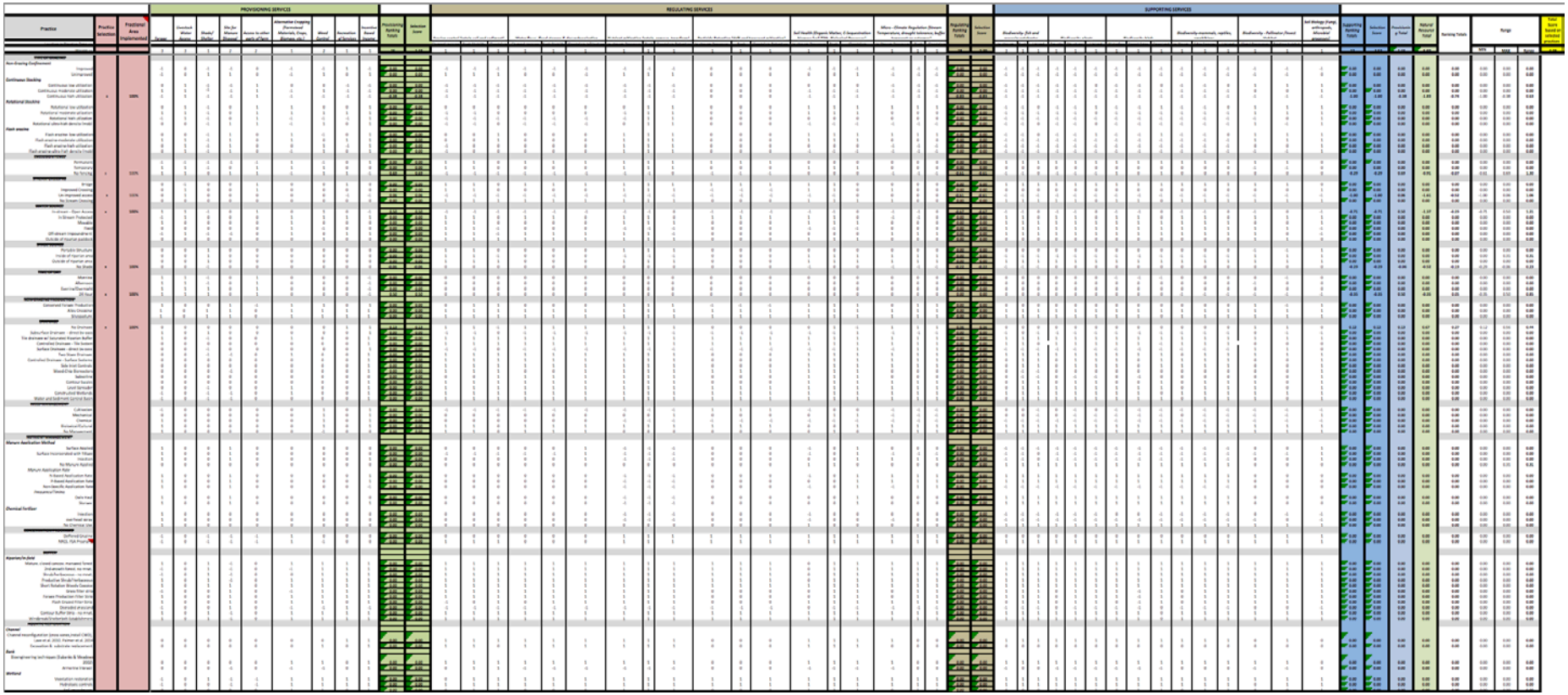
Production and Conservation Trade-off (PaCT) assessment tool



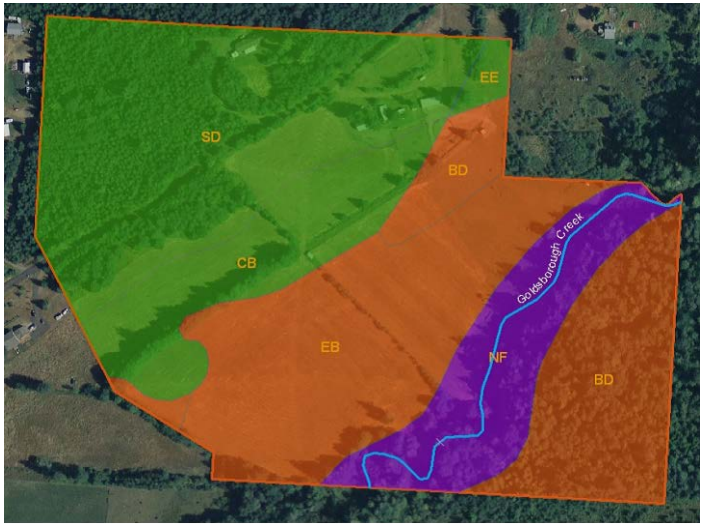
Seeking to better understand the trade-offs associated with different forms of management practices on ecological and economic outcomes

