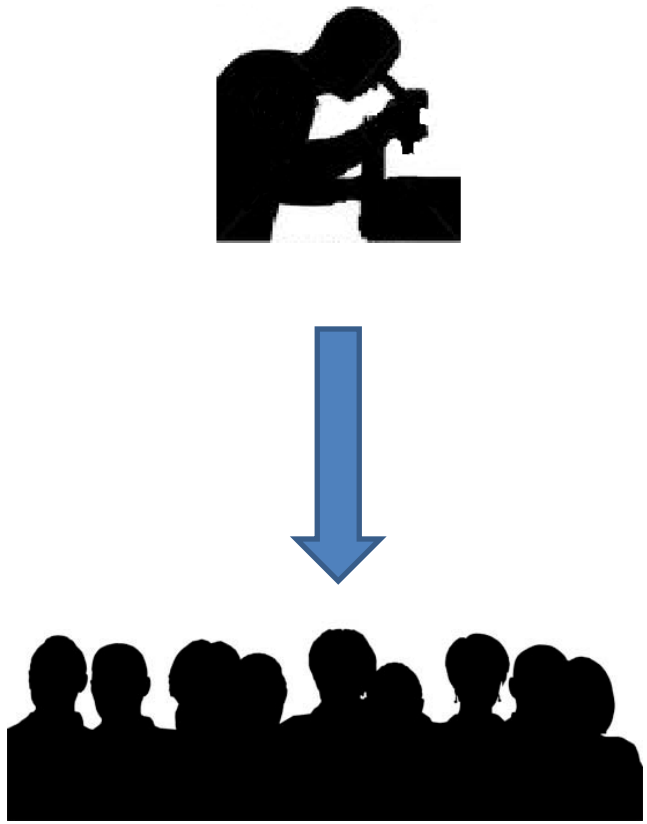
Outline

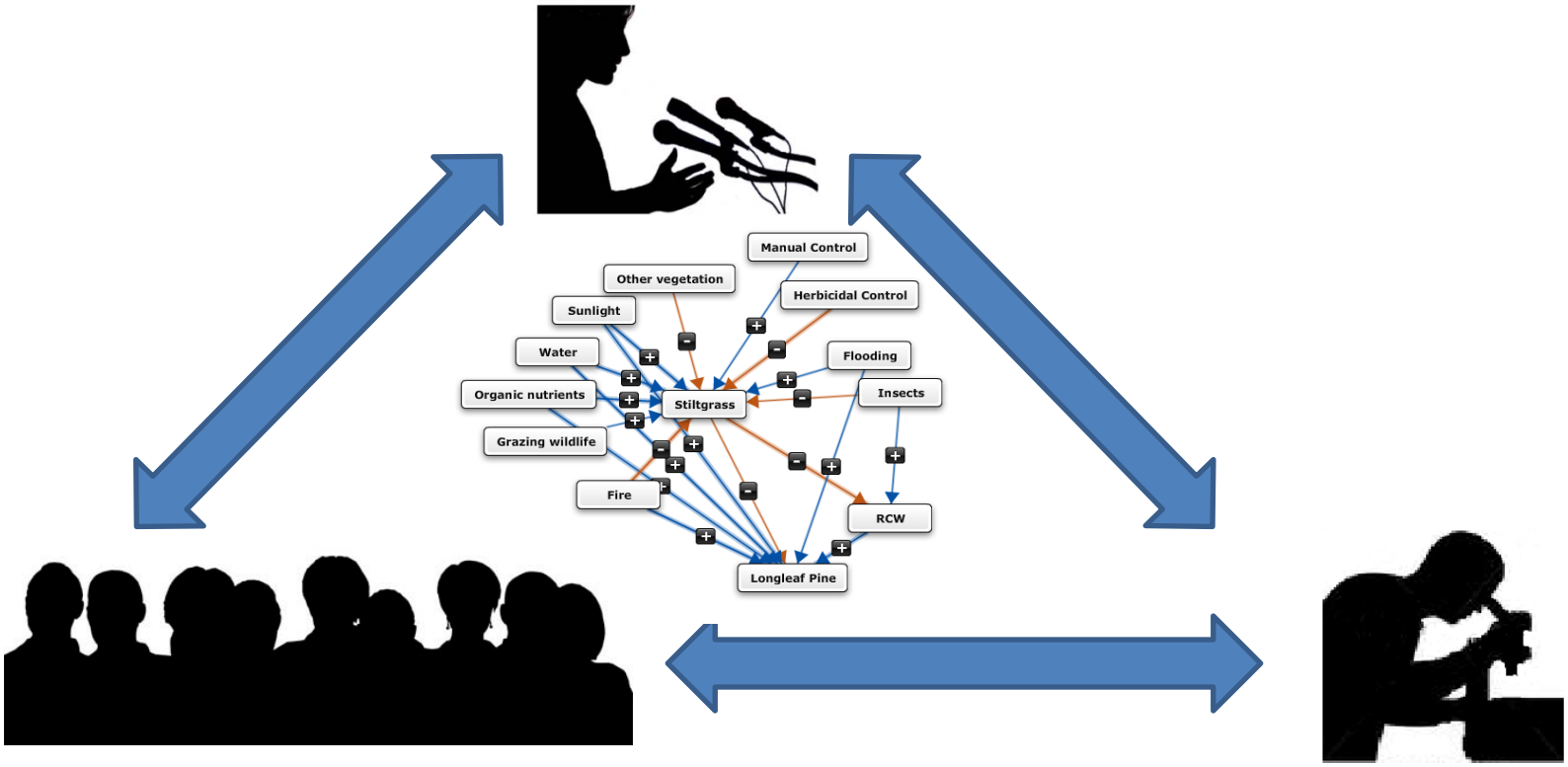
- **Overview of Fuzzy-logic Cognitive Mapping**
  - Fuzzy Numbers and Fuzzy Sets
  - Cognitive Mapping
  - Doing the calculations the old fashioned way:
    - Structural Metrics
    - Functional Metrics
- **Introduction to *Mental Modeler***
  - *Case study of Collaborative Modeling for Citizen Scientists*
- **New Analytical Capabilities coming soon!**
  - Integrating MMP files into R
- **Building a Model**
  - *How do stakeholders view the relationship between logging, economic development and wildlife habitat?*

Outline

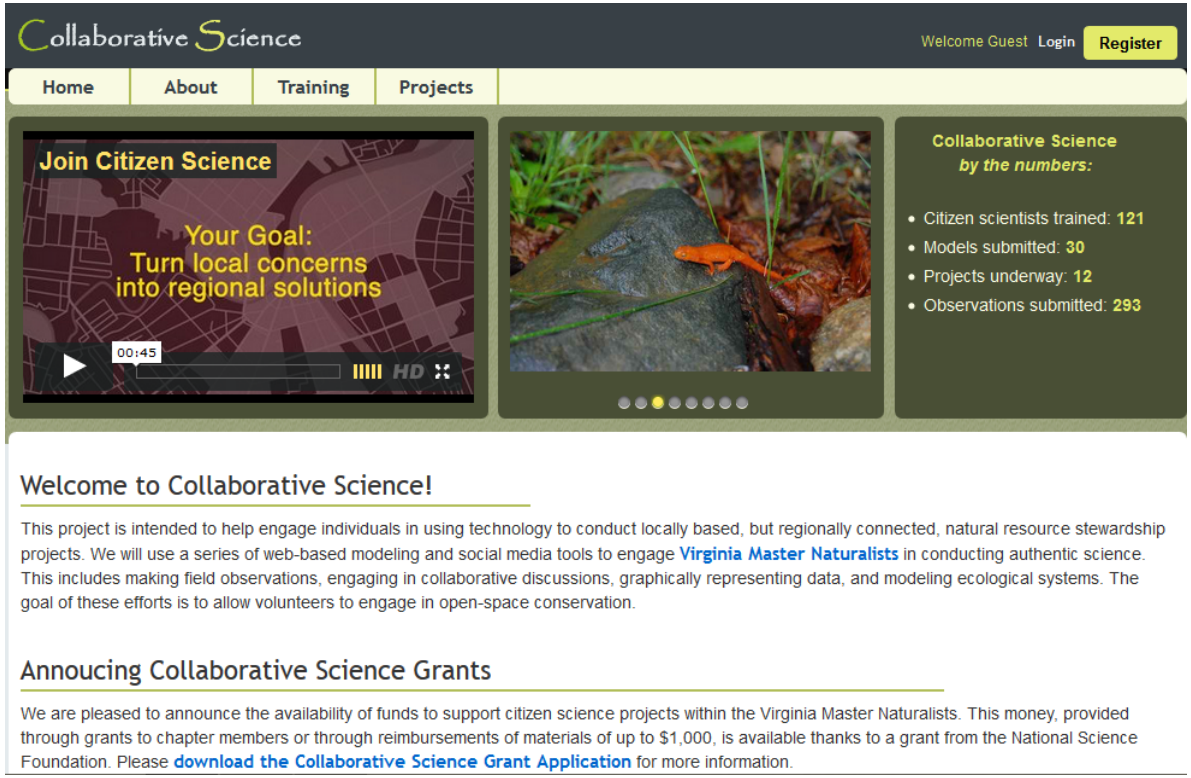
- **Overview of Fuzzy-logic Cognitive Mapping**
  - Fuzzy Numbers and Fuzzy Sets
  - Cognitive Mapping
  - Doing the calculations the old fashioned way:
    - Structural Metrics
    - Functional Metrics
- **Introduction to *Mental Modeler***
  - *Case study of Collaborative Modeling for Citizen Scientists*
- **New Analytical Capabilities coming soon!**
  - Integrating MMP files into R
- **Building a Model**
  - *How do stakeholders view the relationship between logging, economic development and wildlife habitat?*

