Native Prairie Adaptive Management in the USFWS Refuge System

An Overview for Potential Partners

Webinar

January 17, 2014

Presented by:
Jill Gannon
USGS Northern Prairie Wildlife Research Center

Purpose of Webinar

- Share details of Native Prairie Adaptive Management (NPAM) initiative
- Explore potential for expanding NPAM to partners beyond USFWS NWRS
- 60 min presentation
- Explain questionnaire
- Q & A session

Outline

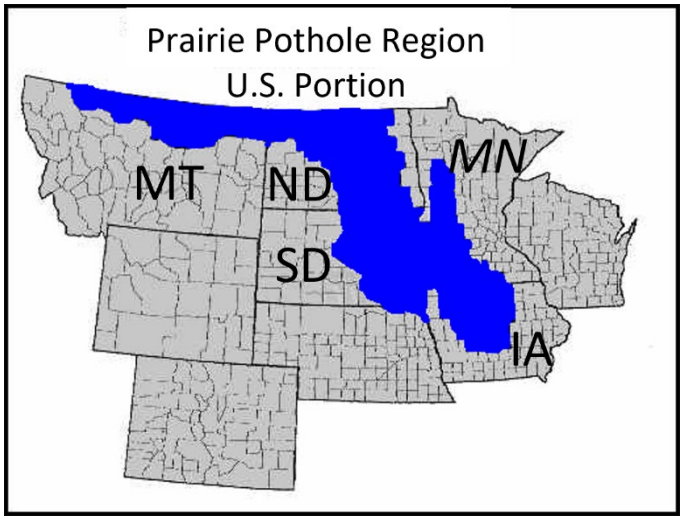
- Problem background and genesis of NPAM
- Adaptive management
- NPAM technical elements
- NPAM infrastructural elements
- What cooperators gain from participation
- How a new partner could potentially participate in NPAM

Native Prairie in North America

- Widespread loss to agricultural conversion
  - Mixed-grass prairie reduced by >70%
  - Tallgrass prairie reduced by >85%
- In remainder, exclusion of historic disturbances
  - Grazing by native ungulates
  - Frequent fires

Native Prairie in the USFWS Refuge System - Prairie Pothole Region

- USFWS Refuge System an important conservation reservoir of remaining native prairie
- Invasion by cool-season introduced grasses
  - Smooth Brome (*Bromus inermis*)
  - Kentucky bluegrass (*Poa pratensis*)



Smooth brome (*Bromus inermis*)

Kentucky bluegrass (*Poa pratensis*)

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Native Prairie in the USFWS Refuge System

- Management against invasive species
  - Re-introduction of disturbance to mimic natural processes that historically shaped native vegetation communities

- Success has been poor to inconsistent
  - Uncertainties about biological response to management
  - Absence of systematic evaluation of management effects
  - Inadequate monitoring, record-keeping
  - No coordination of effort

Native Prairie in the USFWS Refuge System

- "Brome Summit" 2006
- Dakota-wide inventory 2006 – 2008
  - 5 – 55% native grasses and forbs (NP)
  - 10 – 45% smooth brome (SB)
  - 10 – 45% Kentucky bluegrass (KB)
- 1984, 2007 site comparison
  - 39-63% reduced NP cover, replacement by SB and KB
- Conclusion
  - Invasion problem is bad and getting worse
  - USFWS Refuge System is accountable
  - Need to act now

Collaborative Management

- Traditional land management approach – "Go it alone"
  - Despite commonalities in objectives, tools, processes, and uncertainties, decision making is often an individual struggle
- We can link efforts with a multi-partner approach to more effectively learn about management as we're doing it
  - Potential for great conservation benefit, but requires …
    - lots of planning and groundwork
    - tight coordination and clear communication
    - ability to focus on the big picture

NPAM – A Coordinated, Adaptive Approach

- Joint USGS – USFWS effort
  - Began in 2008
- Develop an adaptive decision support system (NPAM)
  - Coordinates local efforts to pursue joint conservation objective
  - Assists in selecting management actions under uncertainty
  - Employs monitoring to learn from management outcomes
  - Reduces uncertainty through time and improves future decision making
- Hierarchical decision framework
  - Individual land units (actions, monitoring)
  - Region (models, learning)

Adaptive Management

- Form of structured decision making, useful for guiding management under uncertainty
- Approach to recurrent decision making based on predictive modeling, monitoring, and knowledge updating
- Integrates decision making and learning to reduce uncertainty and improve decision making through time
- Learning can be accelerated if decision making and monitoring are distributed over space
  - Approach fits naturally in a cooperative conservation environment

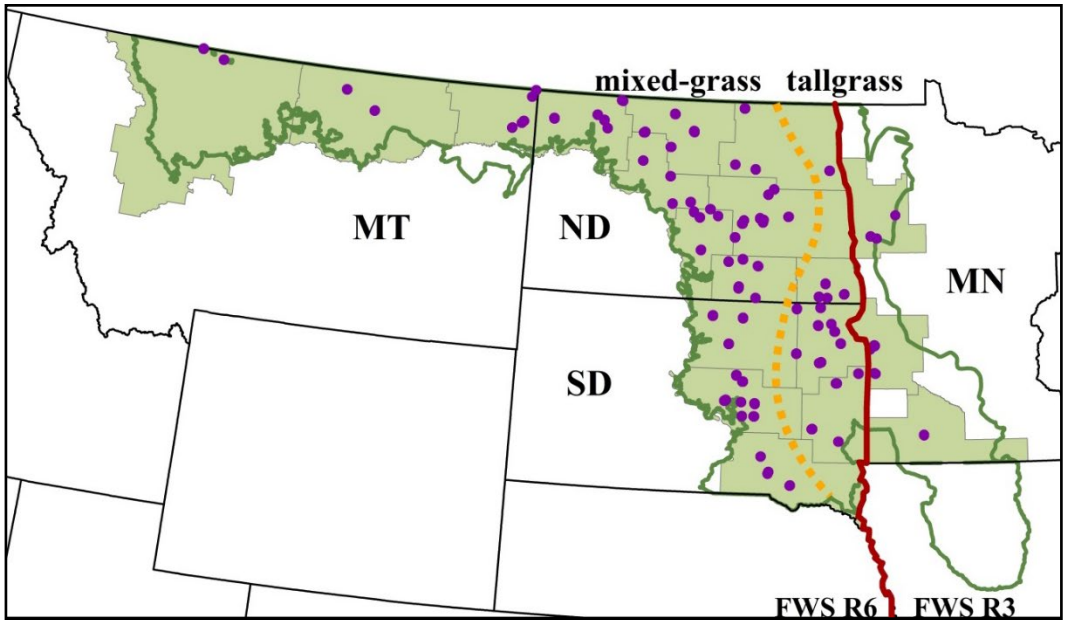
NPAM Technical Elements

- Management objective
  - What we are trying to achieve through our management
- State structure
  - How we describe each parcel
- Management alternatives
  - The "menu" of actions
- Competing models
  - Identifying uncertainty that makes decision making difficult
- Reward function
  - Payoffs for good and poor outcomes
- Optimization
  - Combining models, uncertainty, and rewards → recommendations
- Monitoring
  - Determining where we are today and assessing our predictions
- Model weight updating
  - Learning and the adapting management

USFWS Refuge System Cooperators

- Prairie Pothole Region
- Mixed-grass and tallgrass
- USFWS Refuge System, Regions 3 and 6

- Four states: MN, ND, SD, MT
- 20 stations
- 120 management units (81 mixed-grass, 39 tallgrass)



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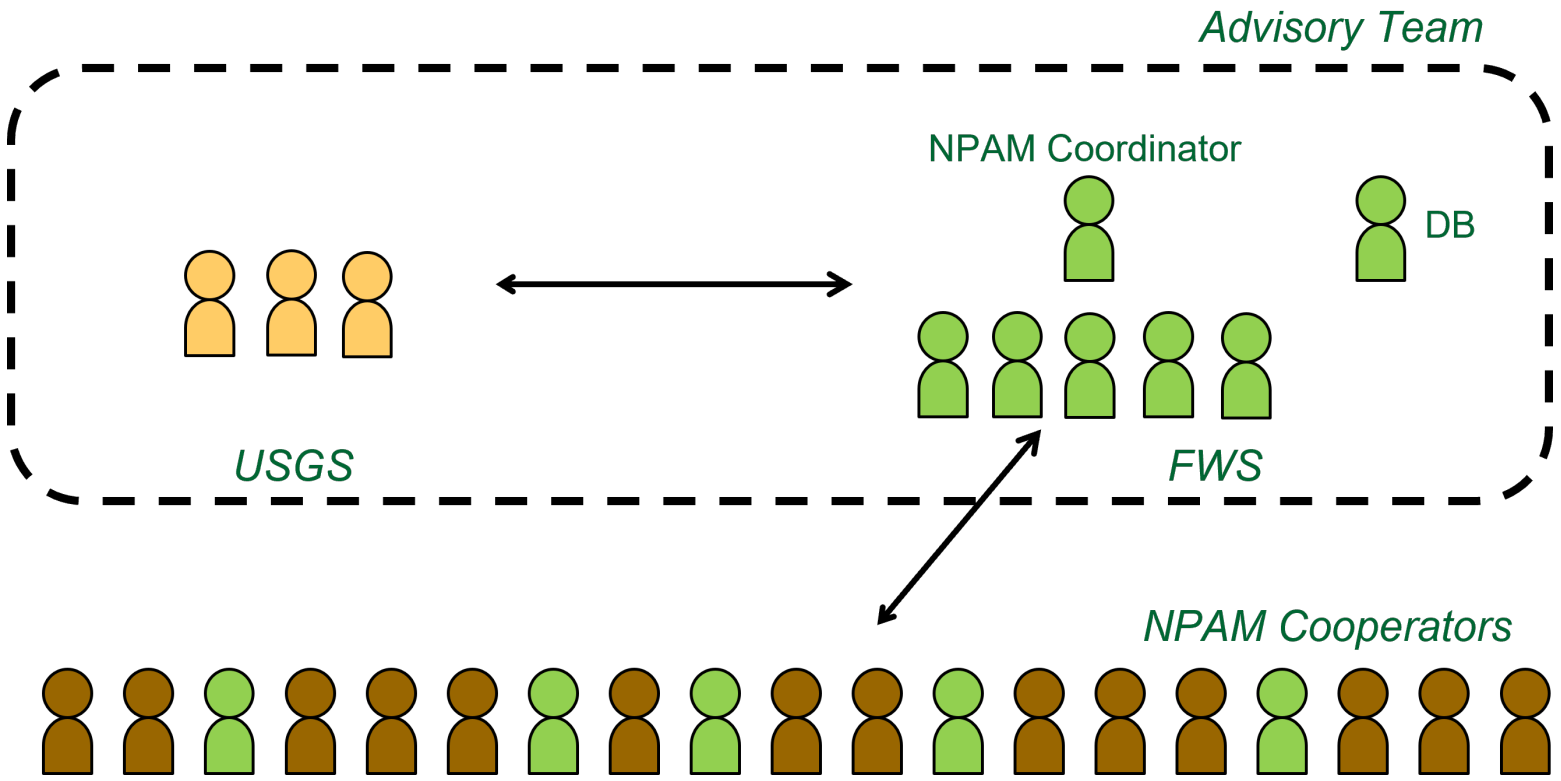
NPAM Elements – Governance structure



