



Development of Suitable Herbaceous Retention Levels for Wildlife on Livestock Allotments, West Zone, Bridger-Teton NF

by: Don DeLong, Wildlife Biologist

June 9, 2020

Outline

Concepts & Principles

Suitable Retention Level

Forest Plan Direction

What Question Needs to be Answered?

Basis of a Minimum 70% Herb Retention

- A. By Specific Species & Species Group
- B. Deconstruction of Habitat and Survival Elements

Conclusion

Presentations

— on the Basis of 70% Retention for Wildlife —

Powerpoint (**Wildlife as a Whole**) Presented to:

- 2009 — Wyo. Chapter, The Wildlife Society
- 2010 — RO, Wildlife & Range Programs (BTNF Bios. on conf. call)
→ this followed an overview conference call in 2009
- 2011 — IDT for cattle allotments, Greys River RD
- 2011 — Alma Winward (retired Regional Veg. Ecologist)
- 2011 — BTNF and WGFD Biologists, at SO
- 2011 — Mike Smith, University of Wyoming
- 2011 — 18 Greys River RD permittees & Mike Smith, UW
- 2012 — BTNF Rangers

Review of Report (**Sensitive Amphibians**):

- 2013-2014 — UW-WNDD, WGFD, ERG (pvt.), Sublette Co., RO and BTNF personnel

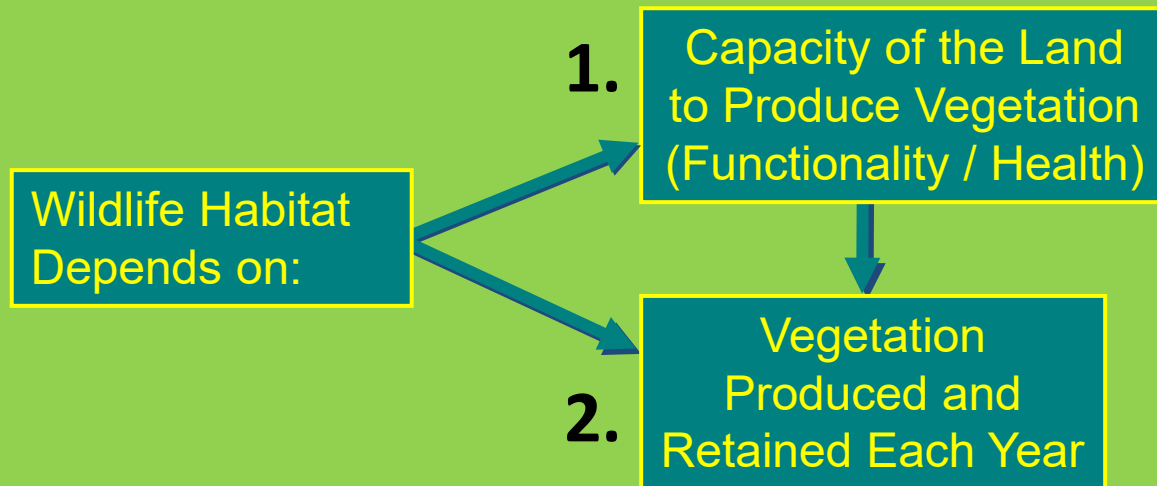
Powerpoint (**Sensitive Amphibians**):

- 2014 — SO, RO, Forest Supervisor, BTNF Rangers, etc.

Concepts & Principles

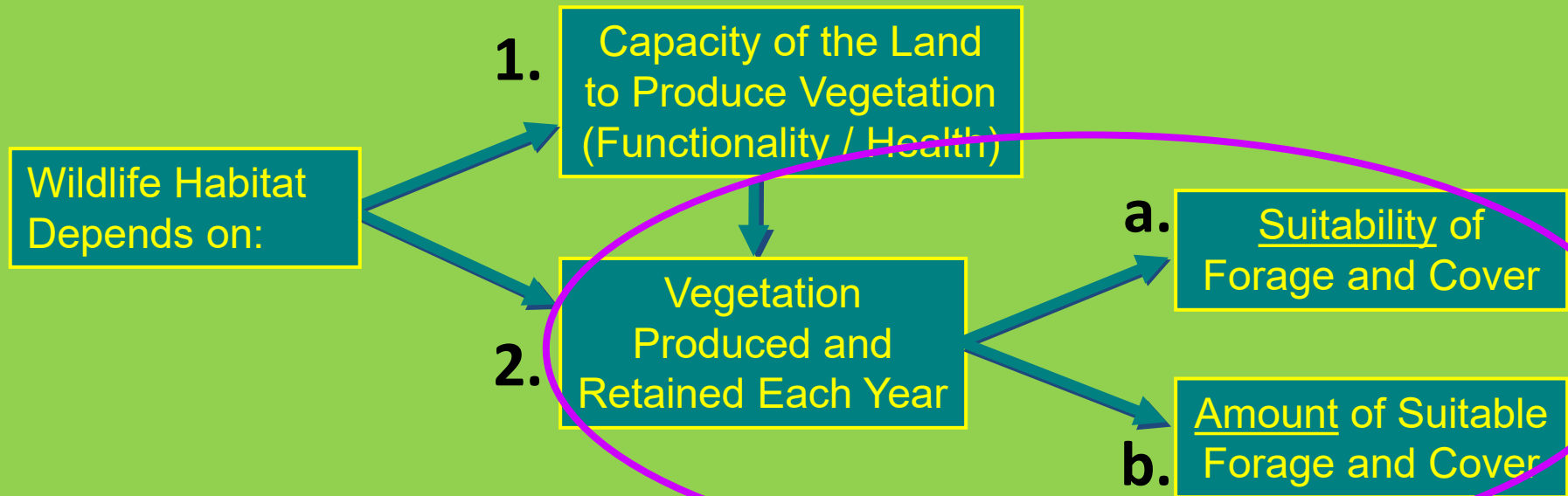
Two Basic Elements of Habitat

Wildlife Requires Habitat, and...



Two Basic Elements of Habitat

Wildlife Requires Habitat, and...



What Wildlife Responds to

In Herbaceous Communities:



Herbaceous vegetation
IS habitat or a major part



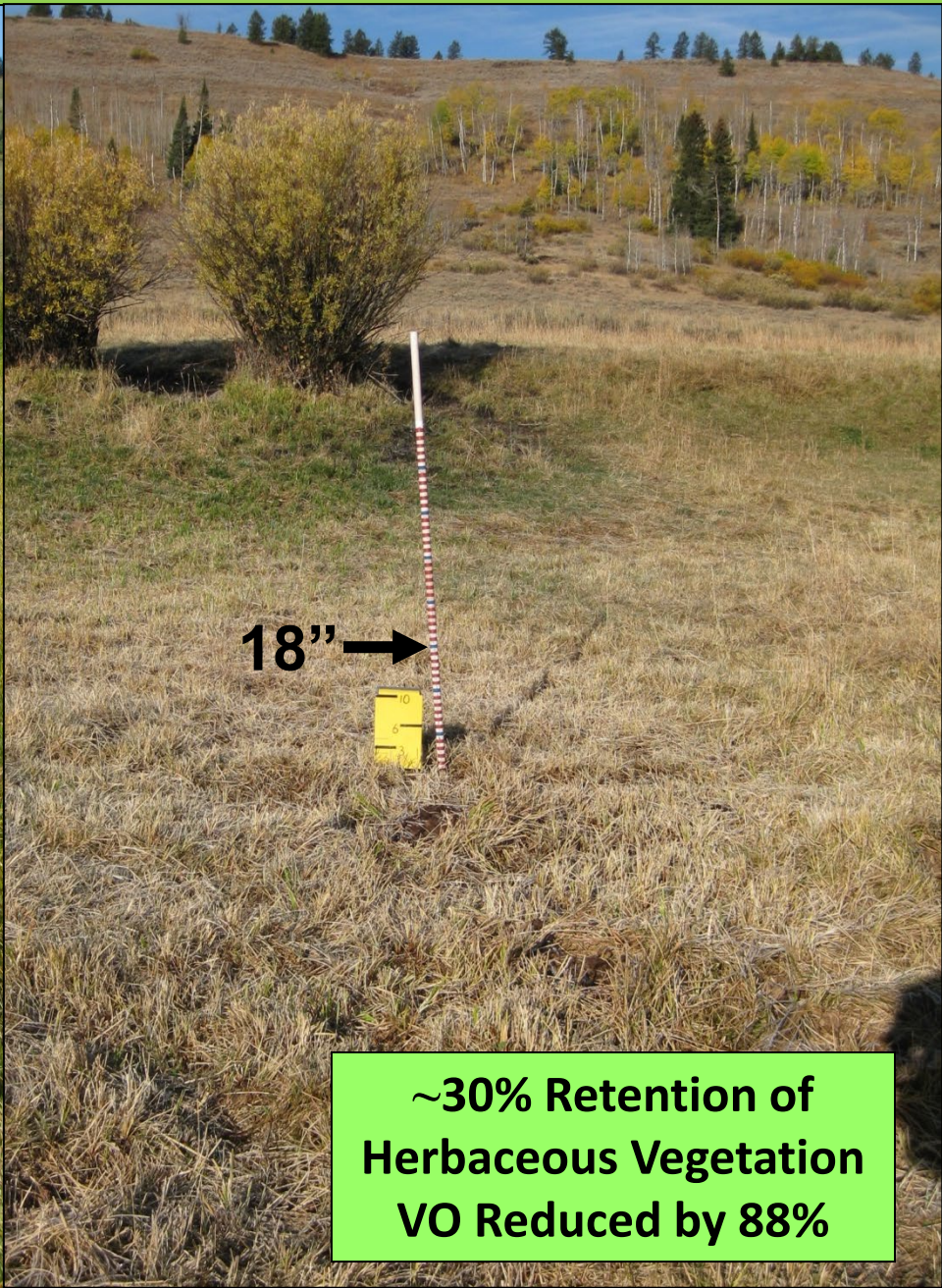
And... Herbaceous
vegetation
is livestock
forage



Plant Species Comp. is Satisfactory, and
Habitat is Suitable for Dependent Wildlife

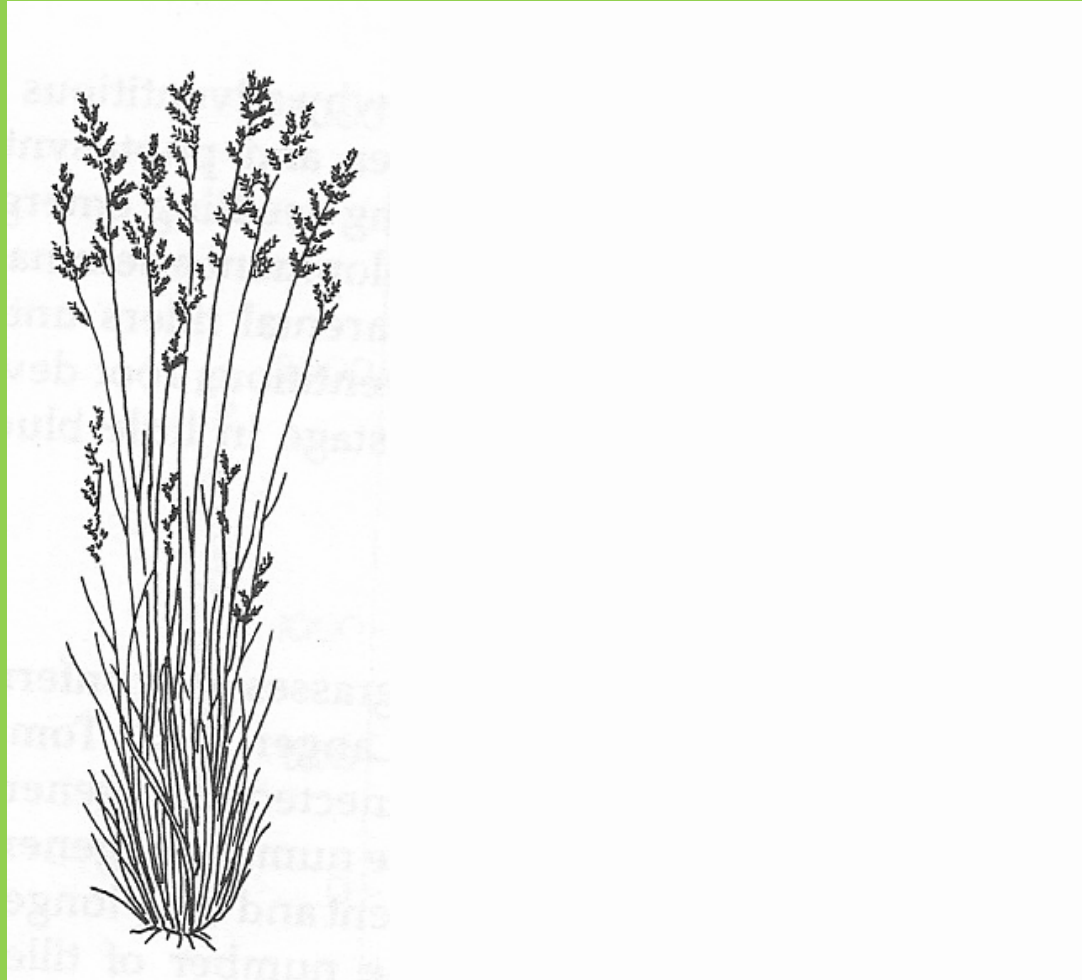


Plant Species Comp. is Satisfactory, but
Habitat is **NOT** Suitable for Dependent Wildlife