Case Study: Collaborative land management in Virginia




Manual Control
Other vegetation
Herbicidal Control
Sunlight
Water
Flooding
Organic nutrients
Stiltgrass
Insects
Grazing wildlife
Fire
RCW
Longleaf Pine

www.collaborativescience.org



http://collaborativescience.org/cwis438/websites/CyberLearning/Home.php?WebSiteID=16

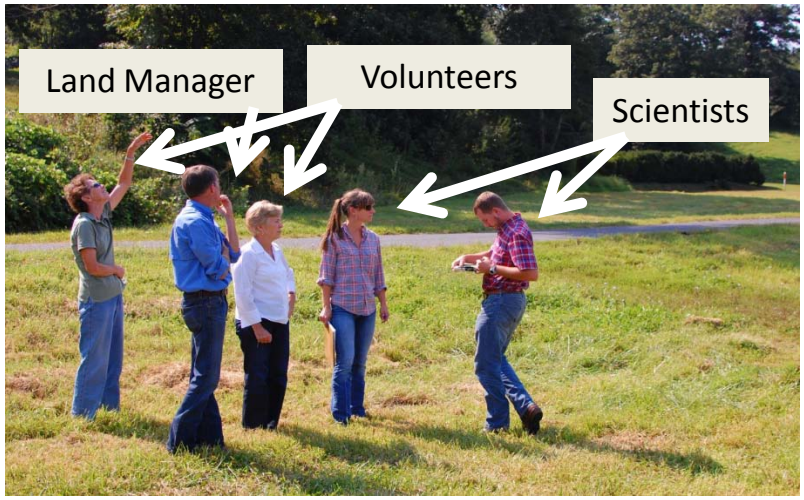
Stream Protection

A local chapter of Virginia Master Naturalists volunteers interested in local land issues and developing an evidence-based management plan

Private land owners lease their land to farmers

Farmers who want to increase grazing capacity and economic benefits from cattle production

State agencies and land owners are concerned about water quality



Stream Protection

A local chapter of Virginia Master Naturalists volunteers interested in local land issues and developing an evidence-based management plan

Private land owners lease their land to farmers

Farmers who want to increase grazing capacity and economic benefits from cattle production

State agencies and land owners are concerned about water quality

Stream Protection

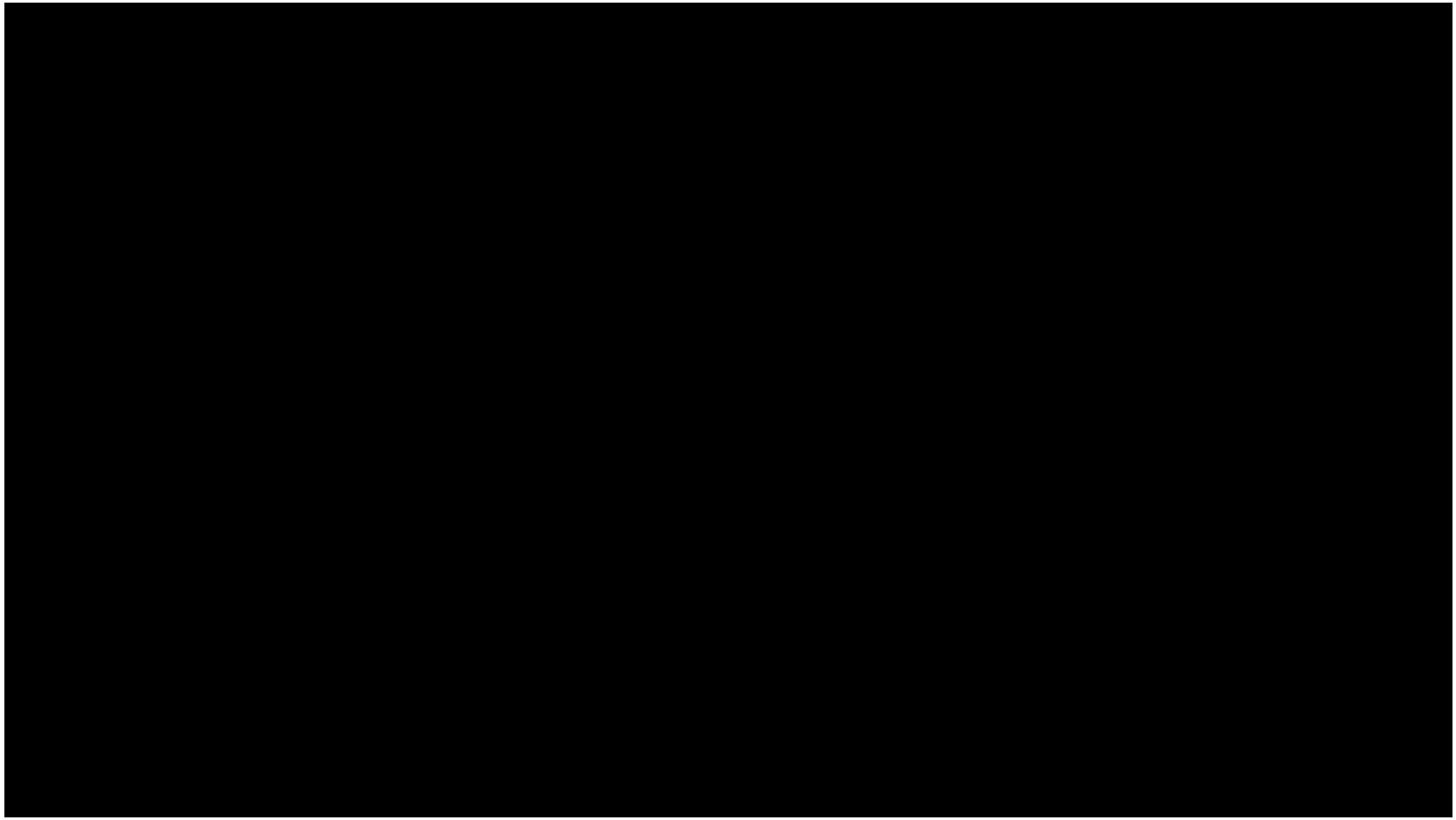
A local chapter of Virginia Master Naturalists volunteers interested in local land issues and developing an evidence-based management plan

Private land owners lease their land to farmers

Farmers who want to increase grazing capacity and economic benefits from cattle production

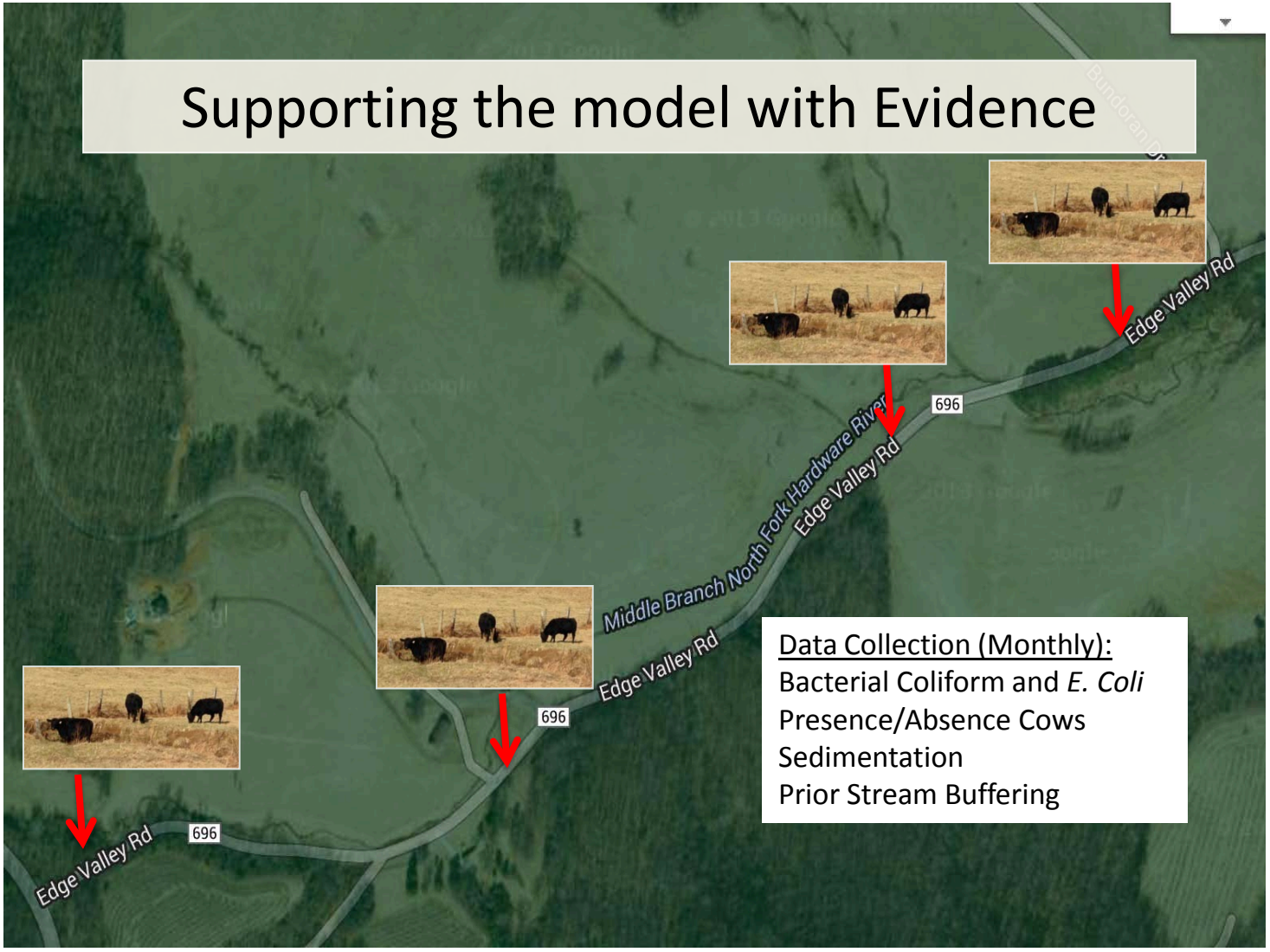
State agencies and land owners are concerned about water quality