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NPAM – Decision Makers

- USFWS National Wildlife Refuge System (NWRS)
  - Multiple decision makers under a single authority
- Decision makers
  - Individual managers of each refuge
  - Autonomy in interpreting goals and implementing management

NPAM – Bounding the Problem

- The Resource Problem
  - Loss of native prairie to cool-season invasive grasses, smooth brome and Kentucky bluegrass
- Area of focus
  - Native sod on NWRS lands across the Prairie Pothole Region in USFWS Regions 3 and 6, where SB and KB are the main invasive species of concern.
- Spatial unit of focus
  - Management unit

NPAM – Mixed-Grass & Tallgrass Differences

- Warm-season component of tallgrass prairies
  - Existence of a “cool-season window”
- Increased precipitation within tallgrass prairies
  - Expect different abilities to carry out management actions and different responses to management actions
- Created similar, yet separate, frameworks for mixed-grass and tallgrass that account for their unique needs
  - Management actions
  - Uncertainties
  - Predictive models
  - Recommendations

NPAM – Management Objective

- Management Objective
  - Measurable
  - Capable of being predicted

Increase the cover of native grasses and forbs while minimizing cost

NPAM Elements – Management Actions

- Decision Alternatives
  - Small set of distinct actions
  - Ability to predict response

- Menu of management action alternatives

Mixed-Grass	Tallgrass
Rest	Rest
Graze	Graze w/in window
Burn	Burn w/in window
Burn/Graze combo	Graze, Burn, or Hay outside window

NPAM – Decision Cycle

- Management cycle
  - Decisions made on an annual basis
- Management year is 1 September – 31 August
  - Designed around the timing when management and follow-up monitoring occur
    - Management implemented – fall, spring
    - Monitoring – July/August (growing season, post-management)

NPAM Elements – Describing a Unit

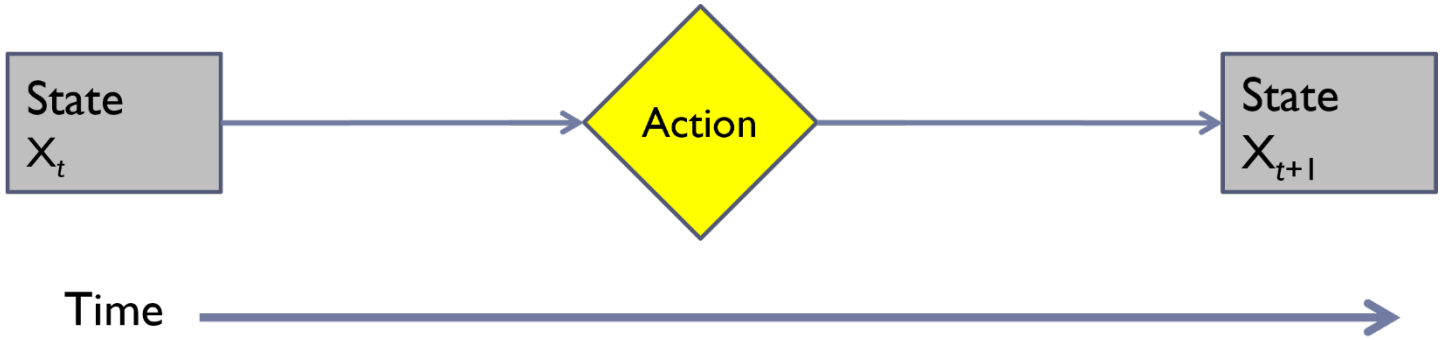
- Vegetation state
  - Percent cover of native grasses and forbs
    - 0-30%, 30-45%, 45-60%, 60-100%
  - Type of dominant invader
    - Smooth Brome (SB)
    - Kentucky Bluegrass (KB)
    - Co-dominant SB and KB (CO)
    - Other (RM)

Native Cover	Dominant Invasive: SB	CO	KB	RM
60 – 100%	1	2	3	4
45 – 60%	5	6	7	8
30 – 45%	9	10	11	12
0 – 30%	13	14	15	16

- Defoliation history
  - Frequency of defoliation: Low, Med, High
  - Years since defoliation: 1, 2-4, 5+

NPAM Elements – Predictive Model

- State transition probability model
  - Predicts the consequences of each management action
  - Links current system state (X_t) to future system state (X_{t+1}) via the management action taken



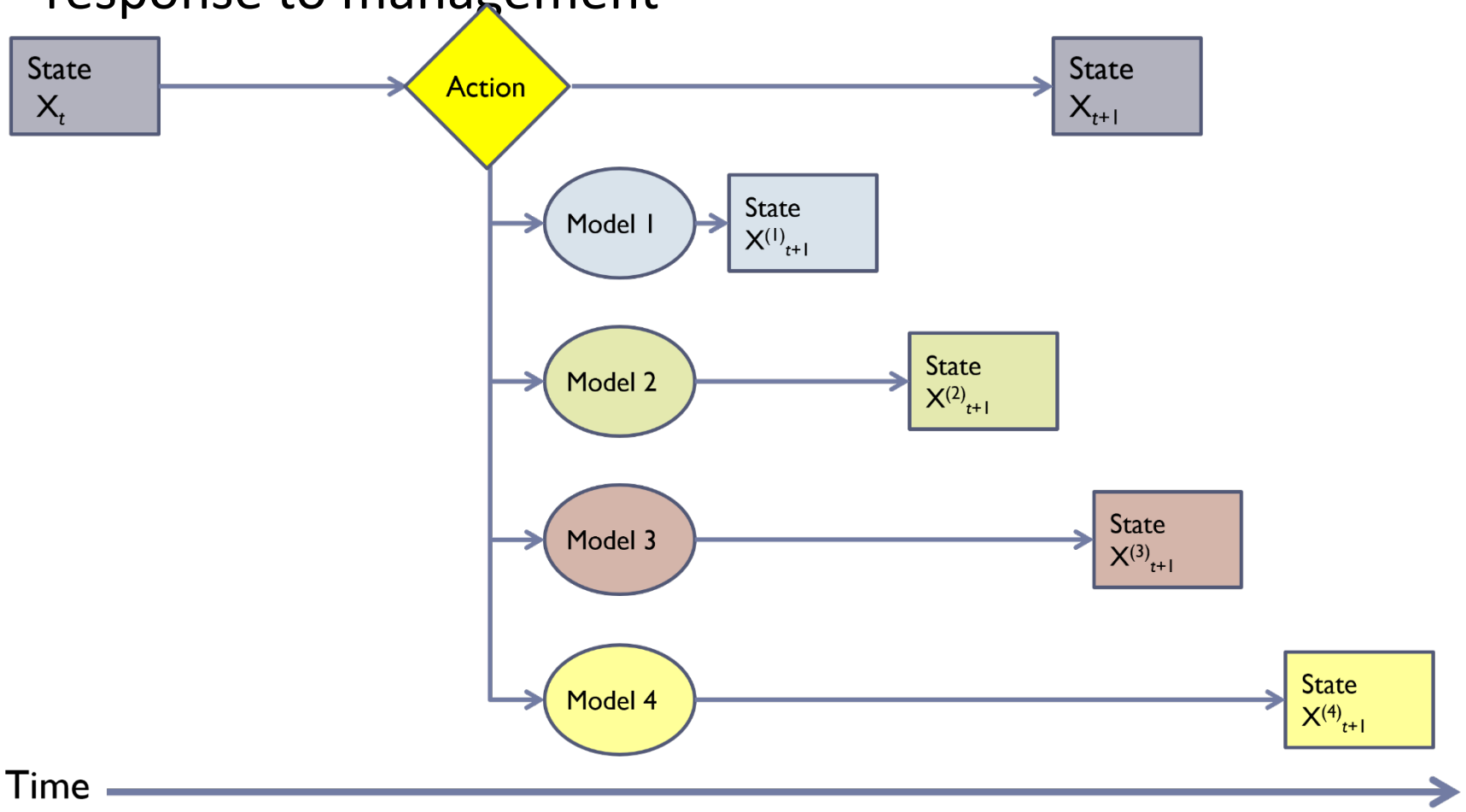
$$\Pr(X_{t+1} \mid X_t, \text{action}_t)$$