Ecology Is Dynamic

Spatially and Temporally Variable

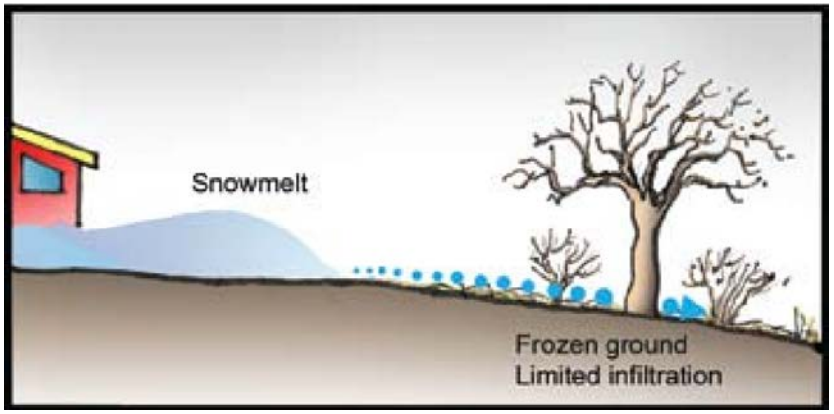
Spatial

- Soils
- Hydrology
- Geology
- Concentrations of Nutrients and Removal



Temporal

- Seasonal Variability in Nutrient Mitigation
- Spring/Fall Dynamics
- Annual changes in hydrologic flows



PaCT

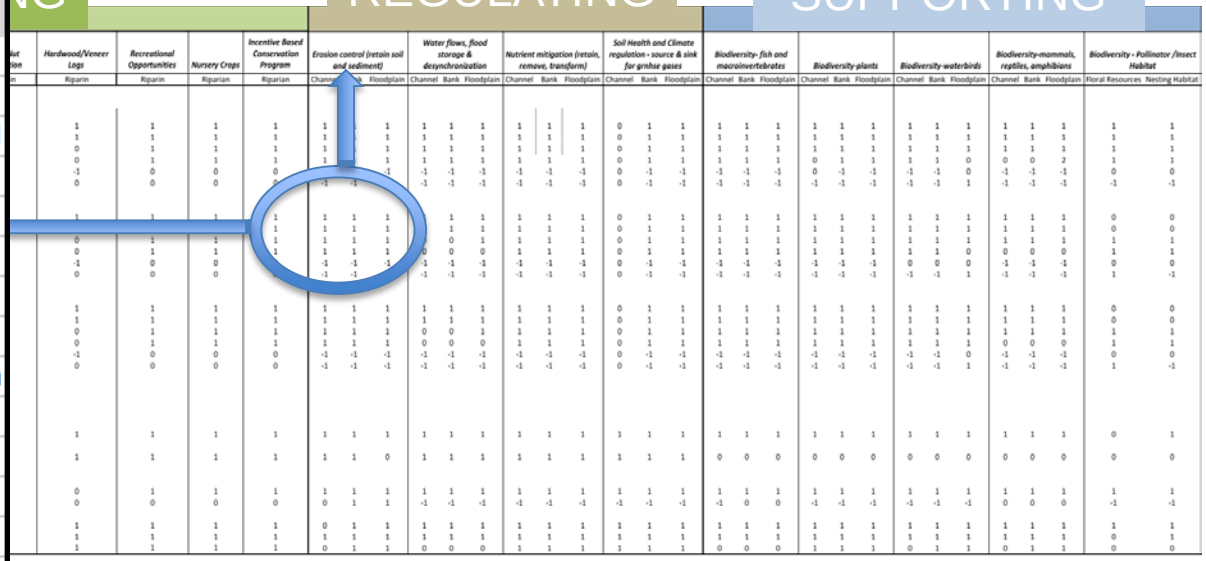
Rating performance based on influence

MANAGEMENT PRACTICES

TYPE OF GRAZING
Non-Grazing Confinement
Improved
Unimproved
Continuous Stocking
Continuous low utilization
Continuous moderate utilization
Continuous high utilization
Rotational Stocking
Rotational low utilization
Rotational moderate utlization
Rotational high utlization
Rotational ultra-high density (mob)
Flash grazing
Flash grazing- low utilization
Flash grazing-moderate utilization
Flash grazing-high utilization
Flash grazing-ultra-high density (mob)
EXCLUSION FENCE
Permanent
Temporary
No fencing