Research/Management Question: How can management decisions balance environmental and economic needs?



http://www.youtube.com/watch?v=G5Cg56ahZJg&feature=em-upload_owner

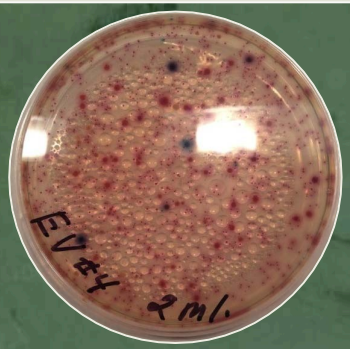
Supporting the model with Evidence



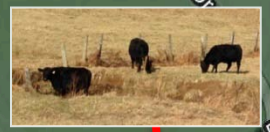
Data Collection (Monthly):
Bacterial Coliform and *E. Coli*
Presence/Absence Cows
Sedimentation
Prior Stream Buffering

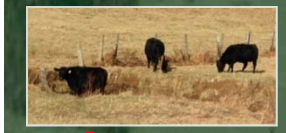
Supporting the model with Evidence

Water Entering Property



Water on Site





Edge Valley Rd

696

Middle Branch North Fork Hardware River

Edge Valley Rd

696

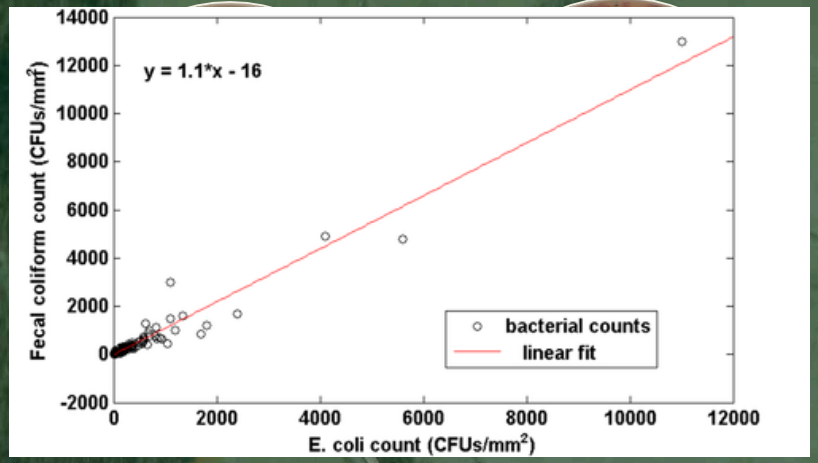
Edge Valley Rd

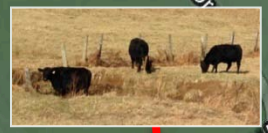
696

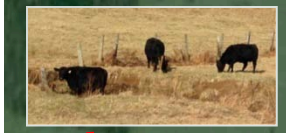
Edge Valley Rd

<u>Data Collection (Monthly):</u>
Bacterial Coliform and *E. Coli*
Presence/Absence Cows
Sedimentation
Prior Stream Buffering

Supporting the model with Evidence







Edge Valley Rd

696

Middle Branch North Fork Hardware River

Edge Valley Rd

696

Edge Valley Rd

696

Edge Valley Rd

Data Collection (Monthly):

Bacterial Coliform and *E. Coli*

Presence/Absence Cows

Sedimentation

Prior Stream Buffering

Outline

- Overview of Fuzzy-logic Cognitive Mapping
  - Fuzzy Numbers and Fuzzy Sets
  - Cognitive Mapping
  - Doing the calculations the old fashioned way:
    - Structural Metrics
    - Functional Metrics
- Introduction to *Mental Modeler*
  - *Case study of Collaborative Modeling for Citizen Scientists*
- New Analytical Capabilities coming soon!
  - Integrating MMP files into R
- Building a Model
  - *How do stakeholders view the relationship between logging, economic development and wildlife habitat?*

Outline

- Overview of Fuzzy-logic Cognitive Mapping
  - Fuzzy Numbers and Fuzzy Sets
  - Cognitive Mapping
  - Doing the calculations the old fashioned way:
    - Structural Metrics
    - Functional Metrics
- Introduction to *Mental Modeler*
  - *Case study of Collaborative Modeling for Citizen Scientists*
- New Analytical Capabilities coming soon!
  - Integrating MMP files into R
- Building a Model
  - *How do stakeholders view the relationship between logging, economic development and wildlife habitat?*

Introducing: FCM Scenario*

R-Package with Shiny User Inte
(still under development

*working title

Objectives

- Provide **addition** to Mental Modeler (… and other FCM software)
- Enable complex FCM simulation and analysis - no programming background required
- Flexible: Open source code in R to facilitate further development
- Web-based: no need to install software
- Free

R and Shiny

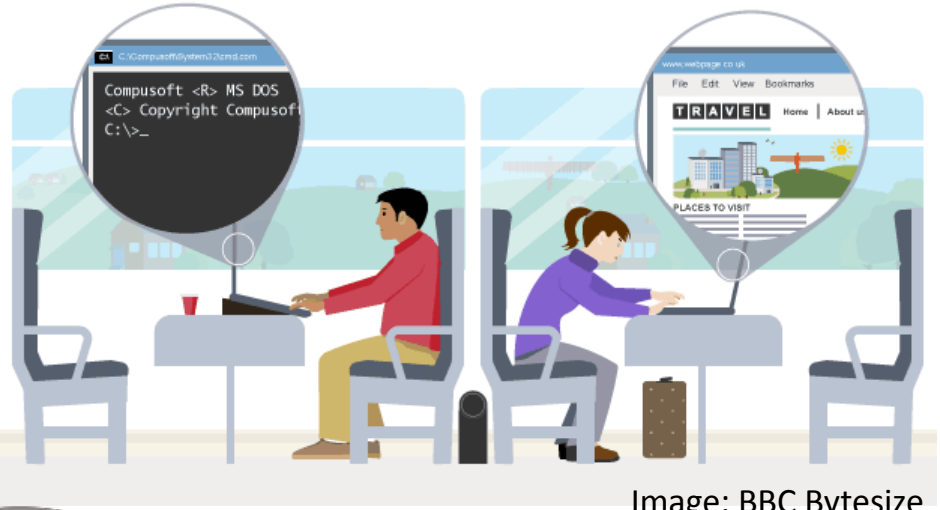
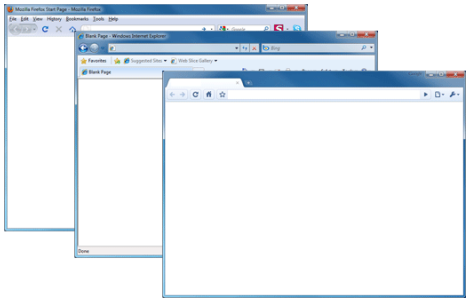