NPAM – Uncertainty

- Uncertainty about vegetation response makes choice of best action difficult
  - Does effectiveness of a given action depend on
    - The type of dominant invader?
    - The past defoliation history of the unit?
    - The level of invasion?
    - *Tallgrass*: Timing of action relative to a cool-season window?
- We formulated these questions as alternative hypotheses and expressed them as a set of four competing predictive models
  - *Tallgrass*: Two additional models related to timing

NPAM Elements – Competing Models

- Competing models make <u>different</u> predictions of system response to management



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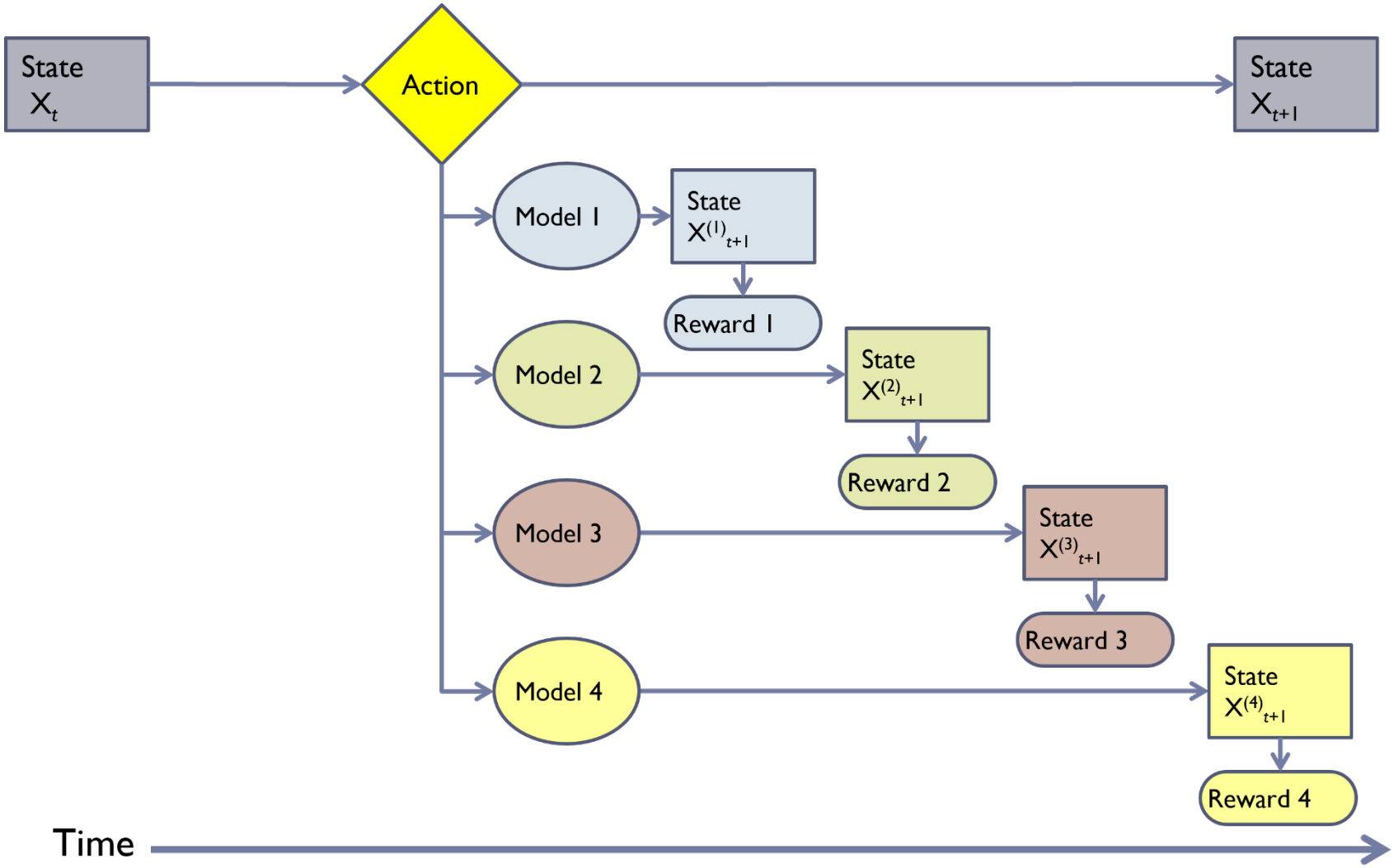
NPAM Elements – Reward Function

- Quantifies how cooperators value an action taken and the outcome it produces
- Combines both aspects of the management objective and is a function of
  - Native cover outcome relative to starting state (resource gain)
  - Management action applied (cost)
- Unitless number between 0 and 1
- Annual measure of what is received for what is invested
  - Larger the value, greater the payoff
- Derived from cooperator elicitation

NPAM Elements – Reward Function



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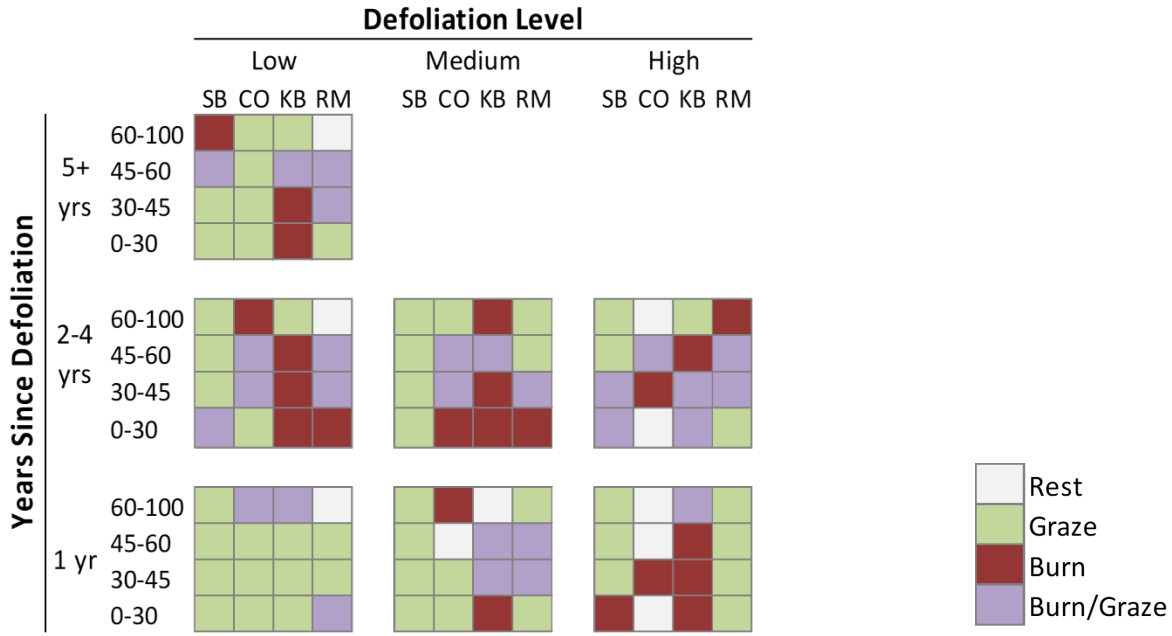
NPAM Elements – Optimization (mixed)

- Optimization computes decision policy
  - Integrates models, uncertainty, reward function

	Model 1	Model 2	Model 3	Model 4
Weight	0.25	0.25	0.25	0.25



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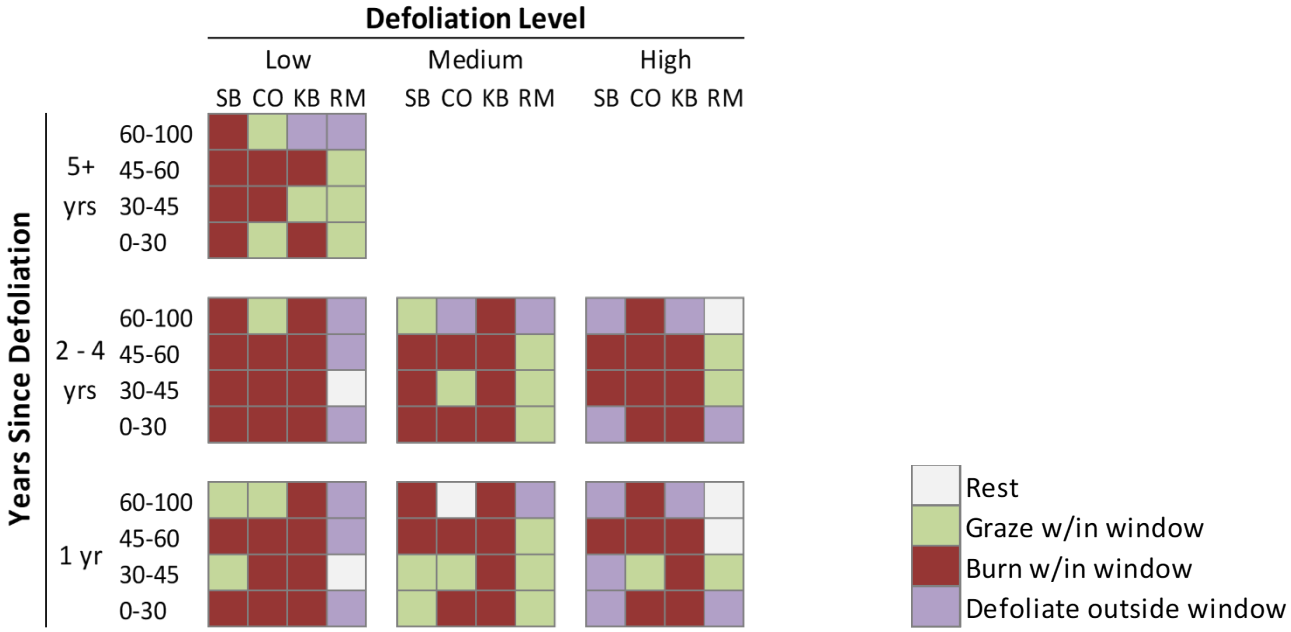
NPAM Elements – Optimization (tallgrass)