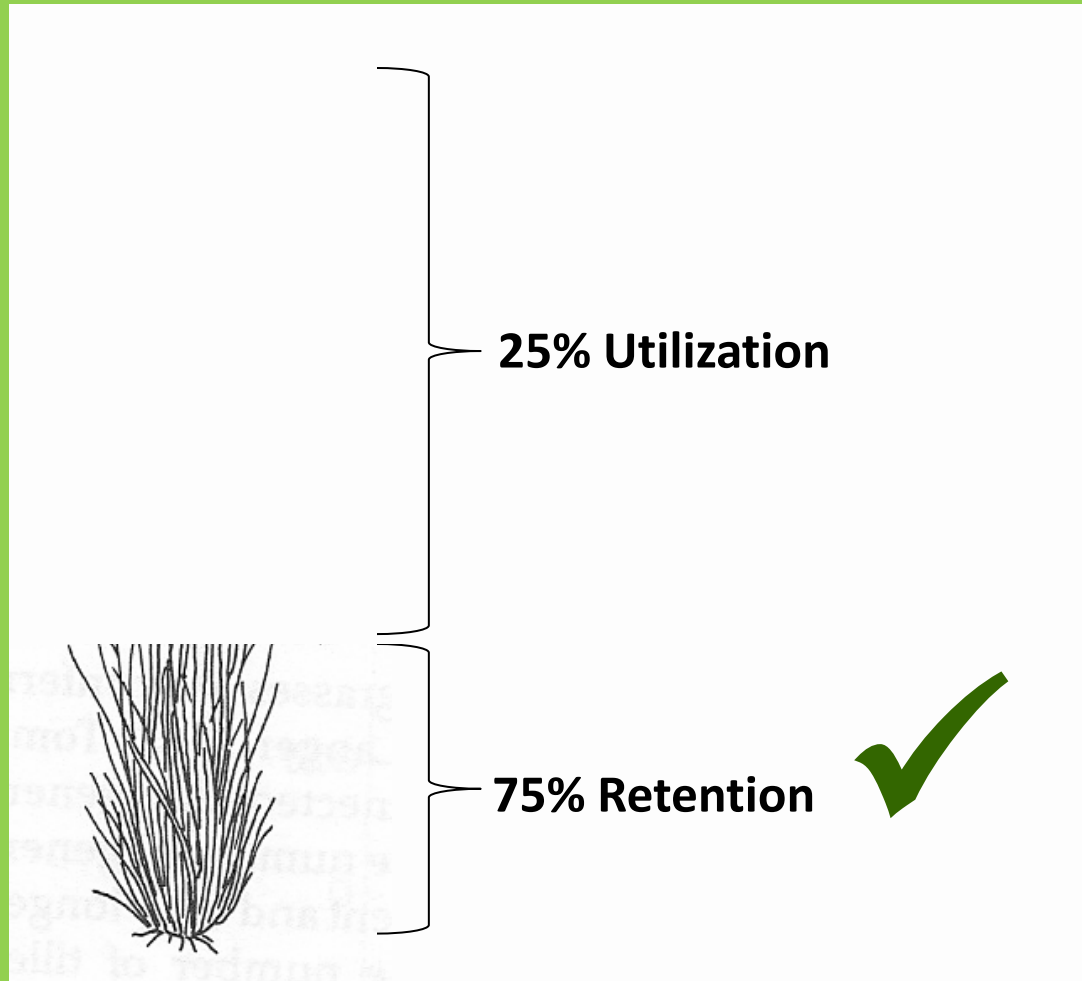


~30% Retention of
Herbaceous Vegetation
VO Reduced by 88%

Retention vs. Utilization



Retention vs. Utilization



Plant Height vs. Plant Weight



Note: the lowest 10% of height contributes little or nothing to cover for many species, but it constitutes substantial weight.

How Plants are Grazed

From the *Wyoming Rangeland Monitoring Guide* (BLM et al. 2008):

UTILIZATION. The available forage consumed or trampled through grazing or browsing. Usually expressed as a percent. See the photo guides below (from McKinney, 1997. *Rangelands* 19(3):4-7).

Photo guide for "even" utilization.

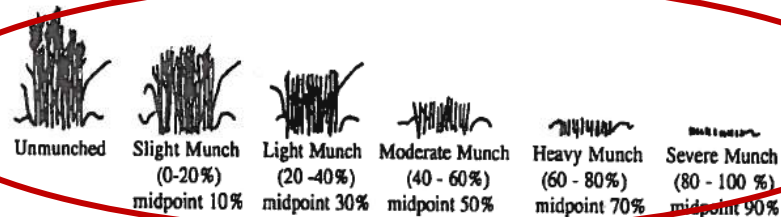
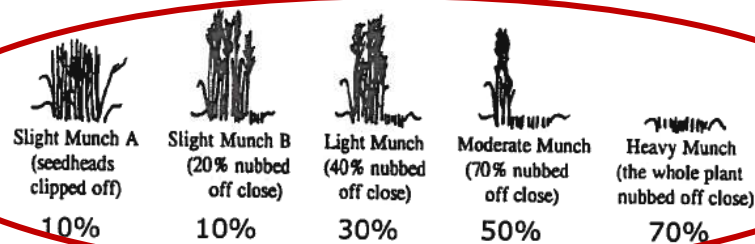


Photo guide for "uneven" utilization



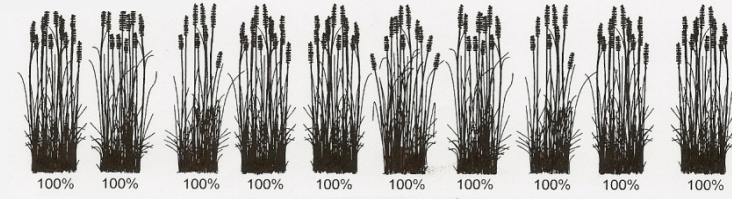
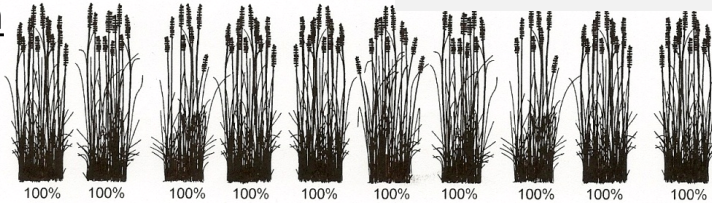
VIGOR. The relative robustness of a plant in comparison to other individuals of the same species. It is reflected primarily by the size of a plant and its parts in relation to its age and the environment in which it is growing.



How Plants are Grazed

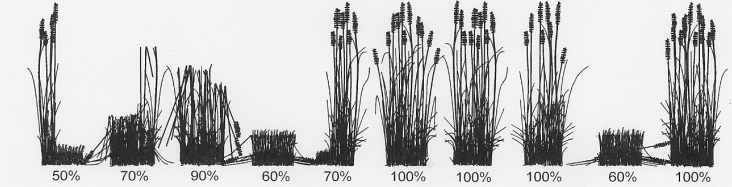
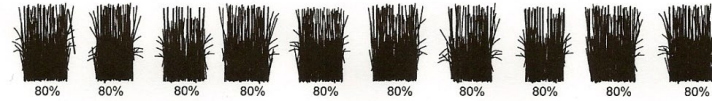
Retention

100%

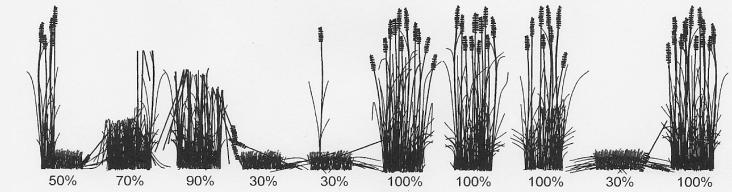
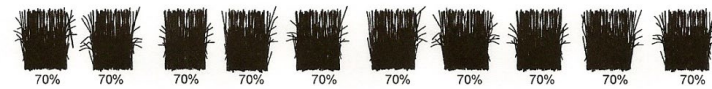


90%

80%

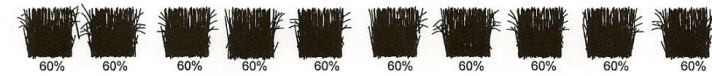


70%

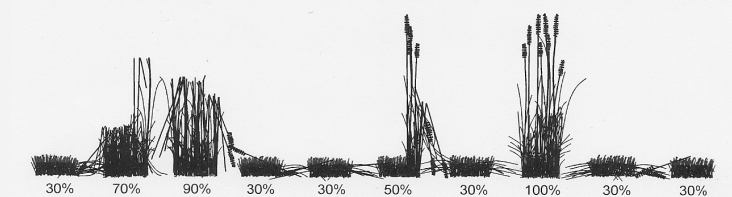
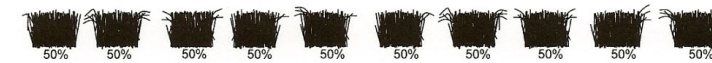