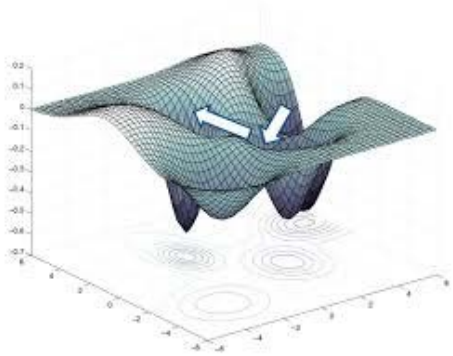
Image: BBC Bytesize

If <Variable 1> and <Variable 2> then Operation 1

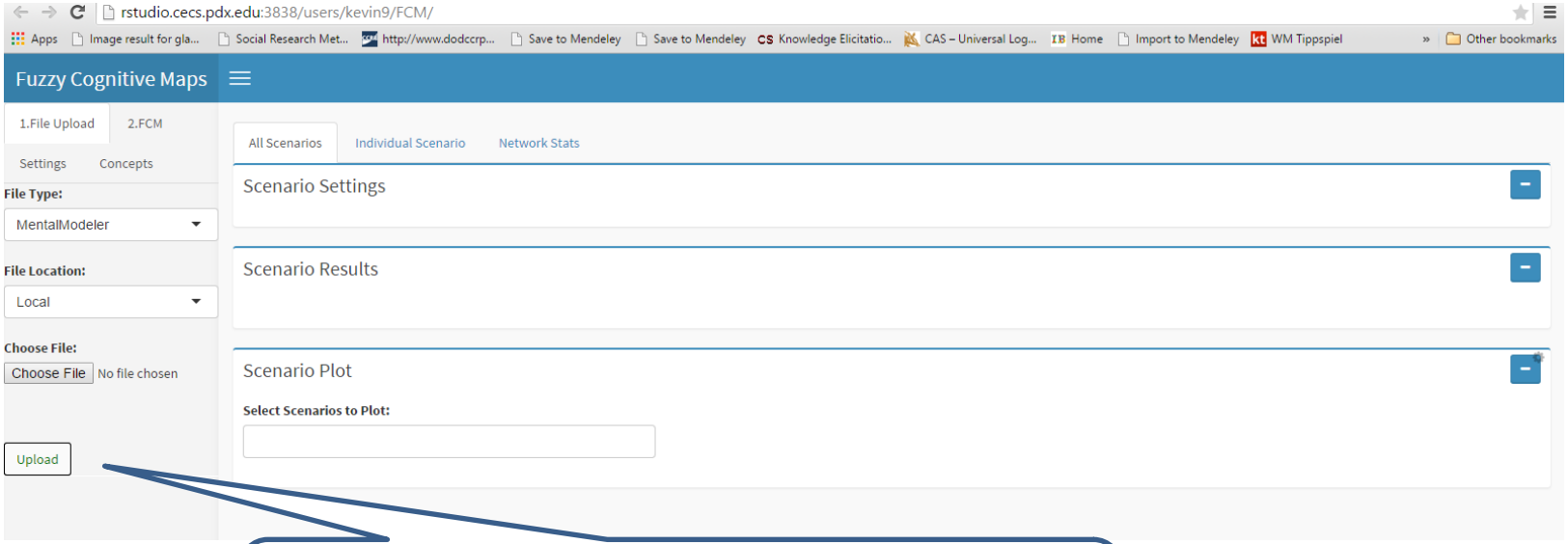


Modeled after workflow

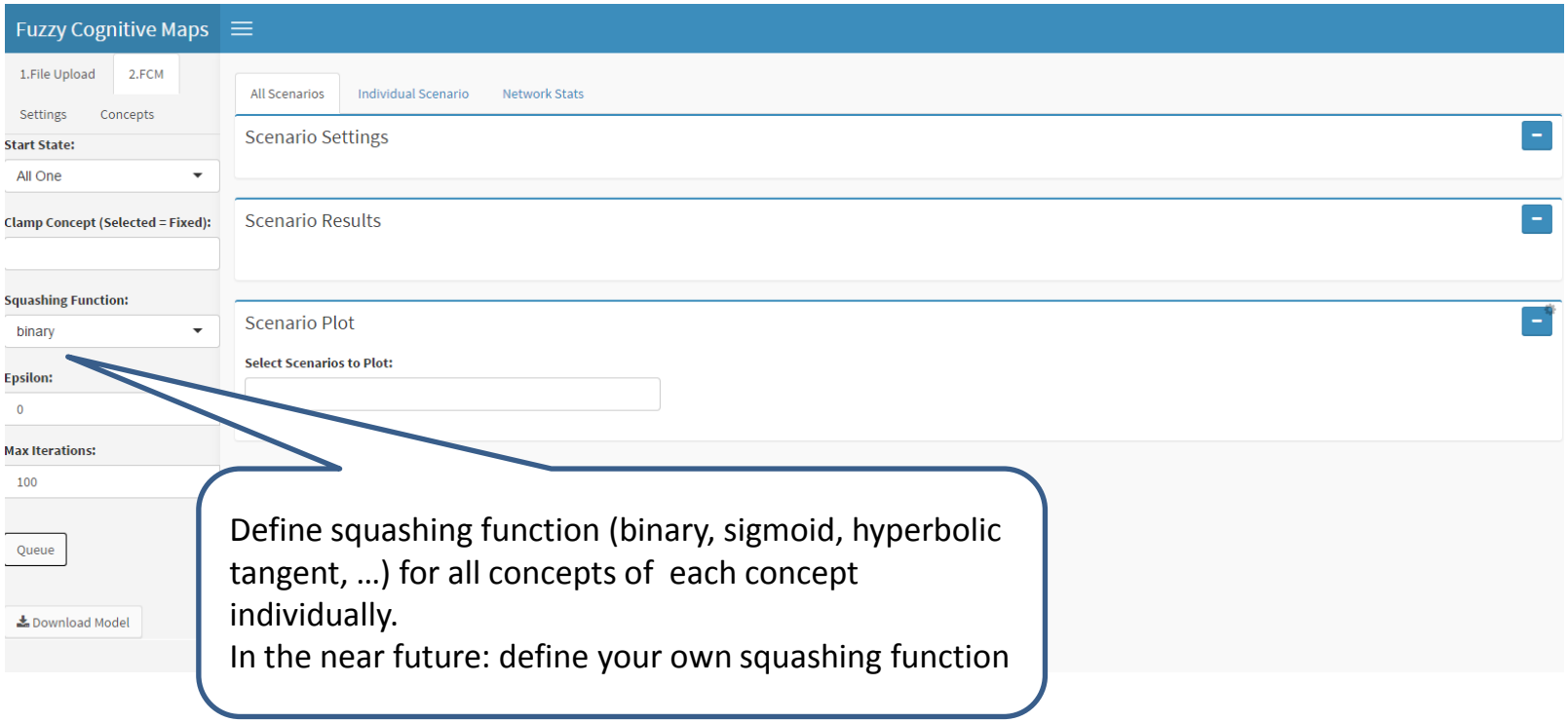
- Build FCM model / Knowledge Capture with Mental Modeler
- Refine FCM Model
- Define scenarios for simulation
- Run simulations
- Analyze and visualize resu

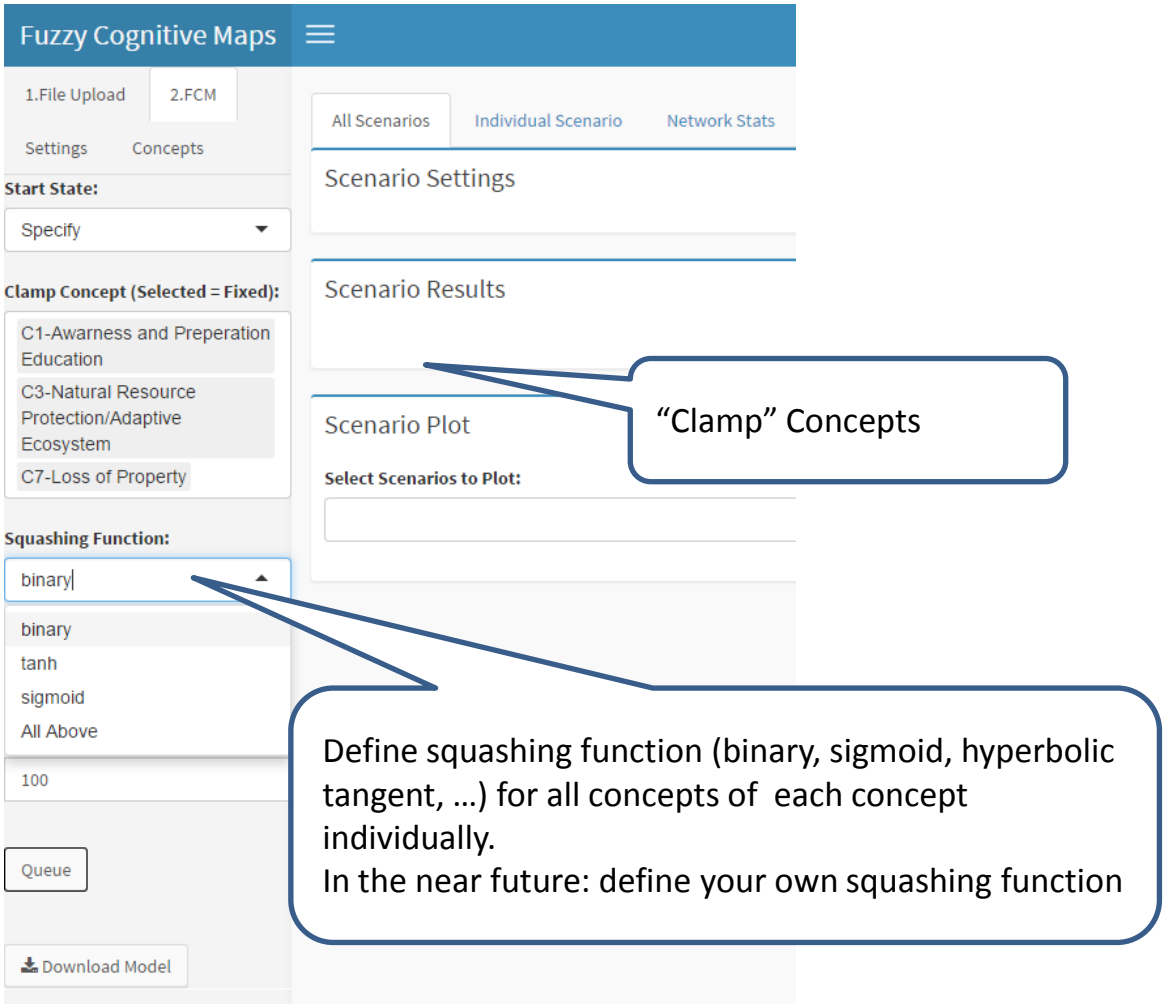


E.g. Jetter, A.J; Kok, K.: Fuzzy Cognitive Maps for futures studies—A methodological assessment of concepts and methods, Futures 2014, 61, 45-57