- Optimization computes decision policy
  - Integrates models, uncertainty, reward function

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Weight	0.167	0.167	0.167	0.167	0.167	0.167



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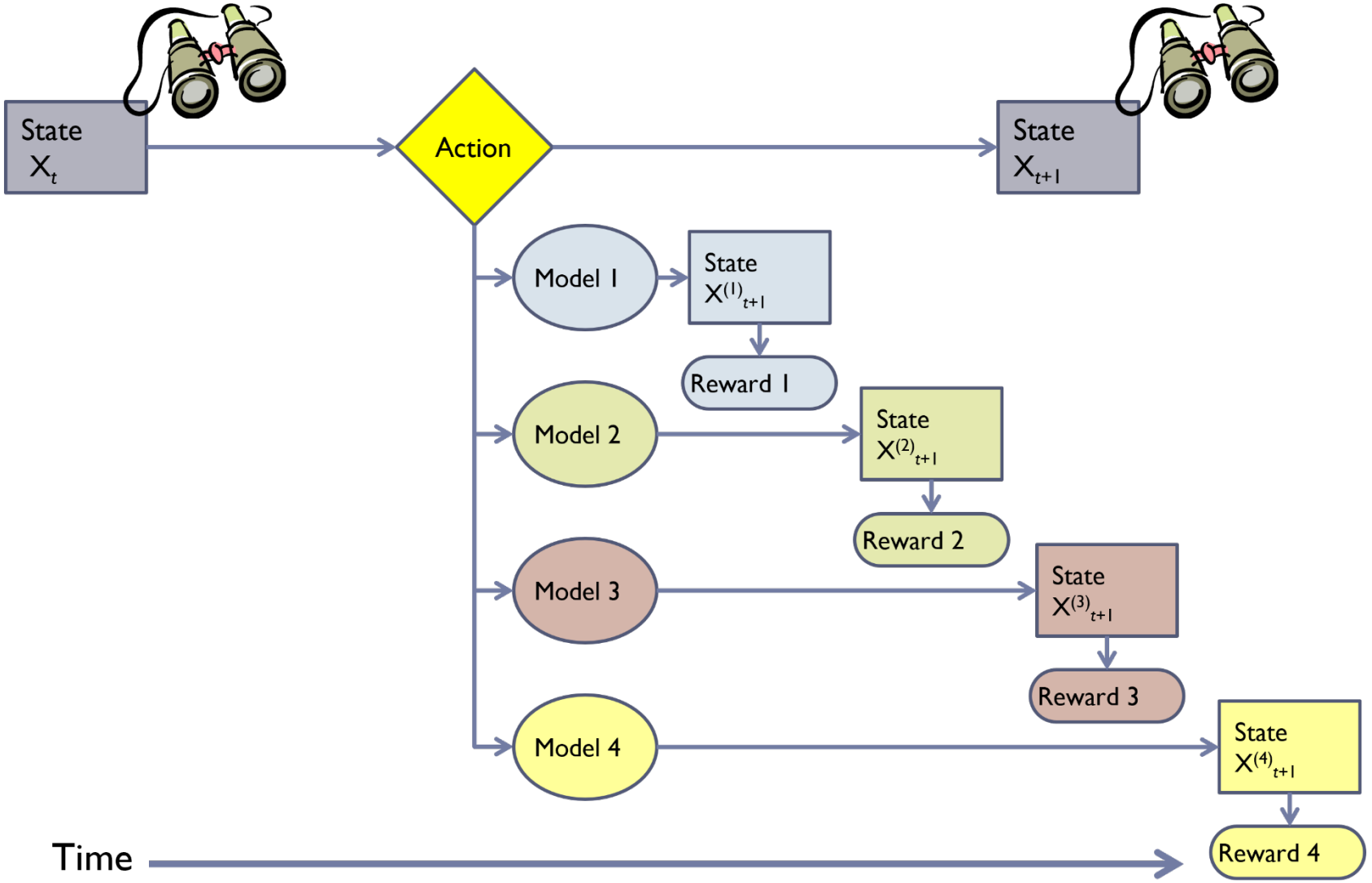
NPAM Elements – Monitoring



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Monitoring – What it Provides

- Monitoring provides
  - Current prairie composition

    → So we can make state-based management decisions
  - Outcome prairie composition (post management)

    → So we can assess the predictive abilities of our alternative models
  - Amount of native cover

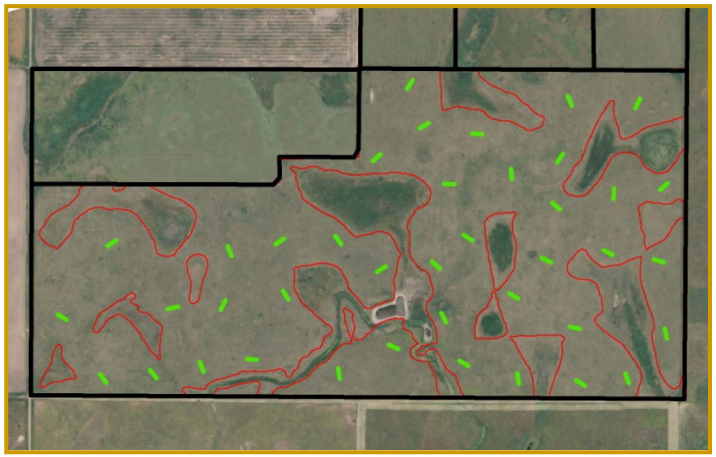
    → So we can gauge our progress towards the management objective

Monitoring – What Data are Necessary

- Monitoring needed for decisions and learning
  - Unit level vegetation composition
    - Percent cover of native grasses and forbs, smooth brome, Kentucky bluegrass, other
  - Management actions implemented
- Some considerations
  - Logistically feasible by Refuge staff
  - Sustainable for the long-term

Monitoring – Vegetation

- Belt-transect vegetation monitoring
  - Familiar; quick; short learning curve for seasonal staff; robust to multiple observers
  - 25-m transect, stop every 0.5m, 0.5m x 0.1m area, record plant code* for dominant cover type
  - Density of 1 per 5 acres (native upland only)

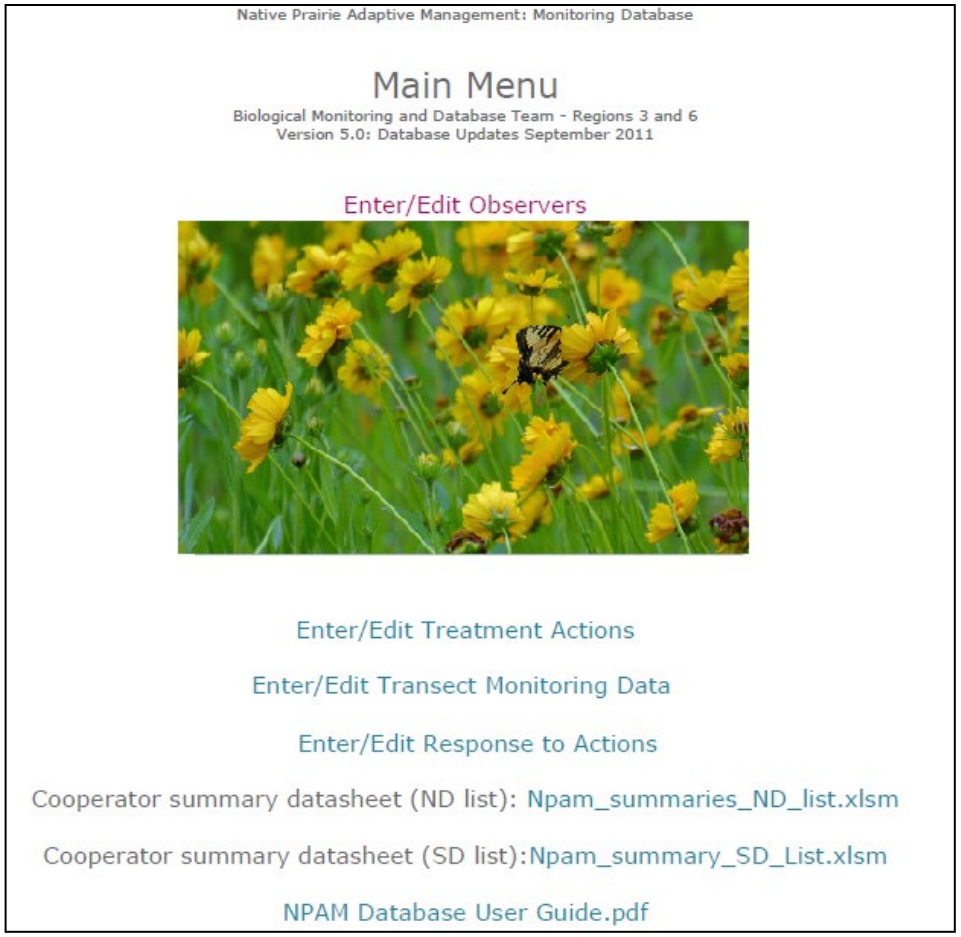


Monitoring – Management

- Past management history for all newly enrolled units
- Management actions and details of application
  - Which action (e.g., Rest, Graze, Burn, Burn/Graze)
  - Timing and length of application
    - Tallgrass includes phenology component to capture timing relative to cool-season window
  - Intensity (e.g., fire heat, stocking rate, utilization)