60%

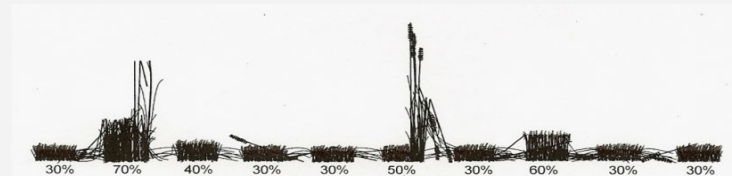
Sedge
Meadows



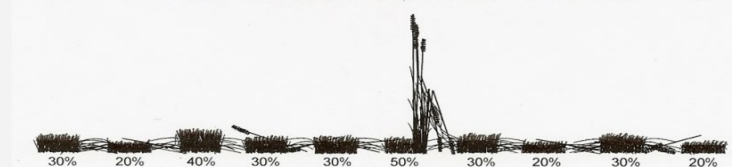
50%



40%



30%

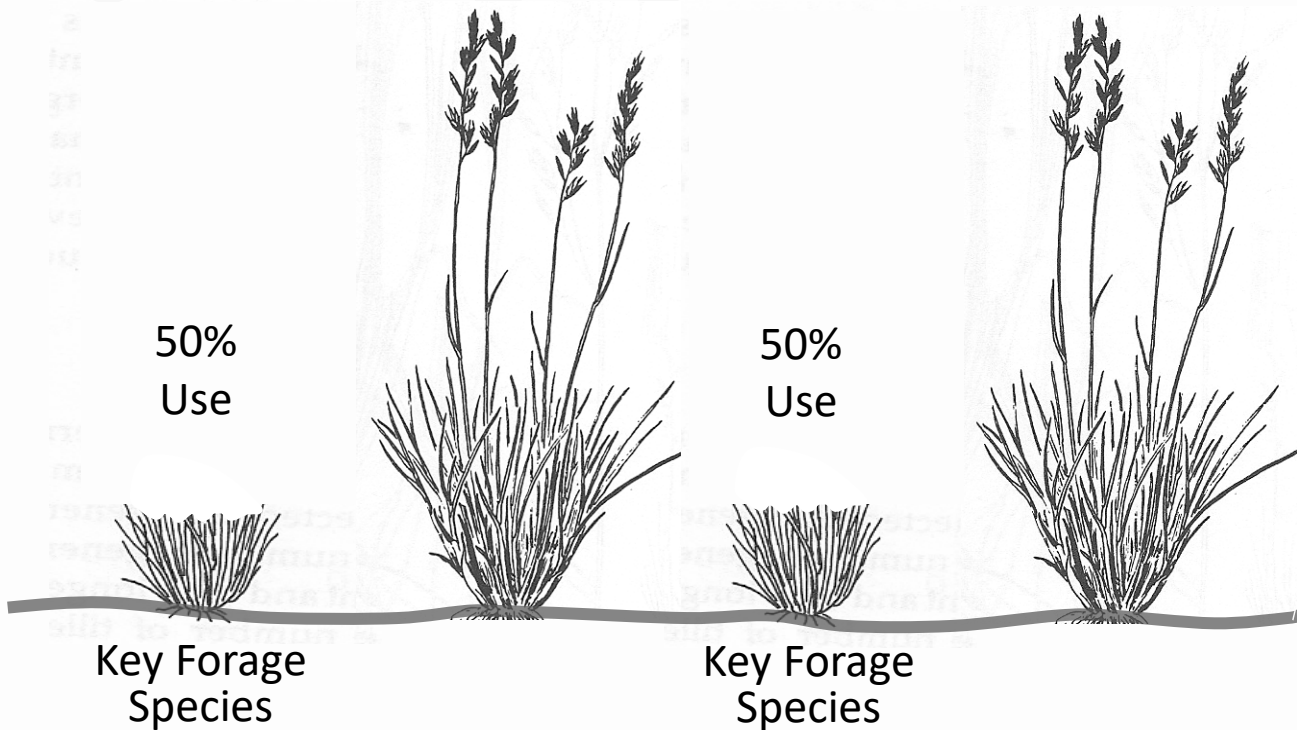


Key Forage Species vs. Total Herbaceous Vegetation

Total Herbaceous Veg. = All grasses, sedges, and forbs in an area **THV**

Key Forage Species = Plant species preferentially eaten by livestock **KFS**

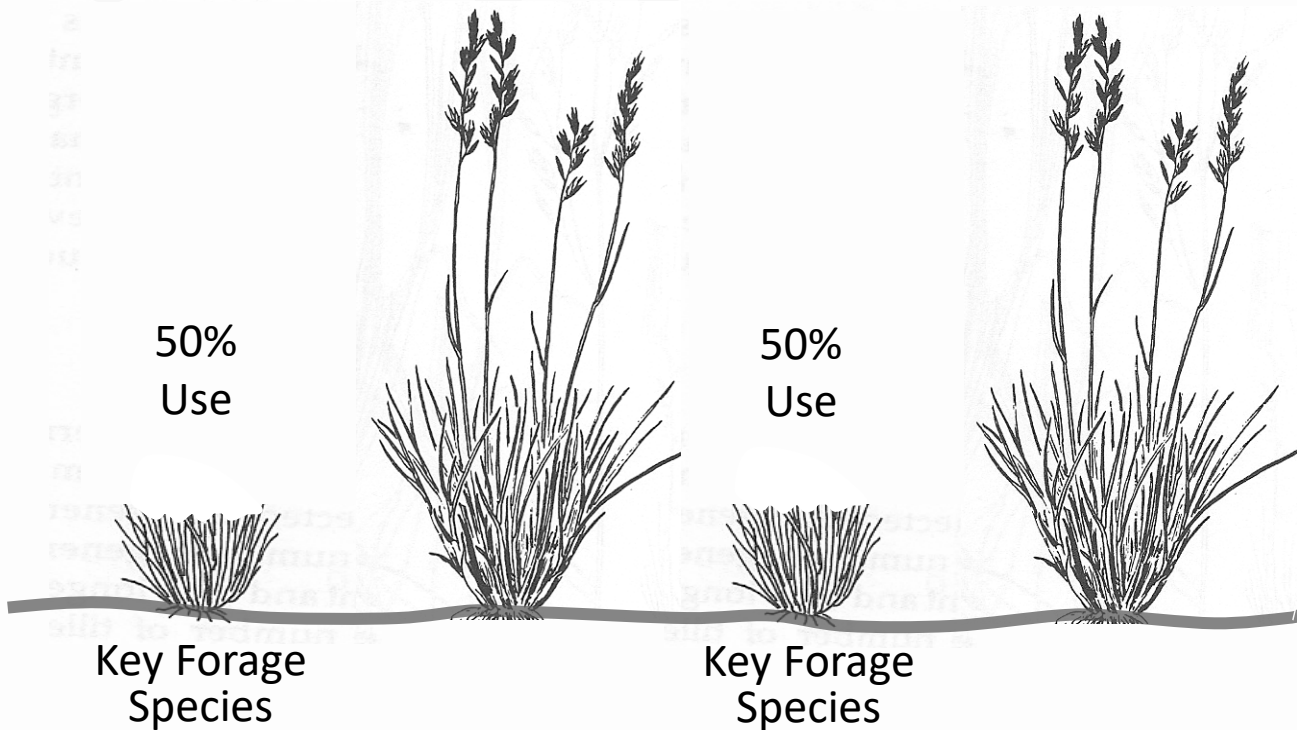
Retention of Key Forage Species vs. Total Herbaceous Vegetation



What is retention of key forage species? 50%

What is retention of total herbaceous vegetation? 75%

Retention of Key Forage Species vs. Total Herbaceous Vegetation



What is retention of key forage species? 50%

What is retention of total herbaceous vegetation? 75%

What is Composition of KFS? 20%



 = Key Forage Spp.
 = Non-Key For. Spp.

What is Composition of KFS? 80%



Total Herbaceous = 54% Retention (44% Use)

Suitable Retention Level

— Upshot & Context —

Suitable Herb Retention for Wildlife on the West Zone:

Retain the following proportions of annual production on $\geq 70\text{-}80\%$ of the acreage of each major veg.-type grouping* in each pasture or equivalent:

$\geq 70\%$ of total herbaceous veg.

$\geq 70\%$ of key forage species (growing season)

$\geq 60\%$ of key forage species (post-growing season).

*

wet meadow, wetland

moist meadow, silver s.b., shrubby cinquefoil

willow, willow-meadow

mtn. big sagebrush, mtn. shrubland, grassland

aspen, open conifer

These assume rangelands & riparian areas are in functioning condition.

Care needs to be taken in cross-walking between total herbaceous veg. and key forage species.

Suitable Herb Retention for Wildlife on the West Zone:

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$\geq 70\%$ of total herbaceous veg.

$\geq 70\%$ of key forage species (growing season)

$\geq 60\%$ of key forage species (post-growing season).

$\geq 75\%$ (or even $\geq 80\%$) may need to be considered where sustaining native wildlife-communities of meadow and silver sagebrush habitat is emphasized.

*

wet meadow, wetland
moist meadow, silver s.b., shrubby cinquefoil
willow, willow-meadow
mtn. big sagebrush, mtn. shrubland, grassland
aspen, open conifer

These assume rangelands & riparian areas are in functioning condition.