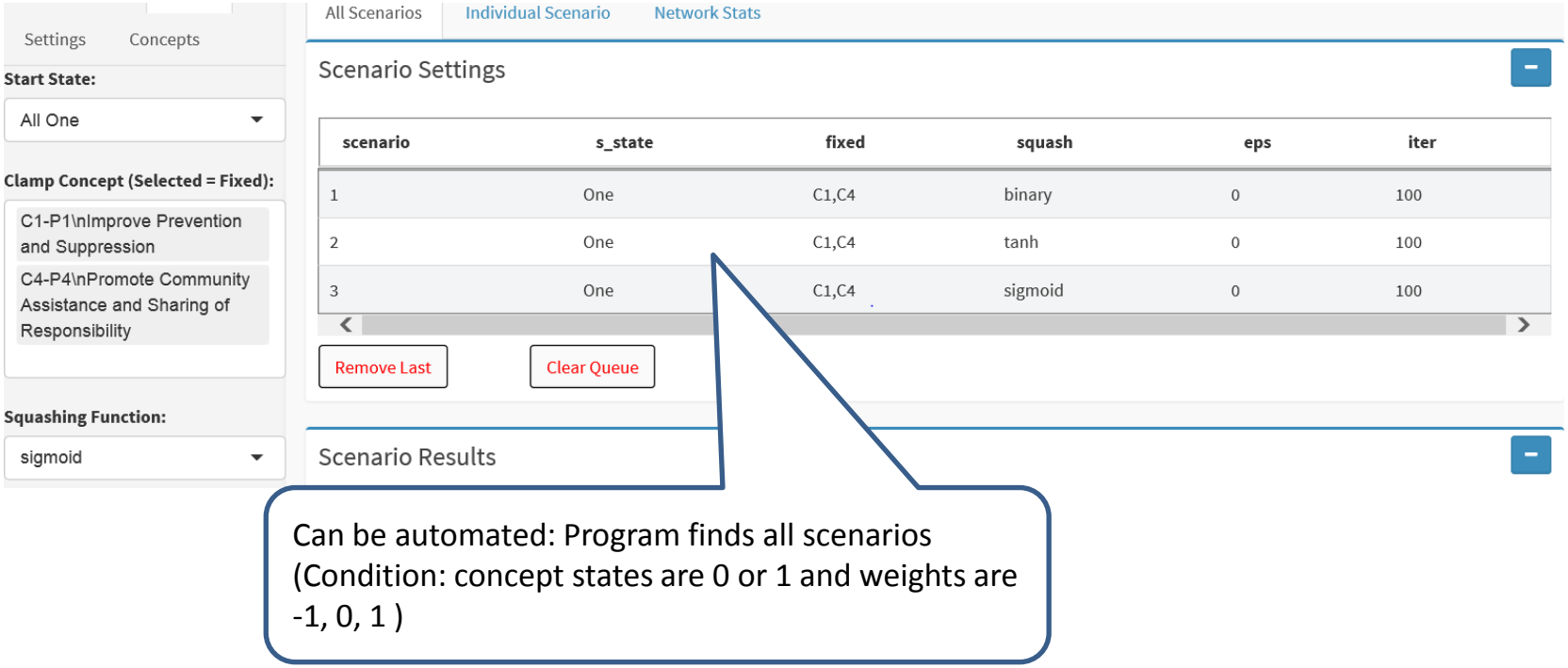


Upload from Mental Modeler or .csv file

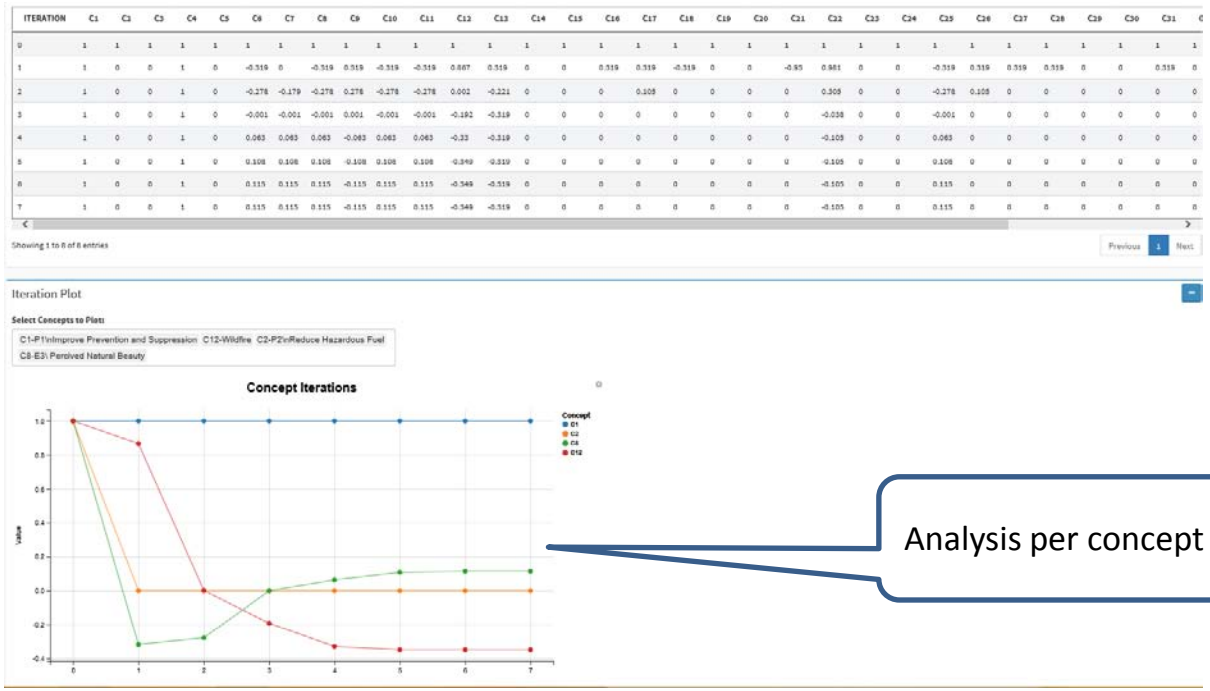

Fuzzy Cognitive Maps
1.File Upload
2.FCM
Settings
Concepts
Start State:
All One
Clamp Concept (Selected = Fixed):
Squashing Function:
binary
Epsilon:
0
Max Iterations:
100
Queue
Download Model
All Scenarios
Individual Scenario
Network Stats
Scenario Settings
Scenario Results
Scenario Plot
Select Scenarios to Plot:
Define squashing function (binary, sigmoid, hyperbolic tangent, …) for all concepts of each concept individually.
In the near future: define your own squashing function


Fuzzy Cognitive Maps
1.File Upload
2.FCM
Settings
Concepts
Start State:
Specify
Clamp Concept (Selected = Fixed):
C1-Awarness and Preperation Education
C3-Natural Resource Protection/Adaptive Ecosystem
C7-Loss of Property
Squashing Function:
binary
binary
tanh
sigmoid
All Above
100
Queue
Download Model
All Scenarios
Individual Scenario
Network Stats
Scenario Settings
Scenario Results
Scenario Plot
Select Scenarios to Plot:
"Clamp" Concepts
Define squashing function (binary, sigmoid, hyperbolic tangent, …) for all concepts of each concept individually.
In the near future: define your own squashing function

Build interesting scenarios and run them together



Show and compare results for each scenario

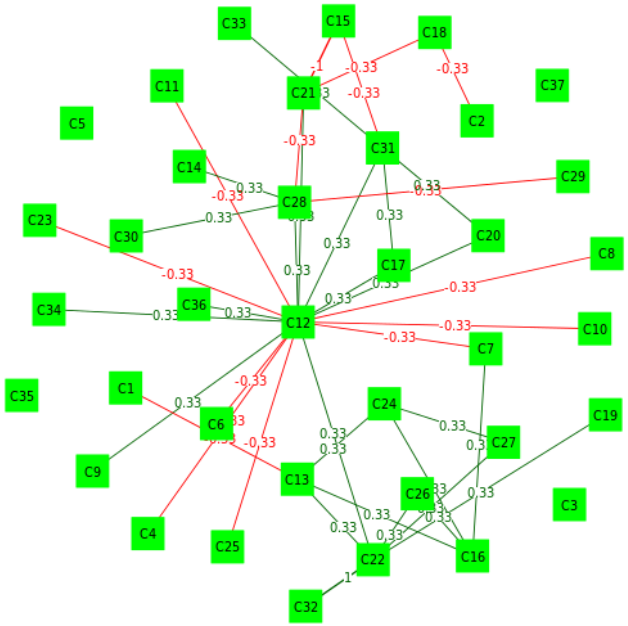


Analysis per concept

Network Plot

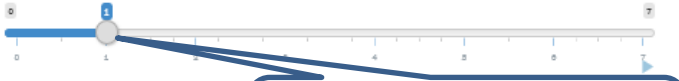
Display Iteration:

Green (+ve), Blue (0), Red (-ve)



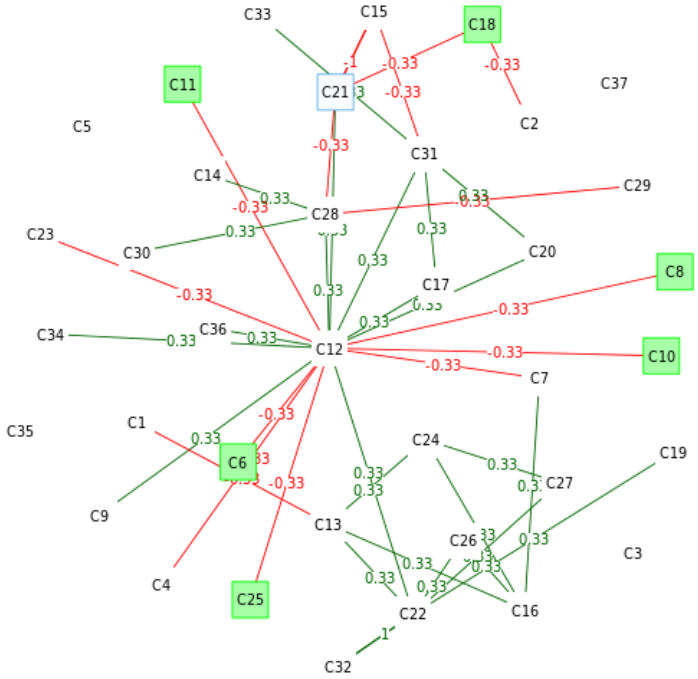
Network Plot

Display Iteration:



Green (+ve), Blue (0), Red (-ve)

Display change of concepts iteration by iteration



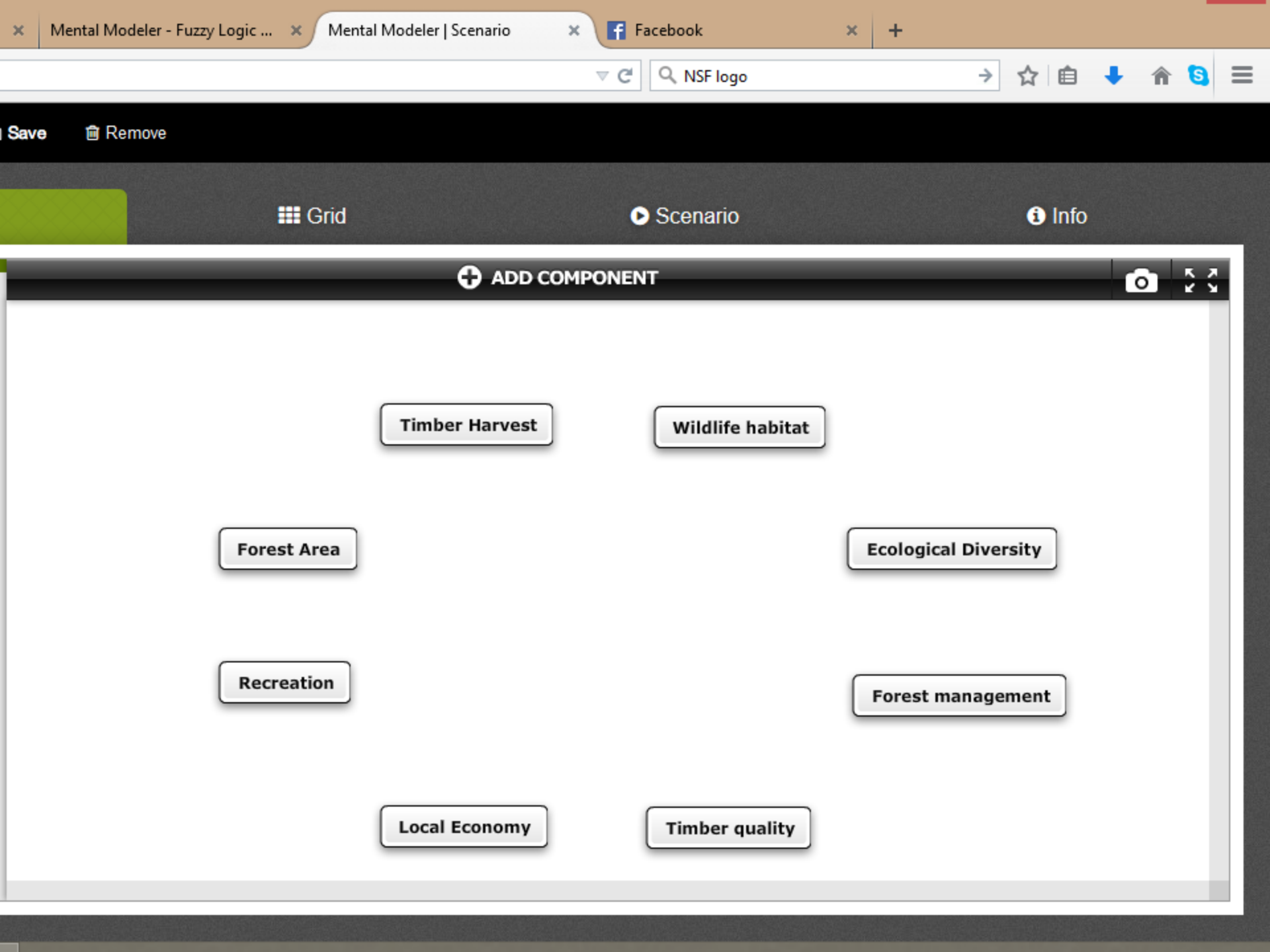
Future plans and how you can help

- Test and further refine, go life (We need daring beta testers!)
- Document R package for further development (Collaborators welcome!)
- Please send e-mail if you want to stay informed: ajetter@pdx.edu

Outline

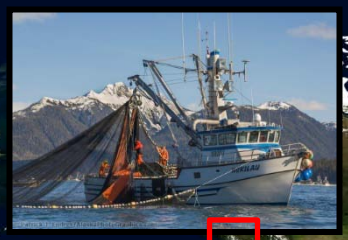
- Overview of Fuzzy-logic Cognitive Mapping
  - Fuzzy Numbers and Fuzzy Sets
  - Cognitive Mapping
  - Doing the calculations the old fashioned way:
    - Structural Metrics
    - Functional Metrics
- Introduction to *Mental Modeler*
  - *Case study of Collaborative Modeling for Citizen Scientists*
- New Analytical Capabilities coming soon!
  - Integrating MMP files into R
- Building a Model
  - *How do stakeholders view the relationship between logging, economic development and wildlife habitat?*