SERVICES

PROVISIONING | REGULATING | SUPPORTING



Buffers and stream restoration

Grazing

Annual crops

Ecosystem Services Considerations

PROVISIONING SERVICES							
Forage	*Water*	*Shade*	*Weed control*	*Manure spreading*	*other parts of farm*	*Recreational services*	*Incentive Based Income*

REGULATING SERVICES											
Erosion control (retain soil and sediment)			*Water flows, flood storage & desynchronization*			*Nutrient mitigation (retain, remove, transform)*			*Soil Health and Climate regulation - source & sink for carbon*		
Channel	Bank	Floodplain	Channel	Bank	Floodplain	Channel	Bank	Floodplain	Channel	Bank	Floodplain

SUPPORTING SERVICES											
Biodiversity- fish and macroinvertebrates			*Biodiversity-plants*			*Biodiversity-Birds*			*Biodiversity-mammals, reptiles, amphibians*			*Biodiversity: Pollinator/Insect Sp.*	
In-stream	Bank	Upland	Aquatic	Structural	Upland	Waterbird	Edge Species	Grassland	In-stream	Edge Soecies	Upland	Floral Resources	Nesting Habitat

PACT Application

Examples from the Riparian Zone

Metrics for rapid decision making considerations…

			REGULATING SERVICES									
Practice	**Practice Selection**	**Fractional Area Implemented**	*ood storage & desynchronization*		*Nutrient mitigation (retain, remove, transform)*			*Pesticide/Herbicide Retention (drift and transport mitigation)*			*Soil Health (Organic Matter, biomass/soil,Tilth, Biologic*	
Location in Riparian Zone =>			Bank Stability	Floodplain Infiltration	In-stream Processes	Bank	loodplain Retentio	In-stream Processes	Bank	loodplain Retentio	In-stream Processes	Bank
Weght			1	1	1	1	1	1	1	1	1	1
Controlled Drainage - Tile System			1	1	1	1	1	1	1	1	1	1
Grassed waterway - NO MNGT			1	1	1	1	1	1	1	1	1	1
Grassed waterway - MNGT	x	100%	1	1	1	1	1	1	1	1	0	1
Surface Drainage - direct by-pass			-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Two Stage Drainage			1	1	1	1	1	1	1	1	1	1
Controlled Drainage - Surface Systems			1	1	1	1	1	0	0	0	1	1
Side Inlet Controls			1	1	1	1	1	0	0	0	1	1
Wood-Chip Bioreactors			0	1	1	1	1	1	1	1	1	1
Subsoiling			1	1	1	1	1	0	0	0	1	1
Contour Swales			1	1	1	1	1	0	0	0	1	1
Level Spreader			1	1	1	1	1	1	1	1	1	1
Constructed Wetlands			1	1	1	1	1	1	1	1	1	1
Water and Sediment Control Basin			1	1	1	1	1	1	1	1	1	1
AQUATIC RESTORATION												
Channel												
Channel reconfiguration (cross vanes,install CWD), Lave et al. 2010, Palmer et al. 2014			1	1	1	1	1	0	0	0	1	1
Excavation & substrate replacement			1	1	1	1	1	0	0	0	1	1
Bank												
Bioengineering techniques (Eubanks & Meadows 2002)			1	1	1	1	1	0	0	0	1	1
Armoring (riprap)			-1	-1	-1	-1	-1	0	0	0	-1	-1
Wetland												
Vegetation restoration			1	1	1	1	1	1	1	1	1	1
Hydrologic controls			1	1	1	1	1	1	1	1	1	1
Soil amendments			0	0	1	1	1	0	0	0	1	1
Specific E.S. Score (based on % influence)			6.00	6.00	5.80	5.80	6.60	6.00	6.00	6.00	4.80	5.80
Specific E.S. Score (based on presence)			8.00	8.00	7.00	7.00	8.00	8.00	8.00	8.00	5.00	8.00