Care needs to be taken in cross-walking between total herbaceous veg. and key forage species.

Some Perspective:

JERRY L. HOLECHEK
REX D. PIEPER
CARLTON H. HERBEL



SIXTH EDITION

RANGE MANAGEMENT
PRINCIPLES AND PRACTICES

Contemporary
Range Mgt.

$\leq 40\%$ – post growing season

$\leq 30\%$ – growing season
(Holechek et al. 2008,
Vallentine 1990)

$\leq 50\%$ (“Take-half, Leave-half”)
(Heady and Child 1994, etc.)

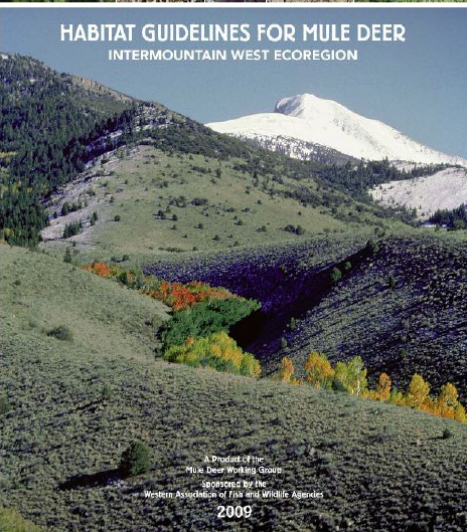
Forest Plan
Forage Utilization Standard

Minimum Suitable
Herb Retention

30% 40% 50% 60% 70% 80% 90% 100%

Utilization of Key Forage Species

HABITAT GUIDELINES FOR MULE DEER
INTERMOUNTAIN WEST ECOREGION



2009

Forest Plan Direction

Forage Utilization Standard:

During AMP revision, ID Team & permittees will prescribe site-specific utilization levels needed to meet Forest Plan objectives.

Site-specific utilization levels on key wildlife ranges will be established by IDT.

Also... “Chapter 90” (FSH) calls for developing allowable-use limits to achieve Forest Plan objectives.

Applicable Forest Plan Objectives:

Objective 2.1(a) — Provide suitable and adequate habitat to support the game and fish populations established by WGFD.

Objective 3.3(a) — Protect sensitive species and provide suitable and adequate habitat to ensure activities do not cause declines in habitat or populations or trends toward federal listing.

Objective 4.7(d) — Retain an adequate amount of suitable forage and cover for wildlife.

Forest Plan Objectives

2.1(a) — Provide *suitable & adequate* habitat for **game and fish** populations.

3.3(a) — Protect **sensitive species** & provide *suitable and adequate amounts* of habitat to ensure that activities do not cause: (1) long-term or further decline in population numbers or habitats supporting these populations; or (2) trends toward federal listing.

4.7(a) — Retain *suitable and adequate amounts* of **wildlife** forage and cover

Migratory Bird Requirements (e.g., EO 13196)

“Protect, restore, and conserve habitat for **migratory birds**, addressing the responsibilities of Executive Order 13186...”

“Pursue opportunities to restore or enhance the composition, structure, and juxtaposition of migratory bird habitat...” to the extent practicable.

Upshot

Retain an **adequate amount** of **suitable** forage and cover for native ungulates, sensitive species, migratory birds, and other wildlife on allotments.

ALSO... Provisions and Guidance of the 2012 Planning Rule

“The Department’s intent is to provide for the diversity of plant and animal communities, and keep common native species common, contribute to the recovery of threatened and endangered species, conserve proposed and candidate species, and maintain species of conservation concern within the plan area. . .”

“Maintaining or restoring ecological conditions similar to those under which native species have evolved therefore offers the best assurance against losses of biological diversity and maintains habitats for the vast majority of species in an area. . .”

These are supported by: *Diamond (1981), Reid and Miller (1989), Keystone (1991), Noss and Cooperider (1994), Hunter (1996), Hughes et al. (2000), Cooperrider (2002), Samways (2005), etc...*



Other Considerations:

- A large number and wide range of birds, small mammals, and invertebrates provide food for TES, MIS, and migratory bird species.
- Invertebrates perform many ecosystem services.
- 2009 and 2010 MOUs identify conservation opportunities for butterflies and pollinators in general.

e.g., the Forest Service shall: “Conserve and manage pollinators and their habitats according to applicable federal law, regulations, and specific direction in Forest Land and Resource Management Plans.”

What Question Needs Answering?

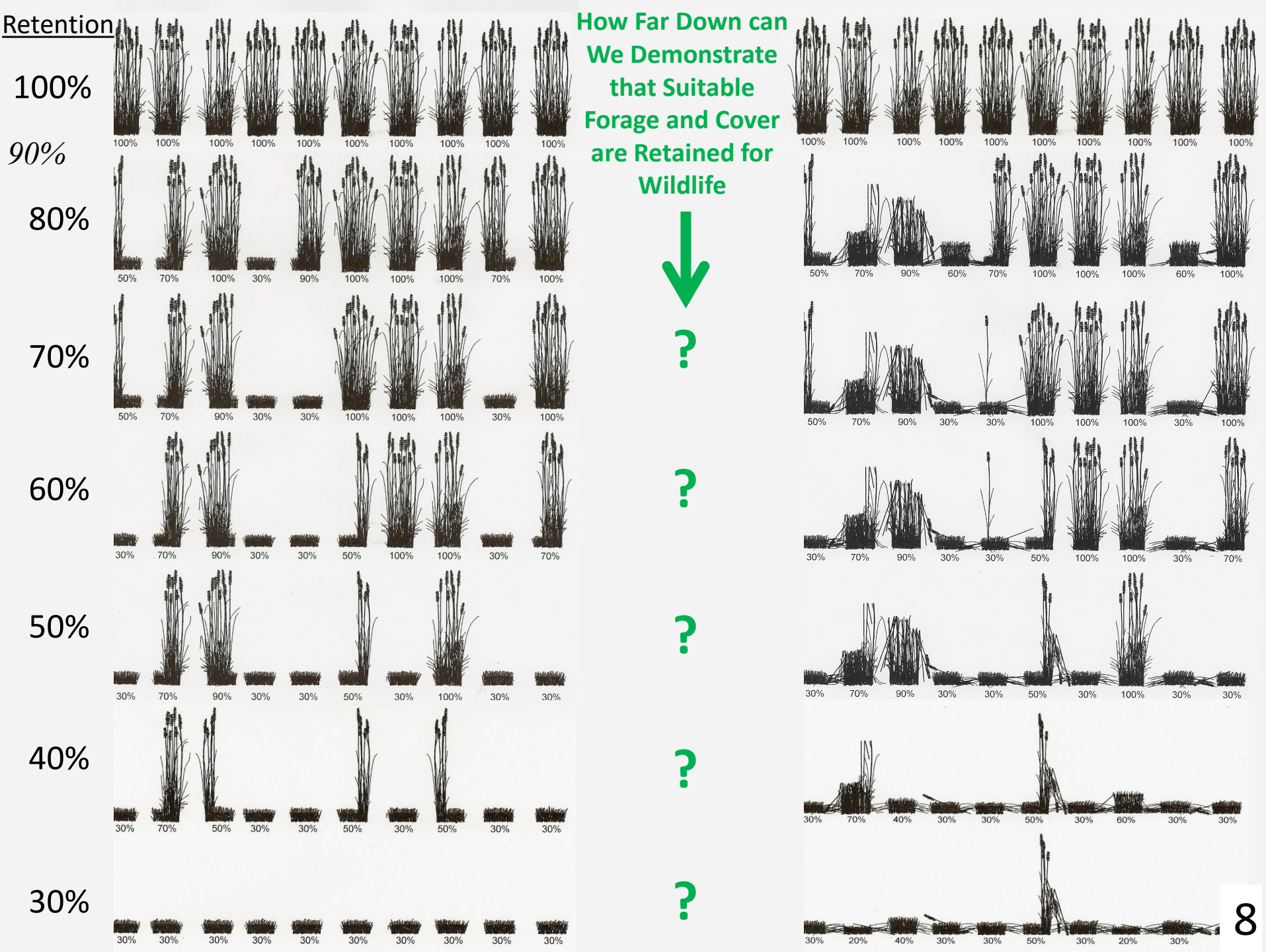
What is the lowest herbaceous retention level that we can still demonstrate provides suitable conditions for wildlife?