Monitoring – Centralized Database

- Centralized database
  - Hosted on SharePoint
  - Accessible to cooperators
  - Data entry/access is password protected and specific to each cooperating refuge
  - Observations are immediately captured and centrally stored
  - Built in queries generate cooperator-level data summaries



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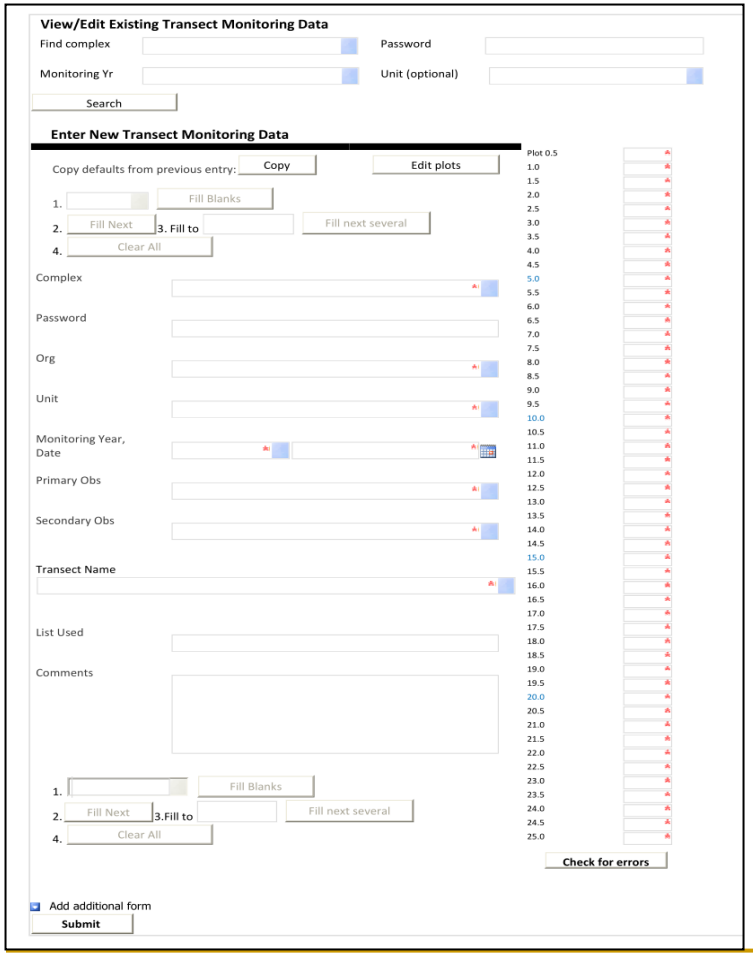
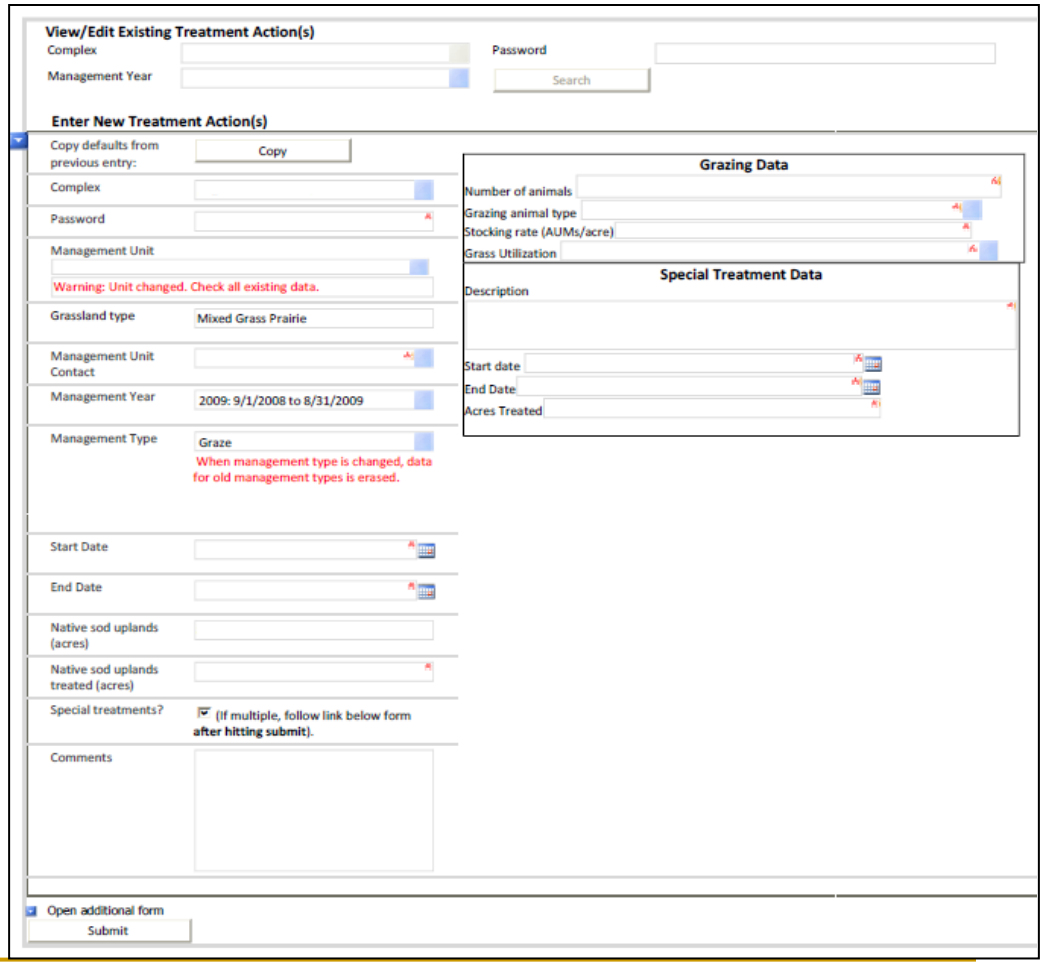
Monitoring – Centralized Database

- Vegetation data & Management action details





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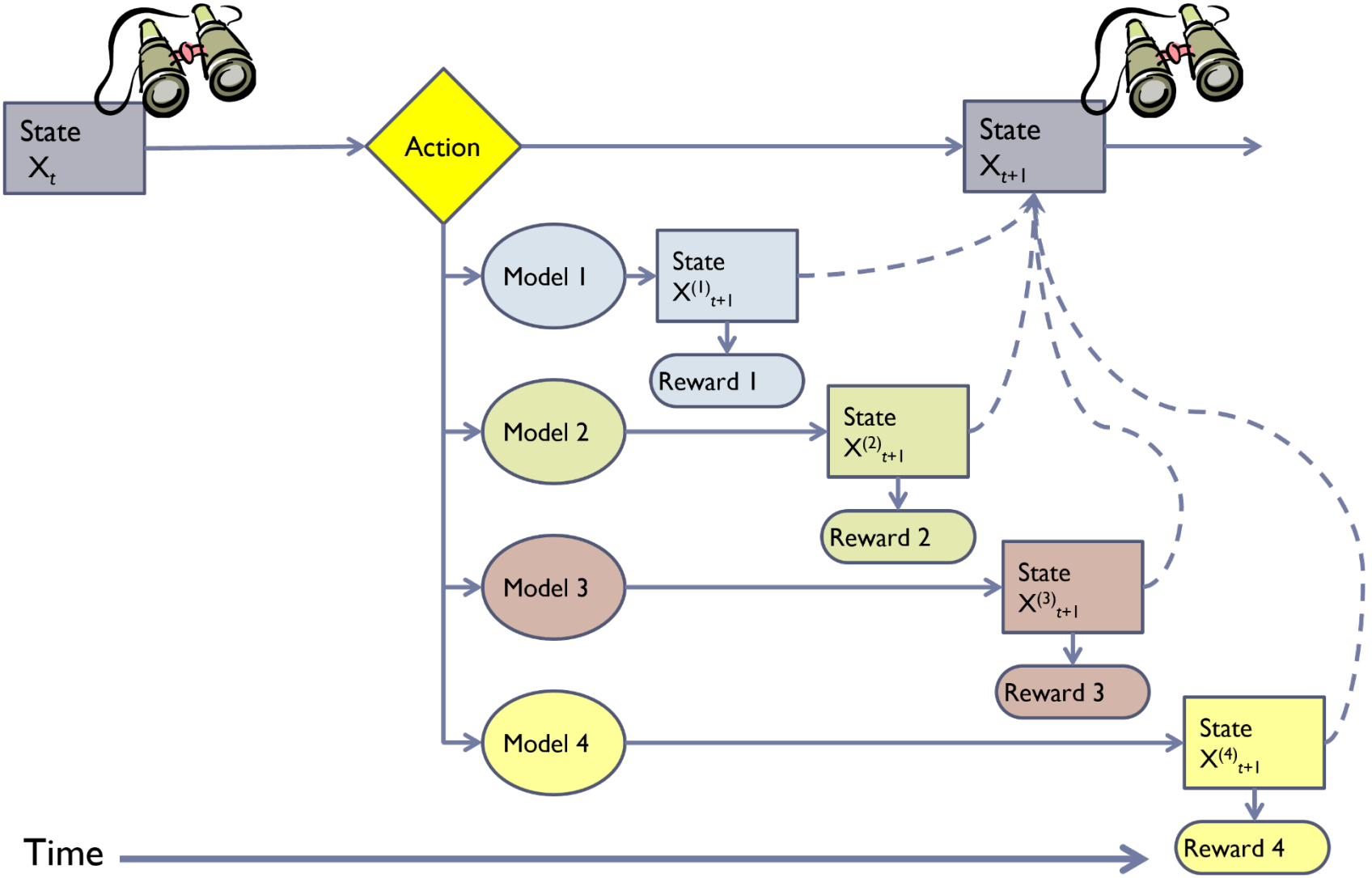
NPAM Elements – Updating