PACT Application

Examples from the Riparian Zone

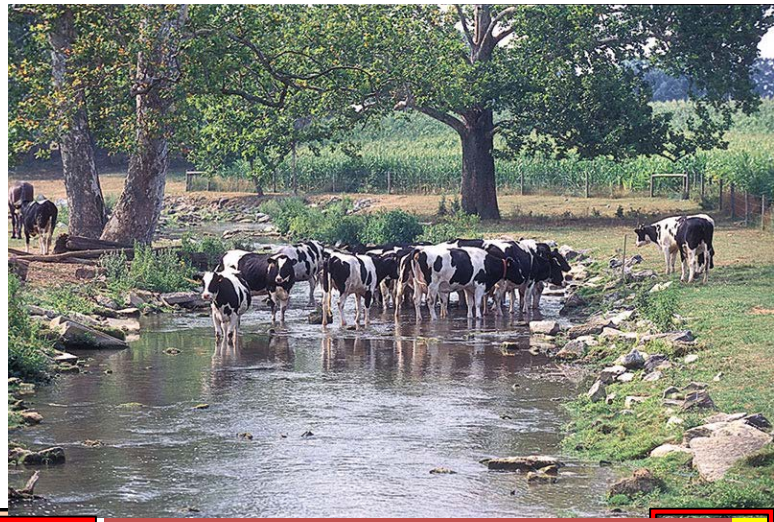
Example 1

Continuously grazed, high utilization operation with a degraded streambank, un-restricted livestock access to the creek.

PACT Application

Examples from the Riparian Zone

Degraded grassland buffer



Practice	Practice Selection	Fractional Area Implemented	Selection Score	Provisioning Totals	Natural Resource Totals
Location in Riparian Zone =>					
Weght			1.33	0.93	0.56
BUFFER					
Riparian/In-field					
Mature Closed Canopy - **MANAGED**			0.00	0.00	0.00
Mature Closed Canopy - **NO mngt.**			0.00	0.00	0.00
Shrub/herbaceous - **NO mngt.**			0.00	0.00	0.00
Productive Shrub/Herbaceous			0.00	0.00	0.00
Short Rotation Woody Coppice			0.00	0.00	0.00
Grass filter strip			0.00	0.00	0.00
Forage Production Filter Strip			0.00	0.00	0.00
Flash Grazed Filter Strip			0.00	0.00	0.00
Degraded grassland	x	100%	-0.73	-0.40	-1.68
Contour Buffer Strip - no mngt.			0.00	0.00	0.00
Windbreak/Shelterbelt Establishment			0.00	0.00	0.00
CROPPING SYSTEM					
Corn-Soy Rotation			0.00	0.00	0.00
Grain - Forage (Dairy)			0.00	0.00	0.00
Perennial Forage			0.00	0.00	0.00
Woody Biomass			0.00	0.00	0.00
Herbaceous Biomass			0.00	0.00	0.00
Alley Cropping			0.00	0.00	0.00
Silvopasture			0.00	0.00	0.00
TILLAGE					
Conventional Tillage			0.00	0.00	0.00
Reduced Tillage			0.00	0.00	0.00
Subsoiling			0.00	0.00	0.00
No Till			0.00	0.00	0.00
SOIL MANAGEMENT					
Cover Crops			0.00	0.00	0.00

Scenario 1: Over grazed

Benefits:

- Stream Water Access
- Ease of Management
- Ease of Maintenance
- Maximized grazing area

Cons:

- Degraded water quality
- Degraded Habitat
- Degraded Animal Health
- Poor
- Degr
- ....

Provisioning Totals	Natural Resource Totals
0.93	0.56

PACT Application

Examples from the Riparian Zone

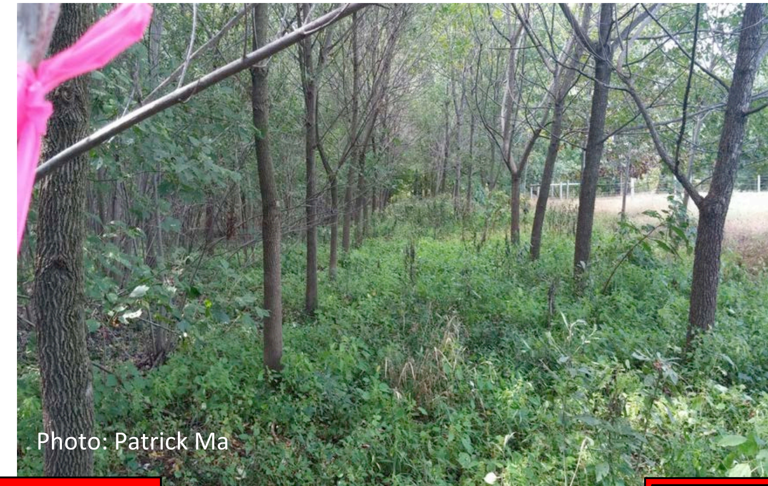
Example 2: CREP Riparian Forest Buffer

Mature CREP riparian forest buffer practice with complete removal of livestock from riparian corridor (100ft from top of bank). CP-21 and CP-22 with proportional area estimated. No vegetation management.