Demonstrating that Forest Plan Objectives will be Achieved

- Can we demonstrate **~100% retention** *retains* suitable wildlife forage & cover?
- Can we demonstrate **90% retention** *retains* suitable wildlife forage & cover?
- Can we demonstrate **80% retention** *retains* suitable wildlife forage & cover?
- Can we demonstrate **70% retention** *retains* suitable wildlife forage & cover?
- Can we demonstrate **60% retention** *retains* suitable wildlife forage & cover?
- Can we demonstrate **50% retention** *retains* suitable wildlife forage & cover?
- etc., etc.

As Answer 'Yes'
Progress Downward





Historic Grazing

The BTNF is outside the range regularly visited by large numbers of bison.

All bands of bison appear to have sporadically inhabited wide valley bottoms and adjoining sagebrush slopes.

They may not have made it to the elevation of the BTNF until after June, with visits to mid and upper elevations being progressively later.

Bison tend to avoid wet meadow habitat during summer months.

Haines (1965), Meagher (1973), Van Vuren (1981), Mack and Thompson (1982), Campbell and Hinkes (1983), Van Vuren (1987), Miller et al. (1994), Burkhardt (1996), Steuter and Hidingier (1999), Canon (2001), Van Vuren 2001, Gates et al. (2005), Fuhlendorf et al. (2010)

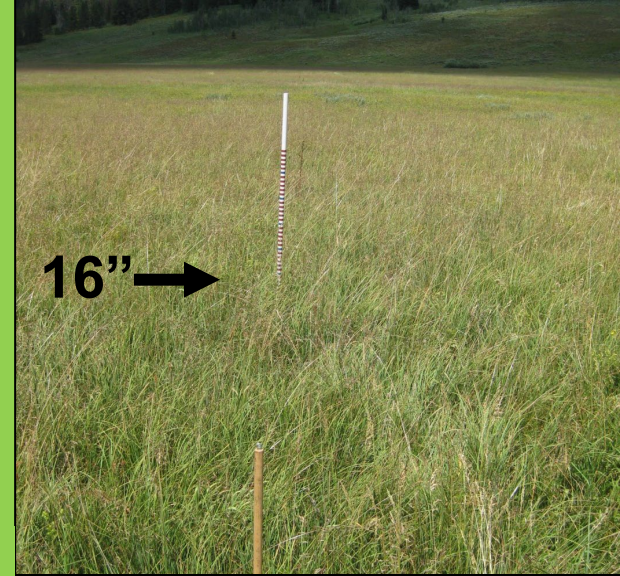
Wet and Moist Meadows, Greys River RD

— June through October —

In most situations, it is difficult to find evidence of grazing before the onset of livestock grazing.

Elk & deer numbers are at or above natural levels.

These are the conditions that likely occurred naturally, except where visited by bison (>June/July).



Basis

— A.1 By Specific Species & Species' Groups —

Elk and Mule Deer -- KFS

Level of Support

Elk

- Near-100% Retention Strong
- $\geq 60\%$ Retention Moderate (*Wisdom & Thomas 1996*)... and Peek (2008)
($\geq 65-75\%$ THV)
- $\geq 50\%$ Retention No more than weak support (*no supporting studies*)

Mule Deer

- Near-100% Retention Strong
- $\geq 60-70\%$ Retention Moderate (*WAFWA 2009*)
- $\geq 50\%$ Retention Weak to no support (*no supporting studies*)

14 Wildlife Biologists from
7 Western States

Migratory Birds

BASIC ECOLOGY

Examples of Birds that Need Diverse and/or Relatively-tall, Dense Herb Veg.

Nesting

Mallards
Green-winged Teal
Northern Harriers
Short-eared Owls
Sandhill Cranes
Soras
Sage Grouse
Savannah Sparrows
W. Meadowlarks
Vesper Sparrows

Feeding – Invertebrates

Brewer's Sparrows
Vesper Sparrows
White-cr. Sparrows
Lincoln's Sparrows

Feeding – Small Mammals

Northern Harriers
Short-eared Owls
Great Gray Owls
Long-eared Owls

Feeding – Seeds

Brewer's Sparrows
Vesper Sparrows
White-cr. Sparrows
Lincoln's Sparrows
Cassin's Finches
Bl-cr. Rosy Finches

Feeding – Nectar

Br-Tld. Hummingbird
Calliope Hummingbird

Living Space

Soras
Savannah Sparrows
W. Meadowlarks
White-cr. Sparrows
Lincoln's Sparrows

Braun et al. (1978), Wheelright and Rising (1993), Gregg et al. (1994), Lanyon (1994), Melvin and Gibbs (1996), Baicich and Harrison (1997), Wyo. Partners in Flight (2003), Wiggins (2004), Slater (2005).

Examples of Birds that Need Short or Sparse Veg.

Nesting

Killdeer

Feeding – Invertebrates

Br-headed Cowbirds
Mountain Bluebird
Killdeer

Brewer's Blackbird
Robin

Feeding – Forbs

Sage Grouse

Specific examples:

>60 studies show that livestock grazing negatively affects waterfowl production.

Kirsch (1969), Braun et al. (1978), Strausman (1987) — Reviews

Predation rates were lower at nests w/ greater concealment in 29 of 36 studies.

Martin (1993) — Review

Sage grouse need herbaceous veg. that is ≥ 7 inches for successful nesting.

Gregg et al. (1994), DeLong et al. (1995), Connelly et al. (2000), Stiver et al. (2010)

However, sage grouse can make greater use of heavily-grazed meadows.

Oakleaf (1971), Klebenow and Burkhardt (1982), Evans (1986).

Goshawks require a diversity of prey items, and one recommendation is to retain $\geq 80\%$ of herbaceous veg. in forest openings.

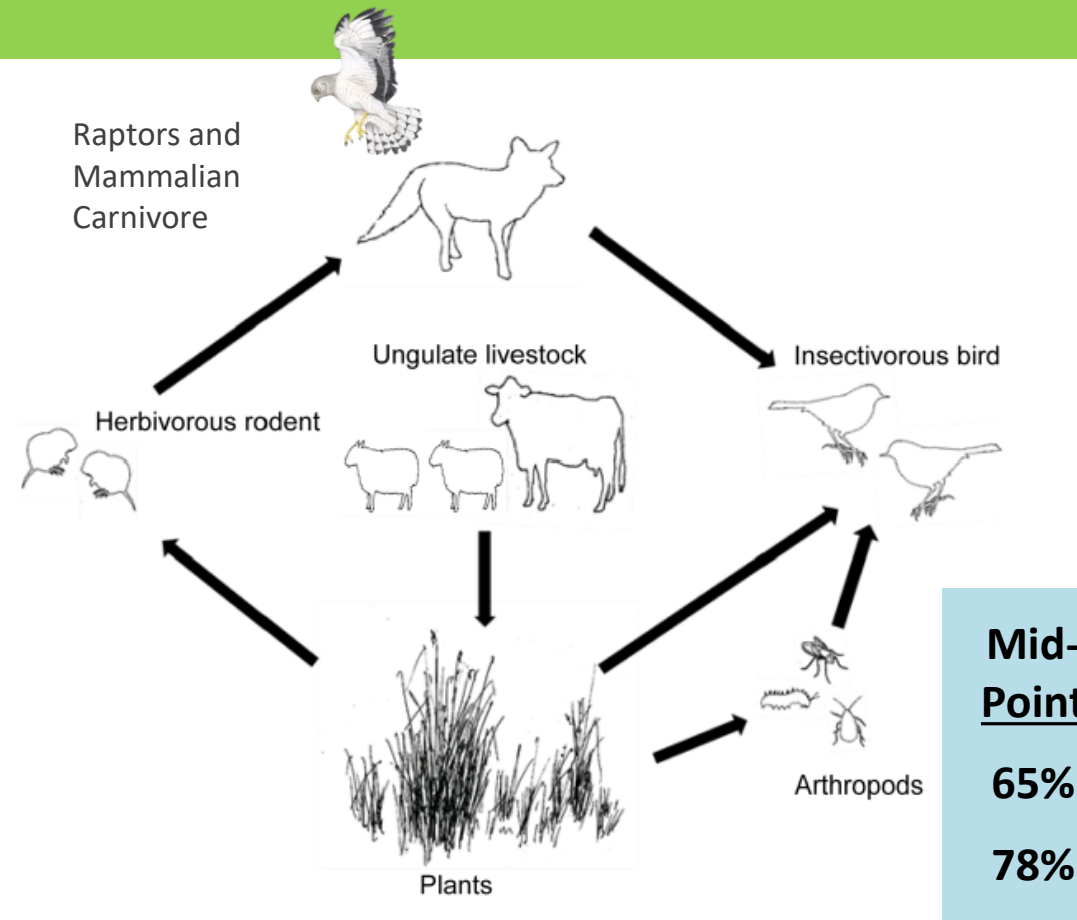
Reynolds et al. (1992)