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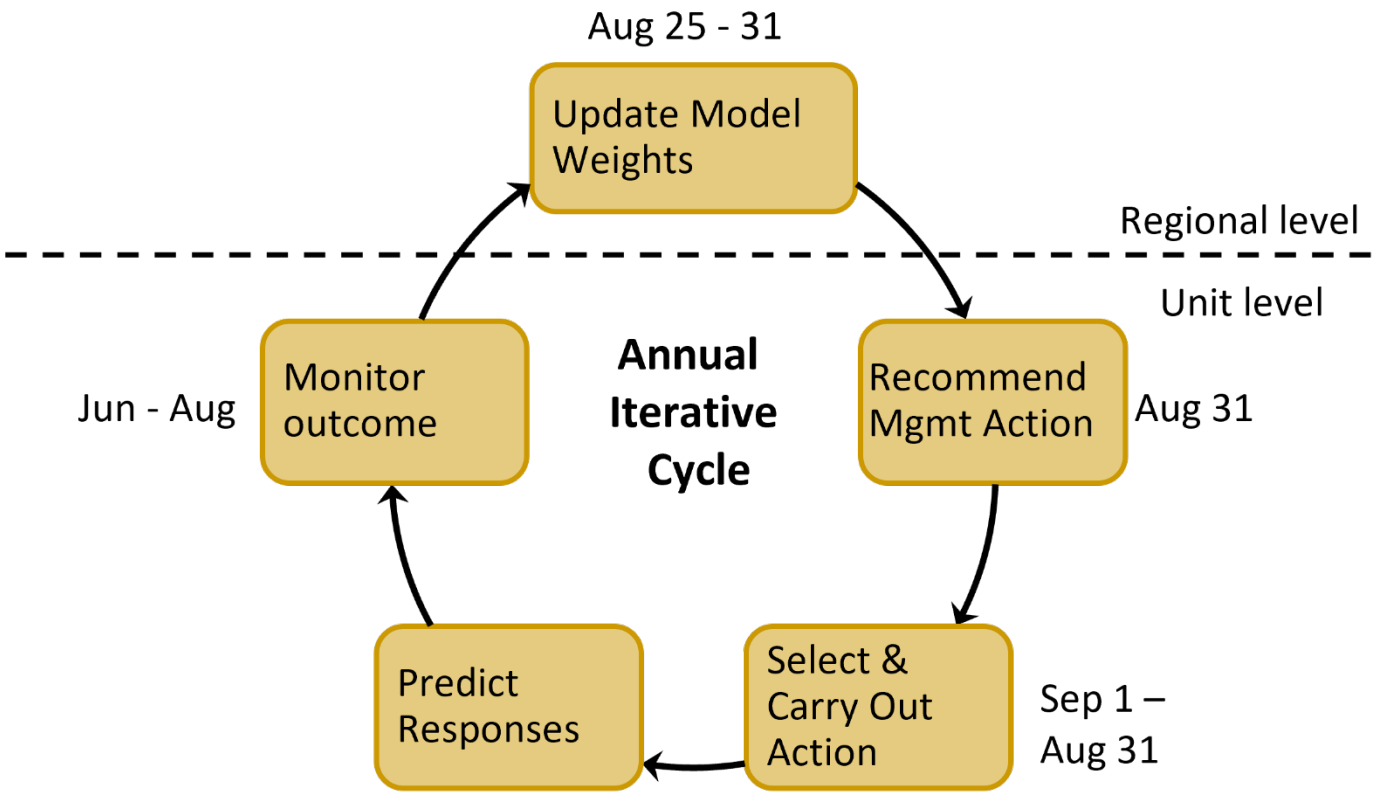
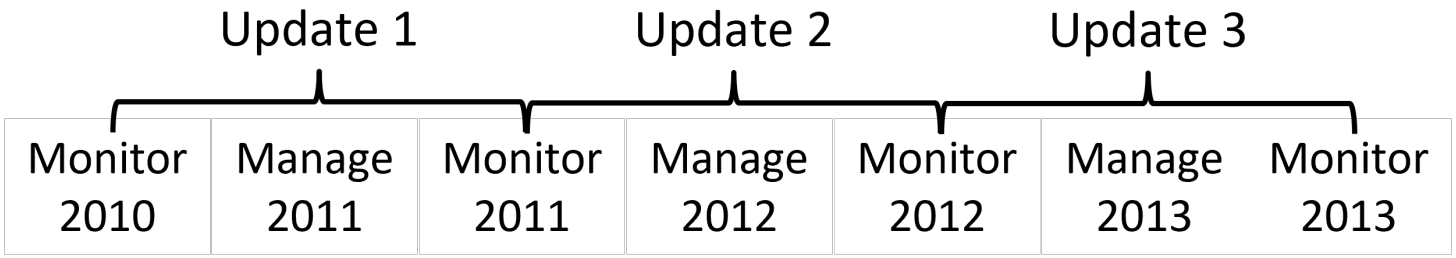
Annual Cycle: Managing & Learning



NPAM Updating Cycles (tallgrass)

- Completed three iterations of the AM decision cycle since project inception (2008)



- Reduced uncertainty among models

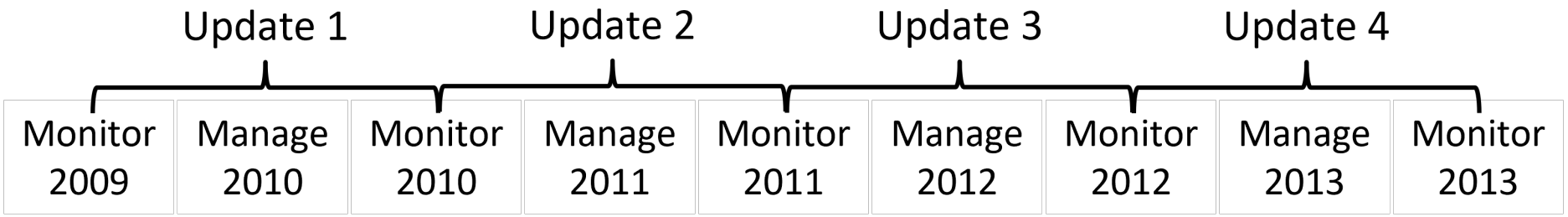
Year	M1	M2	M3	M4	M5	M6
2010	0.167	0.167	0.167	0.167	0.167	0.167
2011	0.179	0.148	0.167	0.173	0.167	0.166
2012	0.187	0.123	0.165	0.189	0.165	0.171
2013	0.210	0.113	0.158	0.187	0.159	0.173

Shift in model weights provides greater evidence for Model 1

  - We know more about behavior of the system than we did before

NPAM Updating Cycles (mixed)

- Completed four iterations of the AM decision cycle since NPAM inception (2008)