PACT Application

Examples from the Riparian Zone

15 year old Forested Buffer
Exclusion Fence
No Livestock in Riparian Zone



Scenario 2: CREP

Benefits:

- Optimized Habitat
- Water quality improvements
- Natural Ecosystem processes
- Erosion mitigation enhanced
- Grassed waterway

Cons:

- Unmanaged concentrated flows
- Enhanced nutrient cycling through leaf senescence
- unmanage
- Removal of … potential

Provisioning Totals	Natural Resource Totals
0.00	4.89

Provisioning Totals	Natural Resource Totals
0.00	4.89
0.00	0.00
-0.20	1.94
0.00	0.00
0.00	0.00
0.00	0.00
-0.25	1.46
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00
0.00	0.00

TILLAGE

SOIL MANAGE

Scenario 1: Over grazed

Benefits:

- Stream Water Access
- Ease of Management
- Ease of Maintenance
- Maximized grazing area

Cons:

- Degraded water quality
- Degraded Habitat
- Degraded Animal Health
- Poor
- Degra
- ….

Provisioning Totals	Natural Resource Totals
0.93	0.56

PACT Application

Examples from the Riparian Zone

Example 3 – Hypothetical

A well managed pasture with a narrow riparian exclusion and mixed grassed and tree/shrub buffer. Rotationally grazed within buffer during optimal pasture growth stages.

PACT Application

Examples from the Riparian Zone

Rotational Grazing in Pasture

Flash Grazing in Buffer

Improved Stream Crossing

Scenario 3: Optimized Grazing

Benefits:

- Stream Water Access
- Improved grassland habitat
- Improved water quality
- Improved erosion prevention
- Improved Provisioning Services
- Improved Pasture/soil health
- Maximized grazing potential

Cons:

- Not optimized habitat
- Not optimized shading potentia
- Some

Provisioning Total	Natural Resource Total
1.86	9.53

Scenario 2: CREP

Benefits:

- Optimized Habitat
- Water quality improvements
- Natural Ecosystem processes
- Erosion mitigation enhanced
- Grassed waterway

Cons:

- Unmanaged concentrated flows
- Enhanced nutrient cycling through leaf senescence
- unma
- Remo
- service

Provisioning Totals	Natural Resource Totals
0.00	4.89

Scenario 1: Over grazed

Benefits:

- Stream Water Access
- Ease of Management
- Ease of Maintenance
- Maximized grazing area

Cons:

- Degraded water quality
- Degraded Habitat
- Degraded Animal Health
- Poor pasture condition
- Deg
- ....

Provisioning Totals	Natural Resource Totals
0.93	0.56

PACT Application

Examples from the Riparian Zone

Example 4 – Hypothetical DAIRY

A short rotation woody shrub buffer for bedding or biomass production (60%). Managed closed canopy streambank edge (20%) Rotationally grazed filter strip (20%).

Example 5 – Hypothetical Cropped

A well managed pasture with a narrow riparian exclusion and mixed grassed and tree/shrub buffer. Rotationally grazed within buffer during optimal pasture growth stages.

PACT Application

Examples from the Riparian Zone

Alley Cropping Fruits and Nuts

Hayed Alleys

Managed Streambank Canopy

Scenario 5: Cropped

Benefits:

- Matched Provisioning Service
- Fruit, Nut and Hay/Straw Production
- Improved water quality
- Improved erosion prevention
- Ease of Maintenance
- Optimized habitat
- Reduced Nutrient Loading

Cons:

- Habi t issue
- Marl able
- Som ling

Provisioning Totals	Natural Resource Totals
1.43	6.82

Scenario 4: Dairy Buffer

Benefits:

- Matched Provisioning Services
- Bedding/Biofuel Material
- Maintain grazing areas
- Ease of Maintenance
- Nutrient Cycling
- Habitat Provisioning

Cons:

- Rotationally harvested
- M ive
- D ealth
- M at
- M

Provisioning Totals	Natural Resource Totals
1.04	6.07

Scenario 2: CREP

Benefits:

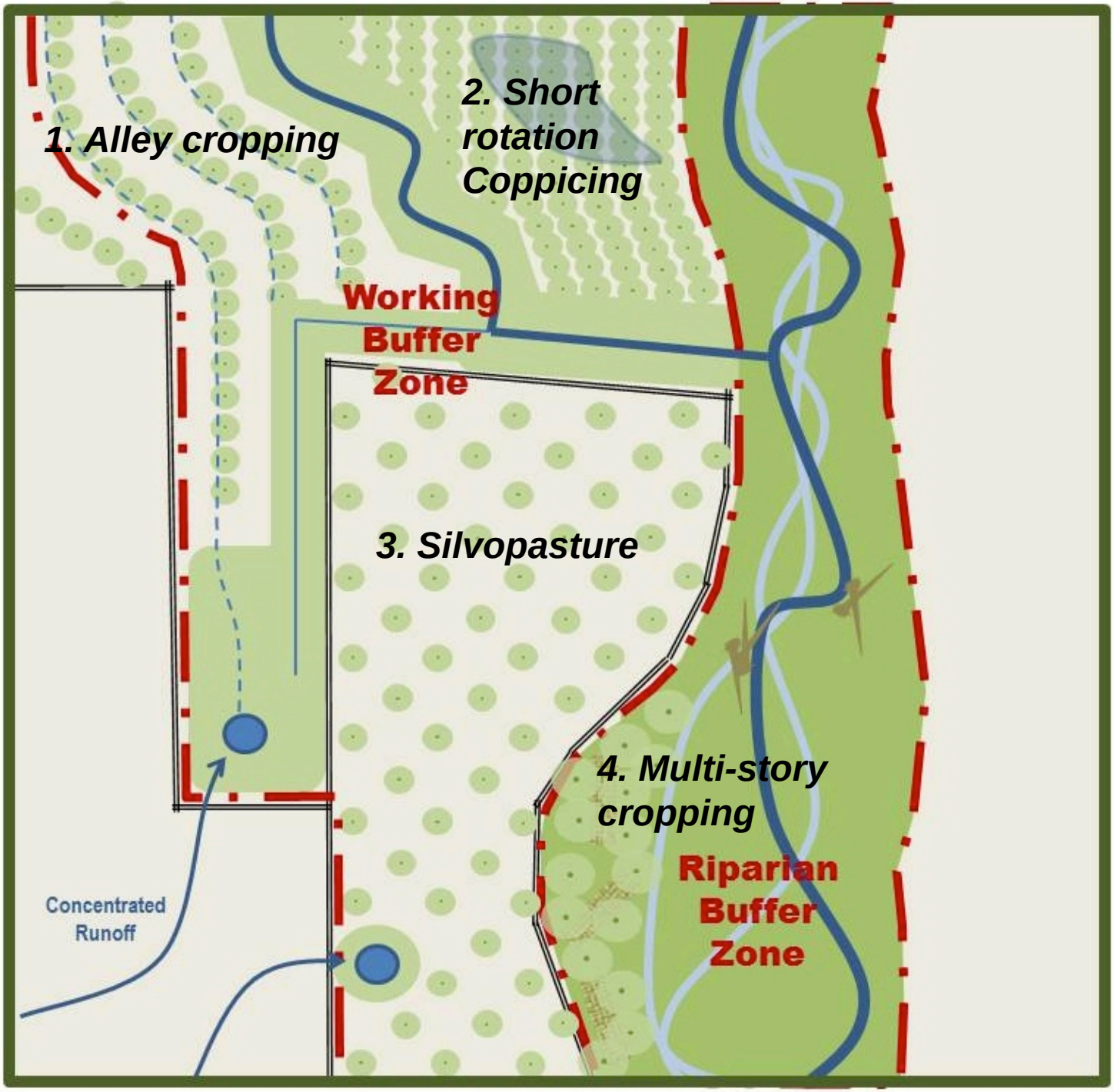
- Optimized Habitat
- Water quality improvements
- Natural Ecosystem processes
- Erosion mitigation enhanced
- Grassed waterway

Cons:

- Unmanaged concentrated flows
- Enhanced nutrient cycling through leaf senescence
- unma
- Remo service

Provisioning Totals	Natural Resource Totals
0.00	4.89


461820 m2


1. Alley cropping
2. Short rotation Coppicing
Working Buffer Zone
3. Silvopasture
4. Multi-story cropping
Riparian Buffer Zone
Concentrated Runoff

Thank You!

Erik Hagan

erik.hagan@psu.edu