Modeling Logging in the Pacific Northwest

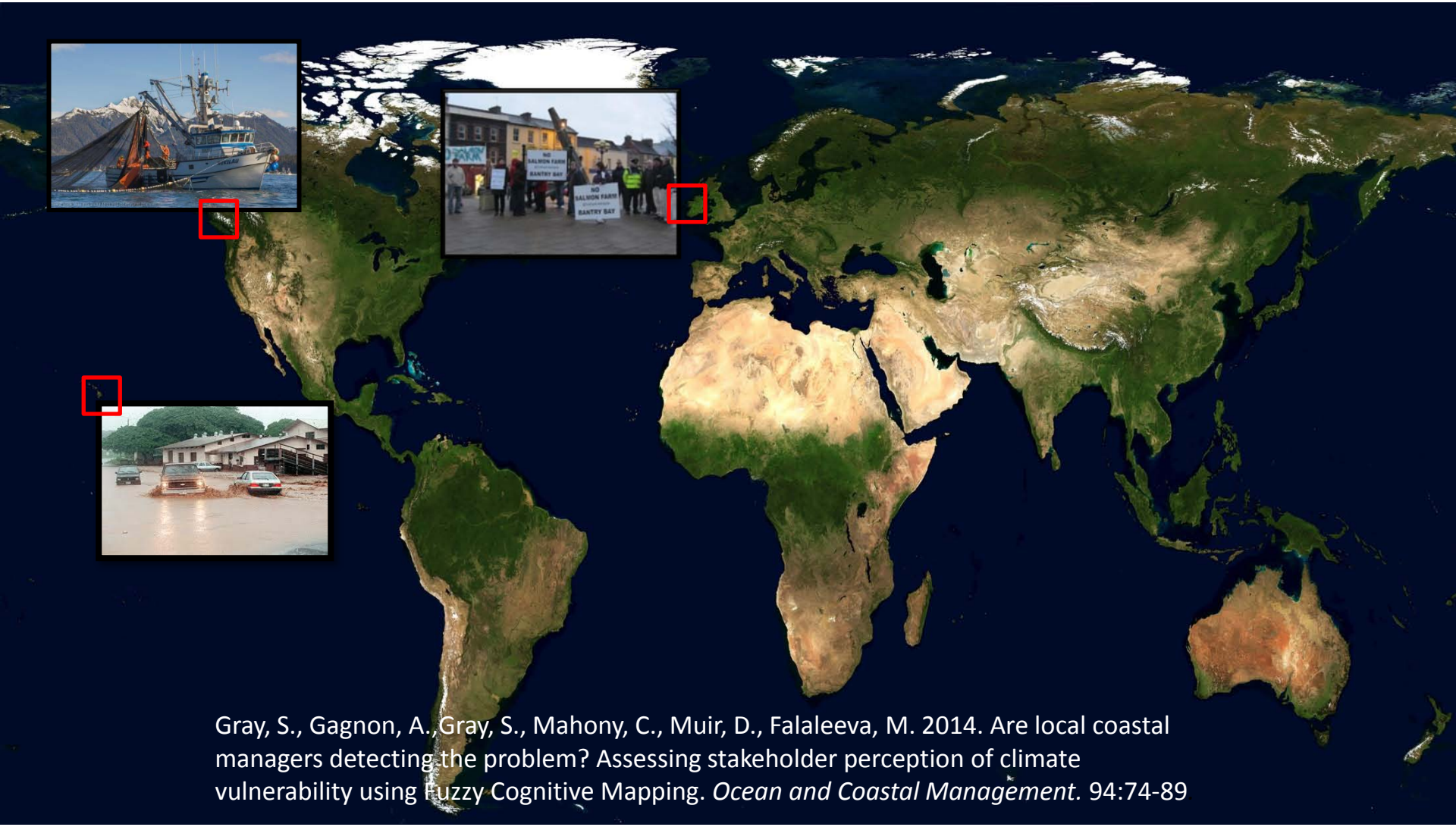

Mental Modeler - Fuzzy Logic ...
Mental Modeler | Scenario
Facebook
NSF logo
Save
Remove
Grid
Scenario
Info
ADD COMPONENT
Timber Harvest
Wildlife habitat
Forest Area
Ecological Diversity
Recreation
Forest management
Local Economy
Timber quality

Henly-Shepard[β], S., Gray, S., and Cox, L. Facilitating community adaptation through participatory modeling and social learning (in press) *Environmental Science and Policy*

Funding: USDA

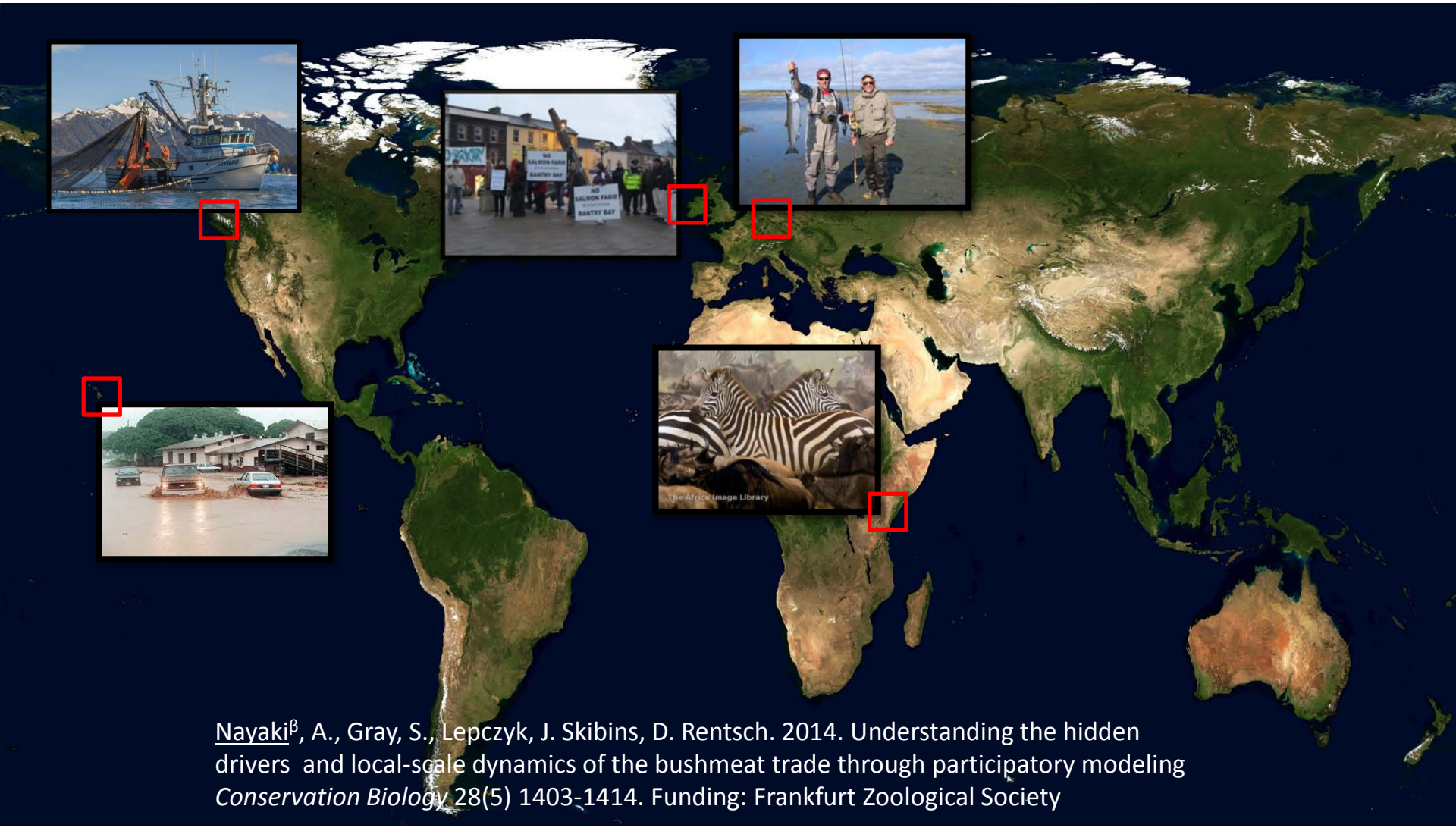


Stier, A., Samhouri, J., Levin, P., Gray, S., Martone, R. and Mach., M. Differences in perception, not (necessarily) values can produce conservation conflict. (in review) *Proceedings of the National Academy of Science.*

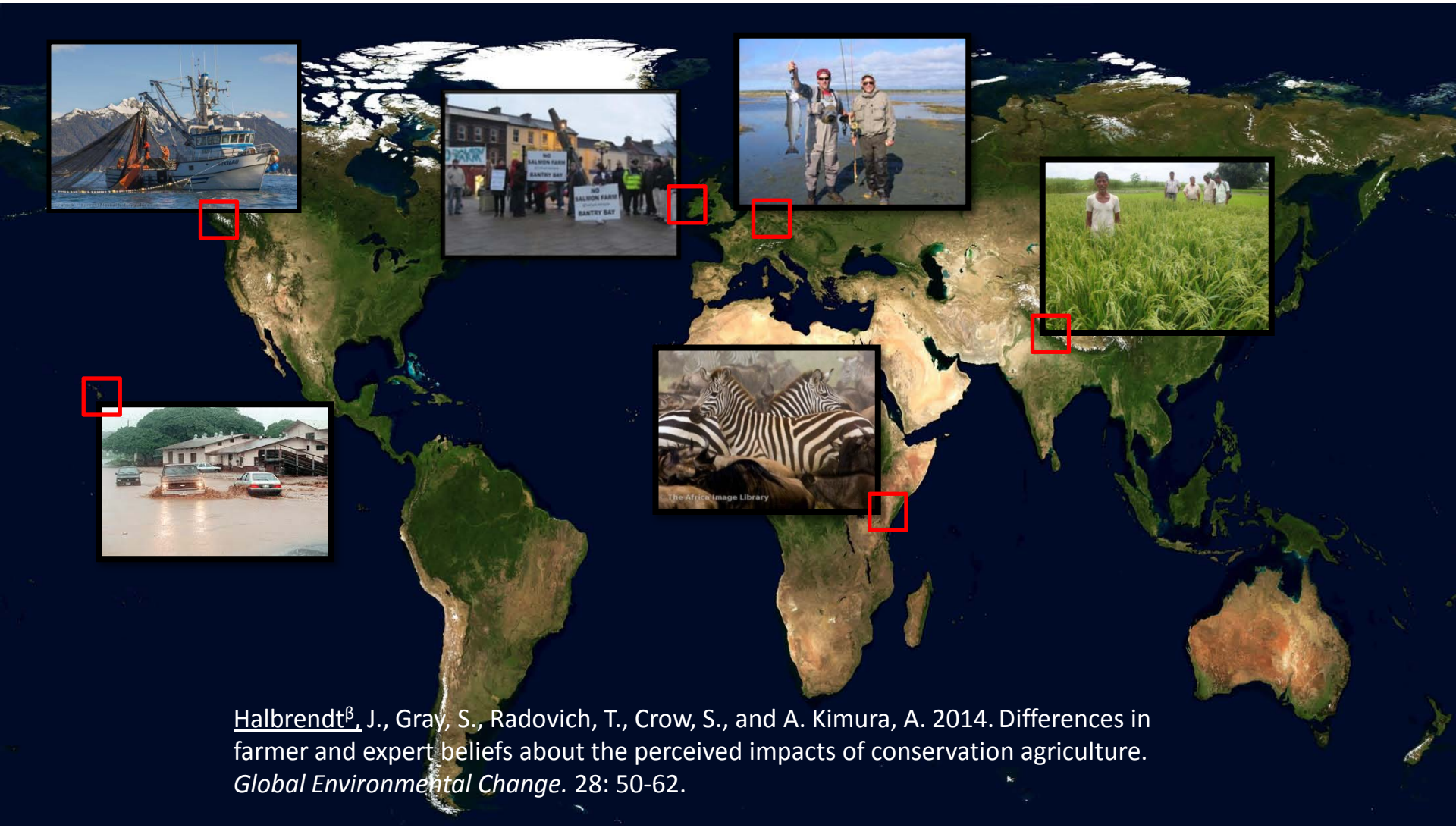


Gray, S., Gagnon, A.,Gray, S., Mahony, C., Muir, D., Falaleeva, M. 2014. Are local coastal managers detecting the problem? Assessing stakeholder perception of climate vulnerability using Fuzzy Cognitive Mapping. *Ocean and Coastal Management.* 94:74-89