- Reduced uncertainty among models

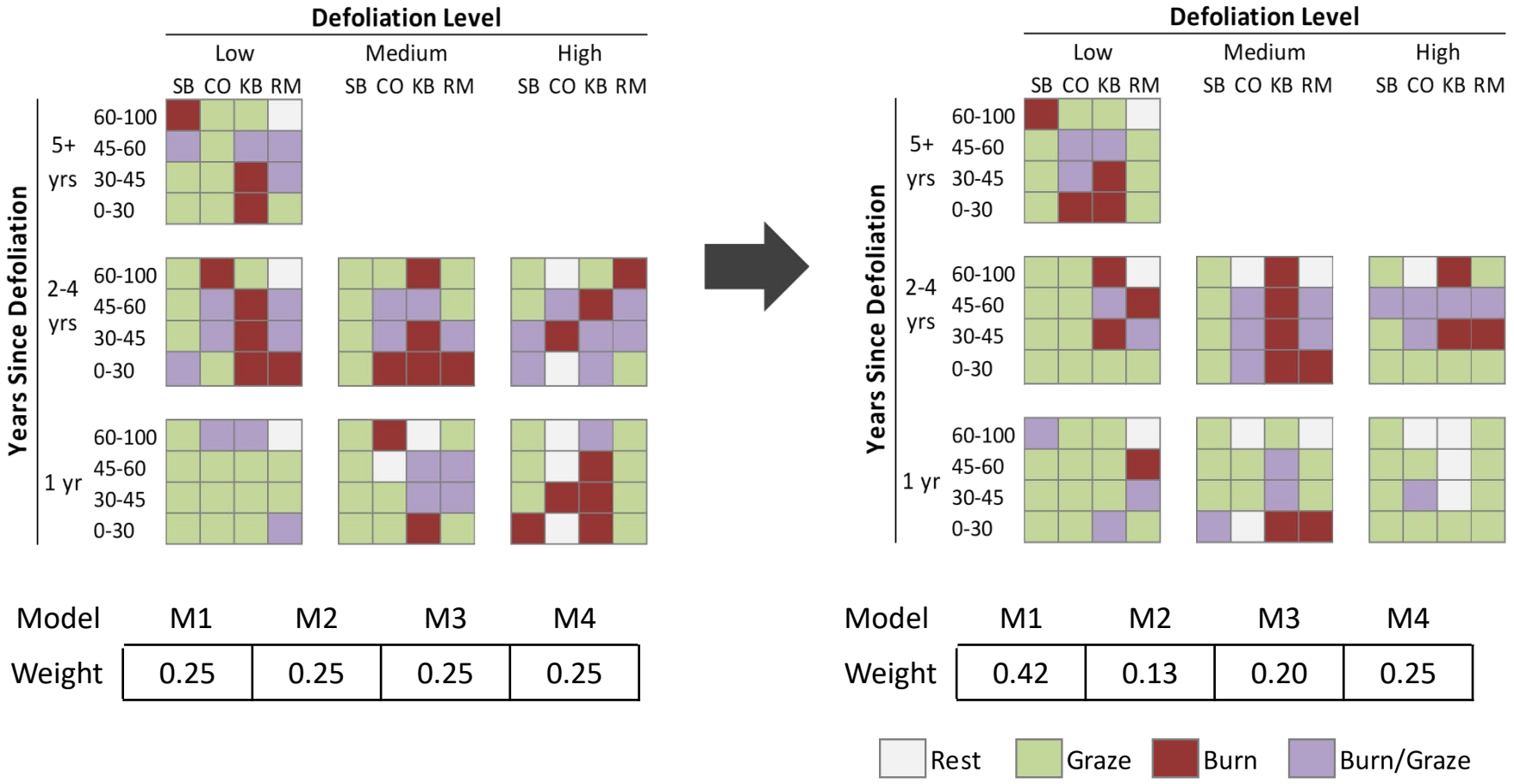
Year	M1	M2	M3	M4
2009	0.25	0.25	0.25	0.25
2010	0.28	0.23	0.24	0.25
2011	0.34	0.19	0.22	0.25
2012	0.38	0.16	0.21	0.25
2013	0.42	0.13	0.20	0.25

Shift in model weights provides greater evidence for Model 1

  - We know more about behavior of the system than we did before

Adapting Management with Learning

Before update – complete uncertainty After 4 updates – reduced uncertainty



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The Annual Cycle: Result

- Result of going through the annual iterative cycle
  - Reduce uncertainty by distinguishing better models from poorer models
  - Improved management decisions as better models exert greater influence on the next management decision via the updated decision policy

Each Annual Cycle Cooperators Receive

Annual decision support for individual parcels, guided by current conditions on the ground and current understanding about system behavior

Management recommendations report

Management Recommendations for Tall Grass Units in 2014

Thursday, August 29, 2013
5:24:12 PM

Grassland	Complex	Org	Unit	Year	NP Proportion	SB Proportion	KB Proportion	RM Proportion	Vegetation State	Defoliation Level	Years Since Level	Management Restriction	Recommended Managment Action
Tall Grass Prairie	SAND LAKE COMPLEX	SPINK COUNTY WPA	Sanderson	2013	0.25	0.60	0.08	0.07	{0-30, SB}	Med	1	None	GRAZE W/IN WINDOW
Tall Grass Prairie	TEWAUKON WMD	RICHLAND COUNTY WPA	Hartleben Unit A	2013	1.00	0.00	0.00	0.00	{60-100, RM}	Low	5+	None	DEFOLIATE
Tall Grass Prairie	TEWAUKON WMD	RICHLAND COUNTY WPA	Hartleben Unit B	2013	0.22	0.00	0.00	0.78	{0-30, RM}	Low	2-4	None	DEFOLIATE
Tall Grass Prairie	TEWAUKON WMD	RICHLAND COUNTY WPA	Hartleben Unit C	2013	0.33	0.09	0.00	0.58	{30-45, RM}	Low	2-4	None	REST
Tall Grass Prairie	TEWAUKON WMD	SARGENT COUNTY WPA	Gainor Unit A	2013	0.12	0.04	0.36	0.48	{0-30, KB}	Med	1	None	BURN W/IN WINDOW

Each Annual Cycle Cooperators Receive

Summary of land unit conditions since NPAM enrollment

Summary of Mixed Grass States from Project Inception (2009) to Present

Thursday, August 29, 2013
2:18:10 PM

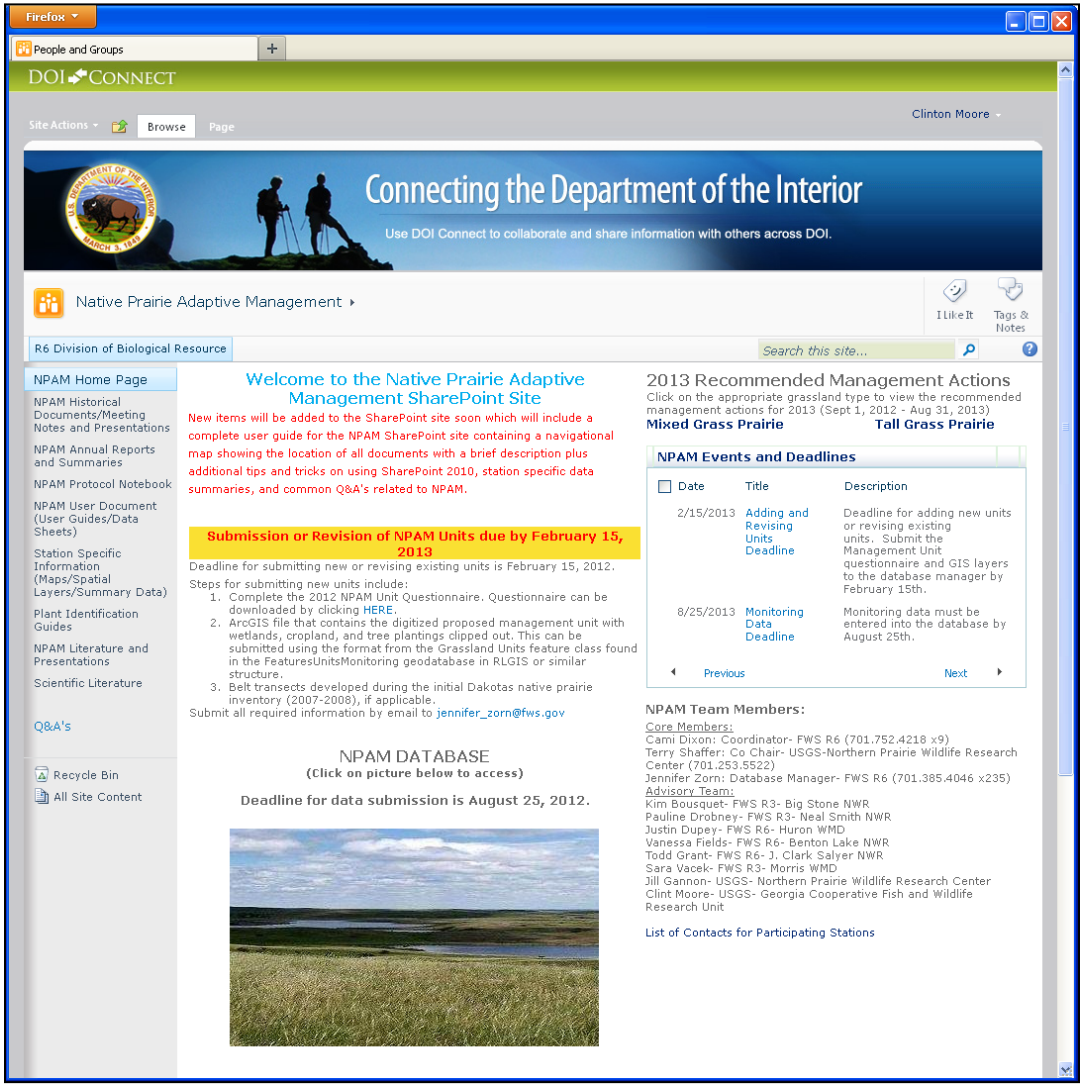
Grassland	Complex	Org	Unit	Management Year	Management Applied	Management Classified	Defoliation Level	Years Since Level	Vegetation State
Mixed Grass Prairie	ARROWWOOD COMPLEX	ARROWWOOD NWR	G14 Pasture 1	2009	burn/graze	N/A	High	1	{30-45, Co}
Mixed Grass Prairie	ARROWWOOD COMPLEX	ARROWWOOD NWR	G14 Pasture 1	2010	rest	REST	High	2-4	{30-45, Co}
Mixed Grass Prairie	ARROWWOOD COMPLEX	ARROWWOOD NWR	G14 Pasture 1	2011	rest	REST	Med	2-4	{0-30, Co}
Mixed Grass Prairie	ARROWWOOD COMPLEX	ARROWWOOD NWR	G14 Pasture 1	2012	burn	BURN	High	1	{45-60, Co}
Mixed Grass Prairie	ARROWWOOD COMPLEX	ARROWWOOD NWR	G14 Pasture 1	2013	burn	BURN	High	1	{45-60, SB}
Mixed Grass Prairie	ARROWWOOD COMPLEX	ARROWWOOD NWR	G14 Pasture 2	2009	burn	N/A	High	1	{0-30, KB}
Mixed Grass Prairie	ARROWWOOD COMPLEX	ARROWWOOD NWR	G14 Pasture 2	2010	rest	REST	High	2-4	{0-30, Co}
Mixed Grass Prairie	ARROWWOOD COMPLEX	ARROWWOOD NWR	G14 Pasture 2	2011	rest	REST	Med	2-4	{0-30, Co}
Mixed Grass Prairie	ARROWWOOD COMPLEX	ARROWWOOD NWR	G14 Pasture 2	2012	burn	BURN	High	1	{60-100, RM}
Mixed Grass Prairie	ARROWWOOD COMPLEX	ARROWWOOD NWR	G14 Pasture 2	2013	burn	BURN	High	1	{45-60, Co}