Norther harriers, short-eared owls, great gray owls, and long-eared owls heavily favor voles, which require tall, dense herb veg.

Duncan and Hayward (1994), Wiggins (2004).

Landscape Level Studies Involving Several Trophic Levels

Effects on herb veg → voles & insects → raptors & foxes



Mid-Point	Effect thresholds (estimated herbaceous retention)
65%	55-75% - Johnson and Horn (2008)
78%	70-85% - Wheeler (2008)
70%	60-80% - Villar et al. (2013)
70%	60-80% - Evans et al. (2015)

USFWS Birds of Conservation Concern

	Trend in Wyo. (1968-2013)	Characterization by <u>Bock et al. 1993</u>	<u>Similarity</u>
Swainson's Hawk	Up	Decr.* (Mixed/Unkn.)	no
Northern Harrier	Down	Decr.	✓
Short-eared Owl	Down	Decr.	✓
Long-billed Curlew	Up	Decr.* (Incr.)	*
Wilson's Phalarope	Down	—	—
Red-naped Sapsucker	Stable	Mixed/Unkn.*	✓*
Broad-tailed Hummingbird	Stable	Mixed/Unkn.*	✓*
Calliope Hummingbird	Down	Decr.	✓
Olive-sided Flycatcher	Down	—	—
Willow Flycatcher	Down	Decr.	✓
Ovenbird	Up	—	—
MacGillivray's Warbler	Down	Decr.	✓
Wilson's Warbler	Down	Decr.	✓
Common Yellowthroat	Down	Decr.	✓
Sage Thrasher	Down	Mixed/Unkn.	no
Lazuli Bunting	Down	—	—
Sage Sparrow	Up	Incr.	✓
Vesper Sparrow	Down	Decr.	✓
Cassin's Finch	Down	Decr.	✓
Brown-headed Cowbird	Up	Incr.	✓
13 of 19 Downward Trends		9 of 14 are Decreasers	

... Also, trampling by livestock can reduce nest success by a large degree.

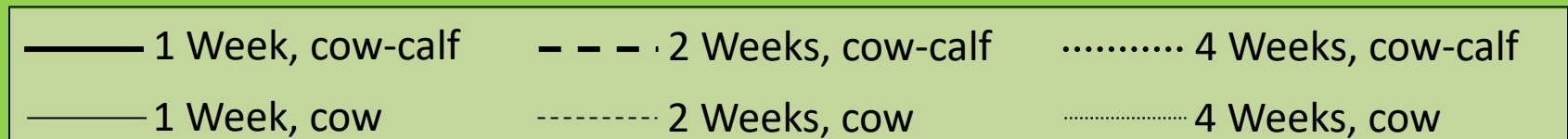
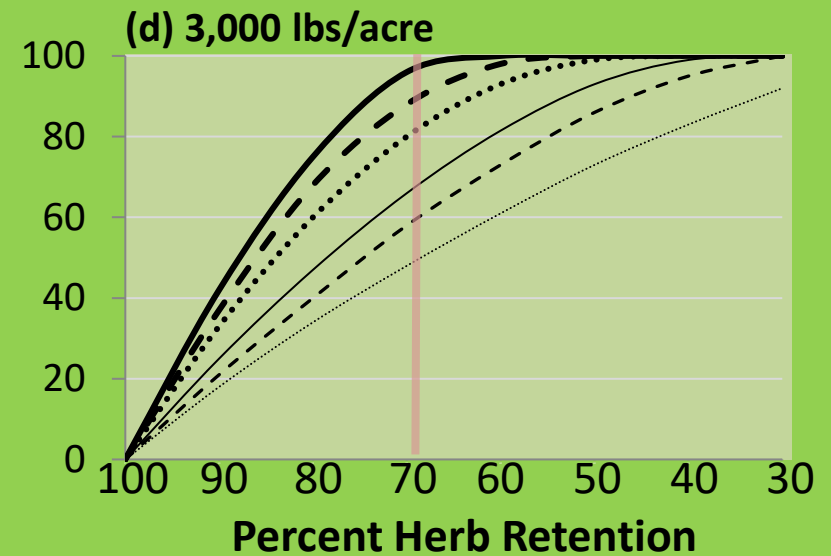
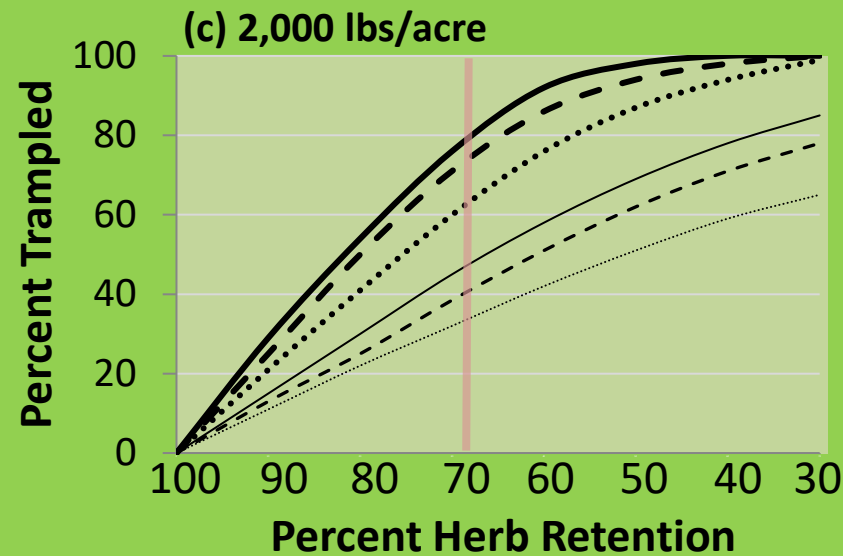
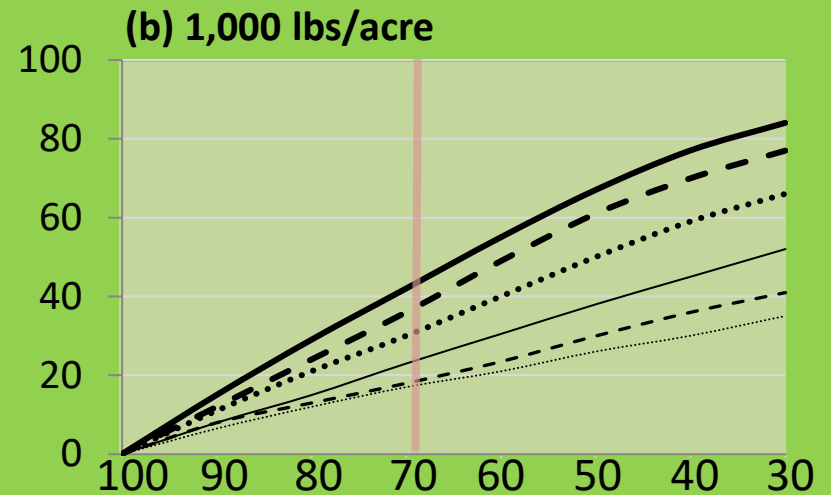
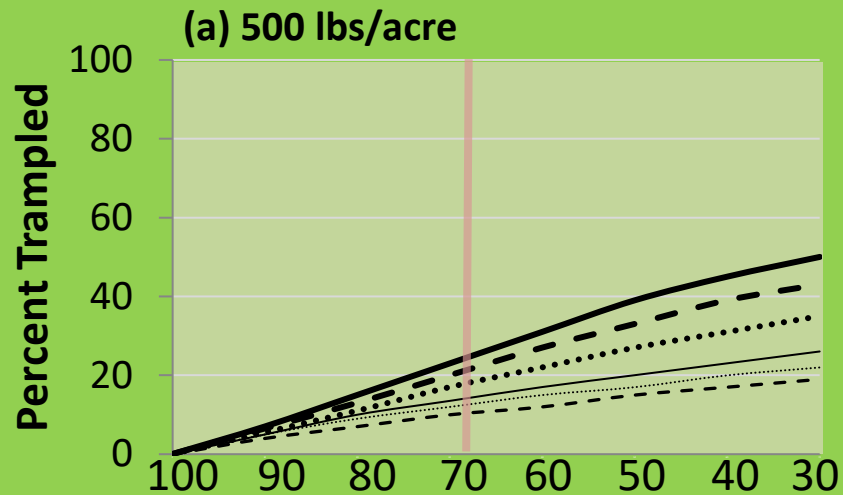
This has been shown in studies of real nests.