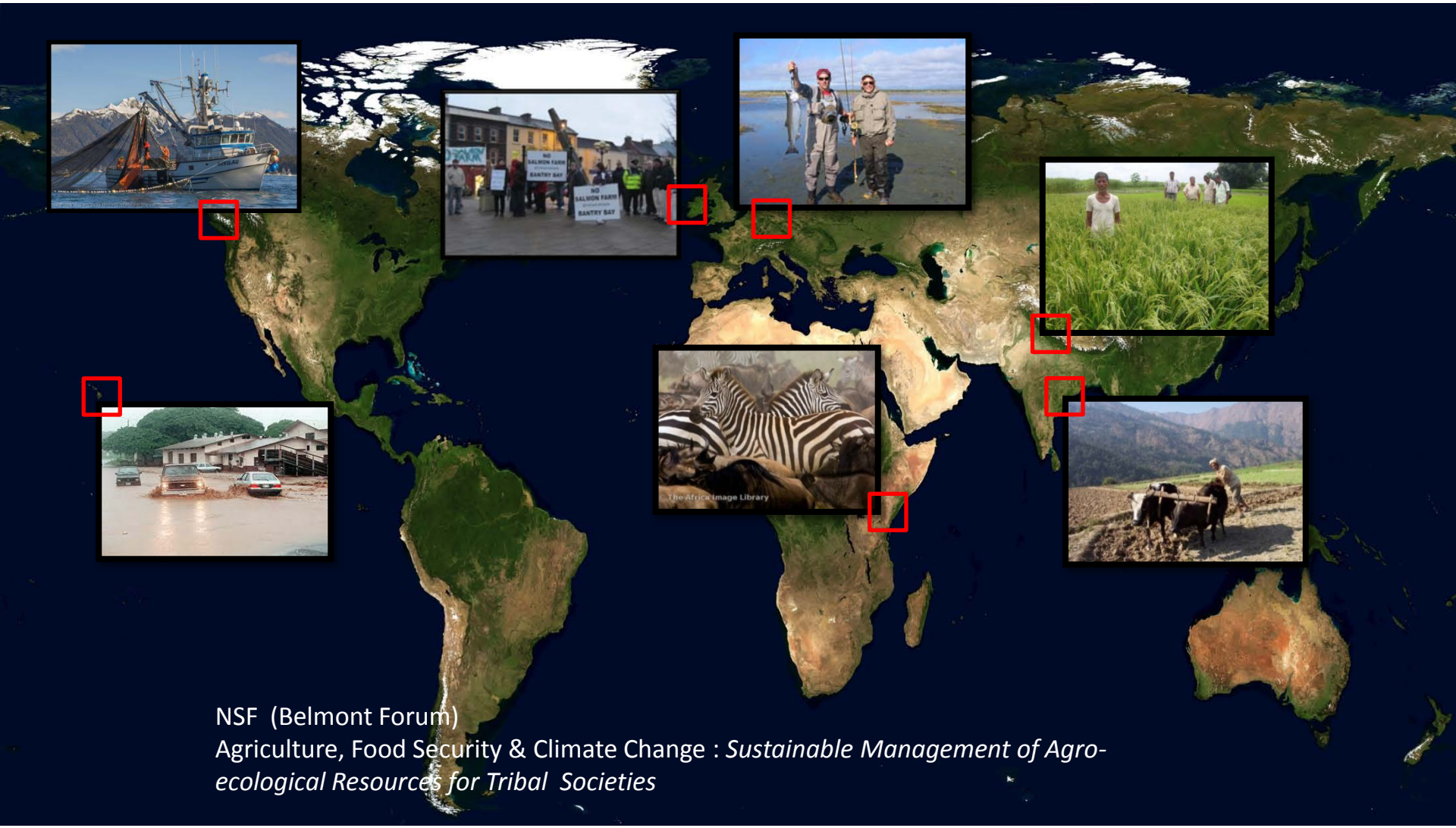
Gray, S., McFall, A., Hilsberg, J., Arlinghaus, R. 2015. The impact of specialization and target species choice on the structure of mental models about fish population dynamics (in press) *Journal of Outdoor Recreation and Tourism*.



Nayaki$^{\beta}$, A., Gray, S., Lepczyk, J. Skibins, D. Rentsch. 2014. Understanding the hidden drivers and local-scale dynamics of the bushmeat trade through participatory modeling *Conservation Biology* 28(5) 1403-1414. Funding: Frankfurt Zoological Society

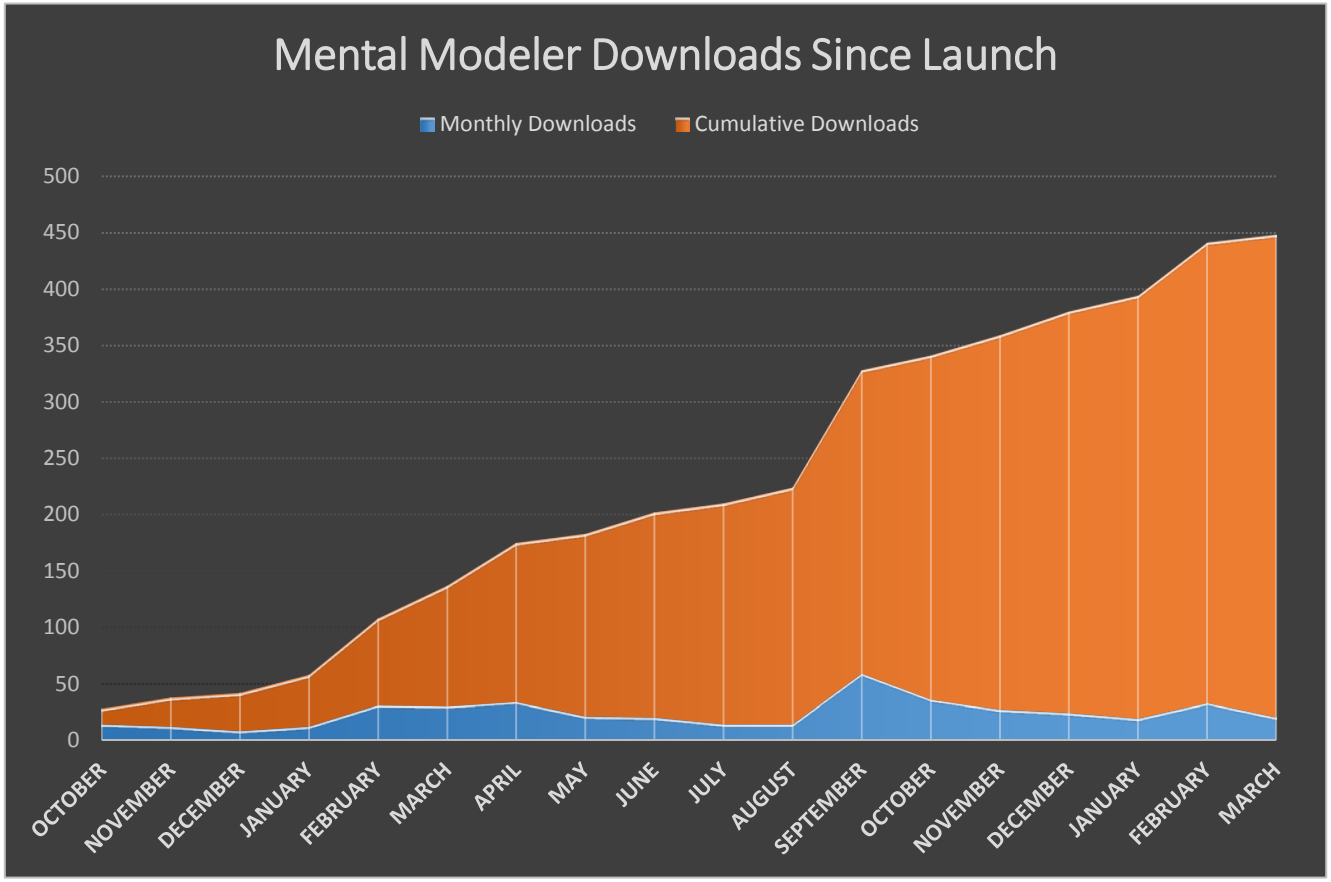


Halbrendt[β], J., Gray, S., Radovich, T., Crow, S., and A. Kimura, A. 2014. Differences in farmer and expert beliefs about the perceived impacts of conservation agriculture. *Global Environmental Change.* 28: 50-62.



NSF (Belmont Forum)
Agriculture, Food Security & Climate Change : *Sustainable Management of Agro-ecological Resources for Tribal Societies*

Academic: 76%
Government: 13%
NGO: 11%



Area of Study

Thanks for coming!

stevenallangray@gmail.com

ajetter@pdx.edu