Into the Future – Continuing the Cycle

- FWS continues implementing the annual iterative cycle
  - Cooperators
    - Manage, Monitor, Enter Data
  - Project and Database Coordinators
    - Update model weights and decision policy
    - Provide recommended management actions
    - Overall guidance to cooperators as needed
- Long-term conservation objective requiring long-term commitment → simply a new way of doing business
- As uncertainties are resolved, management will continue
  - A continued role for monitoring to make state-based decisions

NPAM Infrastructure

- MS SharePoint site for data entry and information support
  - Data are entered by cooperators via web portal
  - NPAM related information stored and retrieved
  - NPAM announcements/ communications



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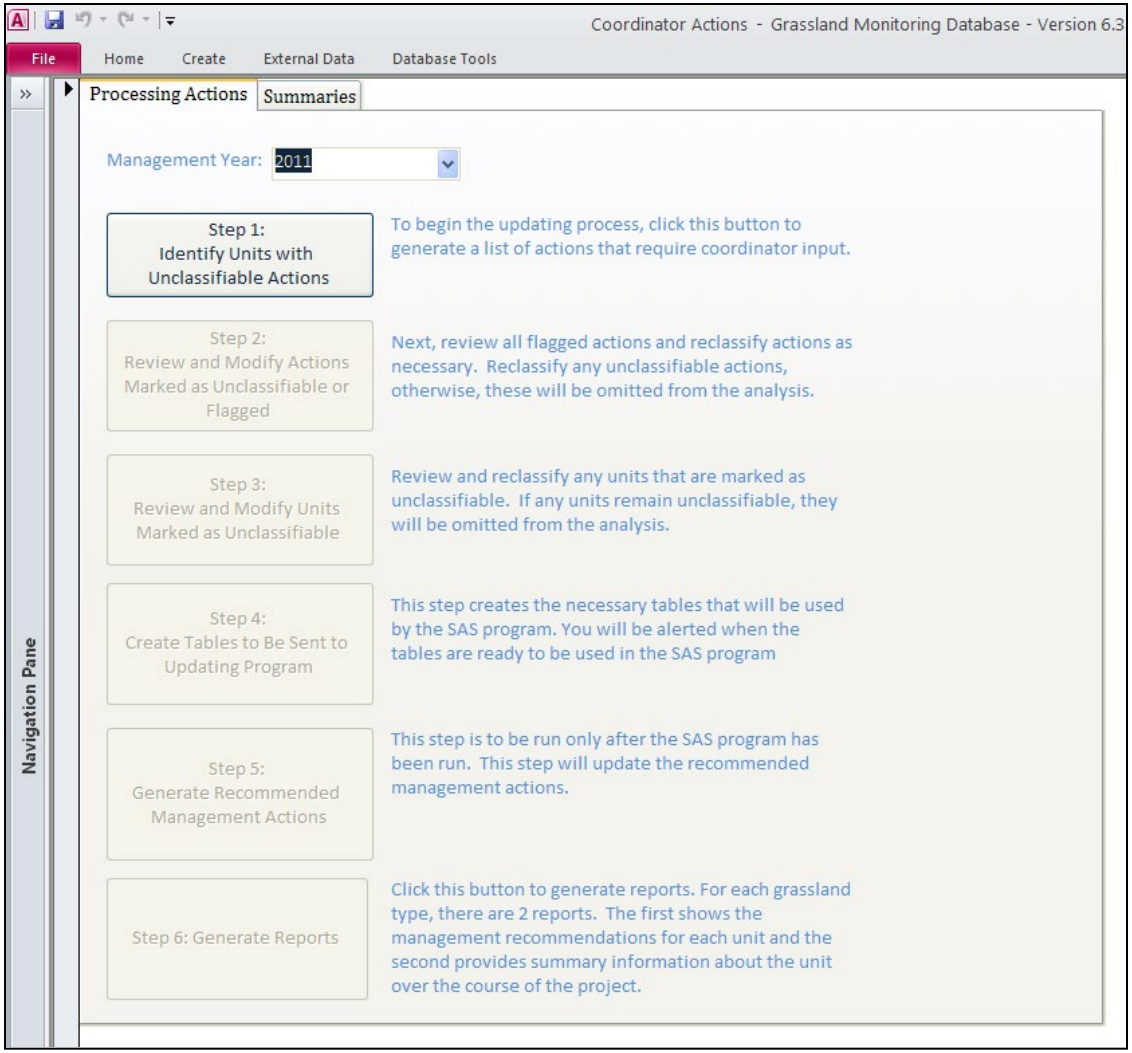
NPAM Infrastructure

- MS Access database for project coordinator
  - Automated steps to process data
  - Prepares data for model weight updating
  - Identifies recommended management actions
  - Generates reports and data summaries for cooperators



NPAM Infrastructure

- Protocol Notebook
  - NPAM Users' Manual
  - Principal document describing overall operation of NPAM
    - Roles
    - Timeline
    - Field protocols
  - Audience is cooperators and project coordinator

TABLE OF CONTENTS

NPAM Protocol Notebook, 22 December 2011

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NPAM – Sustainable 'New way of doing business'

- Relevant to cooperator needs and constraints
  - Uses pre-existing conventions and practices
  - Incorporates cooperator knowledge and preferences
- Operationalized with minimal cooperator investment
  - Seamless integration into routine operations
  - Automation of technical components
  - Flexibility for expansion to additional units
- Grassroots level involvement, not top-down
  - Trans-regional support and operation by cooperators themselves
- Periodic review by USFWS-USGS Advisory Team

What cooperators gain from NPAM

Pre-NPAM

- Working individually
- Different/Unstated objectives
- Decisions based on anecdotal observations
- Lack of recording and monitoring

NPAM

- Coordination of effort
- Shared objective
- Same protocols
- Purposeful monitoring
- Decisions:
  - Transparent
  - Linked to objective
  - Based on:
    - Current system state
    - Current knowledge
  - Take into account uncertainty
- Learning while managing

Spatially-distributed adaptive management: Benefits and Trade-Offs

- Benefits
  - Maintain flexibility of management at the station scale
  - Common protocols for monitoring and decision making
  - Broad-scale consensus on values and what is to be achieved
  - Collective learning from “replication” across system
  - Management improved locally and system-wide
- Trade-offs
  - Flexibility & Large Scales → Noise → Slower learning rate
    - But, learning occurs if stick to the framework

What we have learned from NPAM

- Coordination
  - Timelines & standardized processes
  - Understanding of roles & responsibilities
  - Continuous communication
- Commitment to the process
  - Adherence to protocols
  - Time for learning to unfold
- Multi-partner participation

- Leaders & champions

Participation in NPAM would require potential partner to have…

- Control of native sod land units
- Compatible management objective
- Ability to apply compatible management actions
  - Make annual decisions, based on a management year of 1 Sep – 31 Aug
  - Refrain from broadcast application of herbicides or other non-appropriate actions (outside of spot treatments)
  - In tallgrass, ability to assess phenology to identify appropriate management windows

Participation in NPAM would require potential partner to have…

- Ability to monitor annually and follow same protocol
- Ability to record details of management actions using same protocol
- Ability to enter data by the annual deadline (25 Aug)
- Ability/willingness to consider the recommended management (provided 1 Sep) before deciding upon the action to take that year

Post-Webinar Questionnaire

- Purpose: to assess compatibility between NPAM and potential partner needs and abilities and assess potential to expand NPAM beyond the USFWS NWRS
- Delivery: via email attachment from Cami after the webinar
- Format: Excel file with directed questions that request responses by way of drop-down list or free-form typing, as well as an area for providing additional information*
- Return: to Jill (contact info on questionnaire) within three weeks (7 Feb)

Native Prairie Adaptive Management Team

- USFWS Development Team
  - Kim Bousquet, Cami Dixon, Pauline Drobney, Vanessa Fields, Bridgette Flanders-Wanner, Todd Grant, Sara Vacek
- Database Team
  - Development: Kevin McAbee, Todd Sutherland, Sarah Jacobi, Victoria Hunt
  - Management: Justin Dupey and Jennifer Zorn
- USFWS Refuge Cooperators – Region 3 and Region 6
- USGS
  - Terry Shaffer, Clint Moore, Jill Gannon