*Beintema and Müskens (1987), Green (1988), Rohrbaugh et al. (1999),
Fondell and Ball (2004), Pavel (2004), Schultz (2009), Pakanen et al. (2011),
Beja et al. (2014), Chaiyarat and Eiam-Ampai (2014).*

...And has been shown in studies of artificial nests.

*Koerth et al. (1983), Jensen et al. (1990), Guthery and Bingham (1996),
Paine et al. (1996), Mandema et al. (2013)*

Trampling Rate of Small Stationary Objects by Percent Retention



Small Mammals

Of 17 small mammal species associated with herbaceous and shrub-herb communities:

- 13 favor or are associated with relatively-tall, dense veg.
- 3 favor short and/or sparse veg.
- 1 can thrive in a range of conditions.

Tomich (1982), Zeveloff and Collett (1988), Fagerstone and Ramey (1996), Cerovsky et al. (2004),

Voles are highly important to several raptor and owl species*, as well as to several mammalian predators.

Bailey (1924), Andersson and Erlinge (1977), Baker and Brooks (1991), Grant et al. (1991), Holt and Leasure (1993), Duncan and Hayward (1994), Korpinmaki (1994), MacWhirter and Bildstein (1996), Sulkava and Huhtala (1997), Sundell et al. (2004), Wiggins (2004), Slater (2005).

* Includes sensitive species (great-gray owl) and USFWS birds of conservation concern (short-eared owl, northern harrier, Swainson's hawk)

Small mammals associated with dense herbaceous veg. and moist conditions (e.g., 4 vole species, w. jumping mice, 5 shrew species):

- Need relatively **tall, dense** herbaceous vegetation.
- Are disproportionately impacted by grazing.

Brown (1967)

Getz (1985)

Kie and Loft (1990)

Fagerstone and Ramey (1996)

Klaus and Beauvais (2004)

Burt and Grossenheider (1976)

MacCracken et al. (1985)

Meden and Clary (1990)

Batzli et al. (1999)

Johnston and Anthony (2006)

MacAninch et al. (1978)

Belk et al. (1988)

Edge et al. (1995)

Fisher et al. (2000)

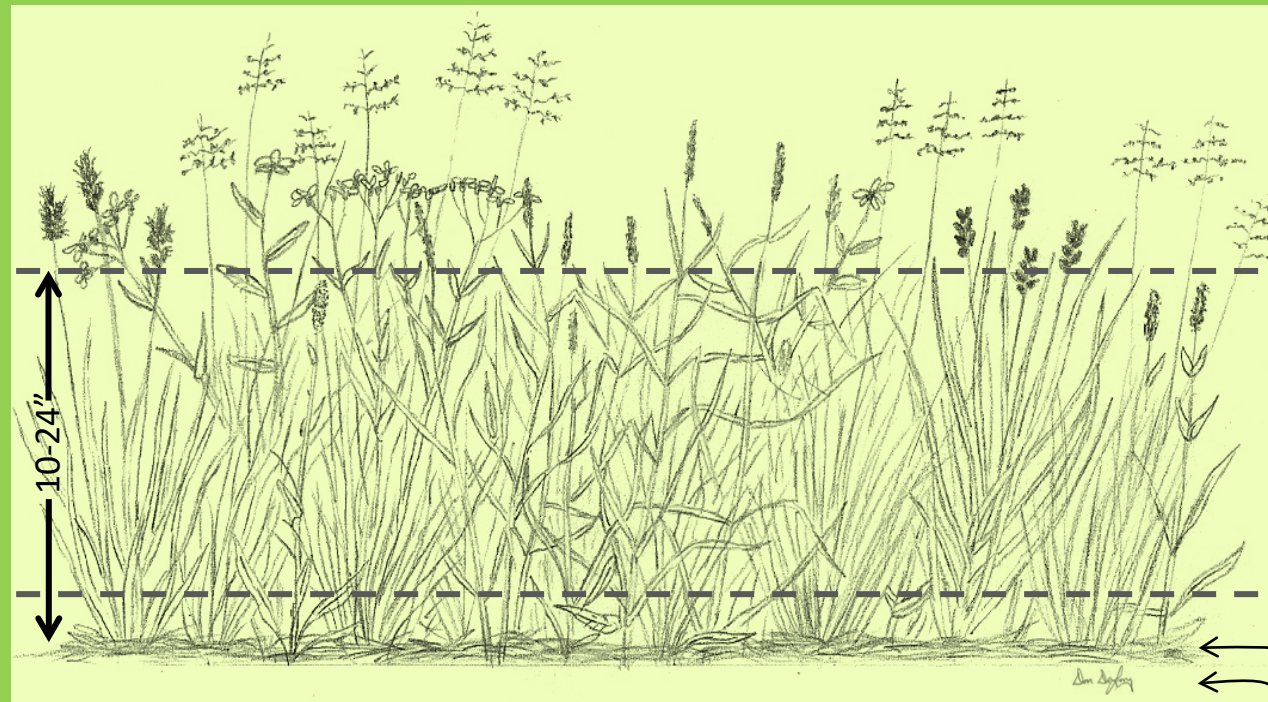
Two species of ground squirrels prefer short veg, and deer mice inhabit a range of conditions.

Fagerstone and Ramey (1996).

Pocket gophers favor meadows and rangelands in health condition.

Fagerstone and Ramey (1996), Batzli et al. (1999), Klaus and Beauvais (2004).

Vertical Biophysical Layers in Meadow Habitat



Upper layers provide forage (leaves, seeds, and invertebrates)...

And drive conditions in the lower layers, including litter layer which is highly important.

Numerous studies (next several slides)

Upper Layer

- Fully exposed to ambient climate
- High light, virtually no shade
- Low Visual Obstruction
- Abundance of Flower and Seed Forage
- Species composition fully realized
- Abundance of Substrate

Middle Layer

- Moderate humidity, little wind
- Somewhat moderated temperatures
- Reduced light, moderate shade
- Moderately high visual obstruction
- Meets behavioral attachment to dense overhead canopy
- High diversity of forage and substrate types
- Abundance of leaf forage and substrate

Lower Layer

- High humidity, moderated temperature
- No wind
- Deep shade, little light
- High visual obstruction
- Some basal leaf forage

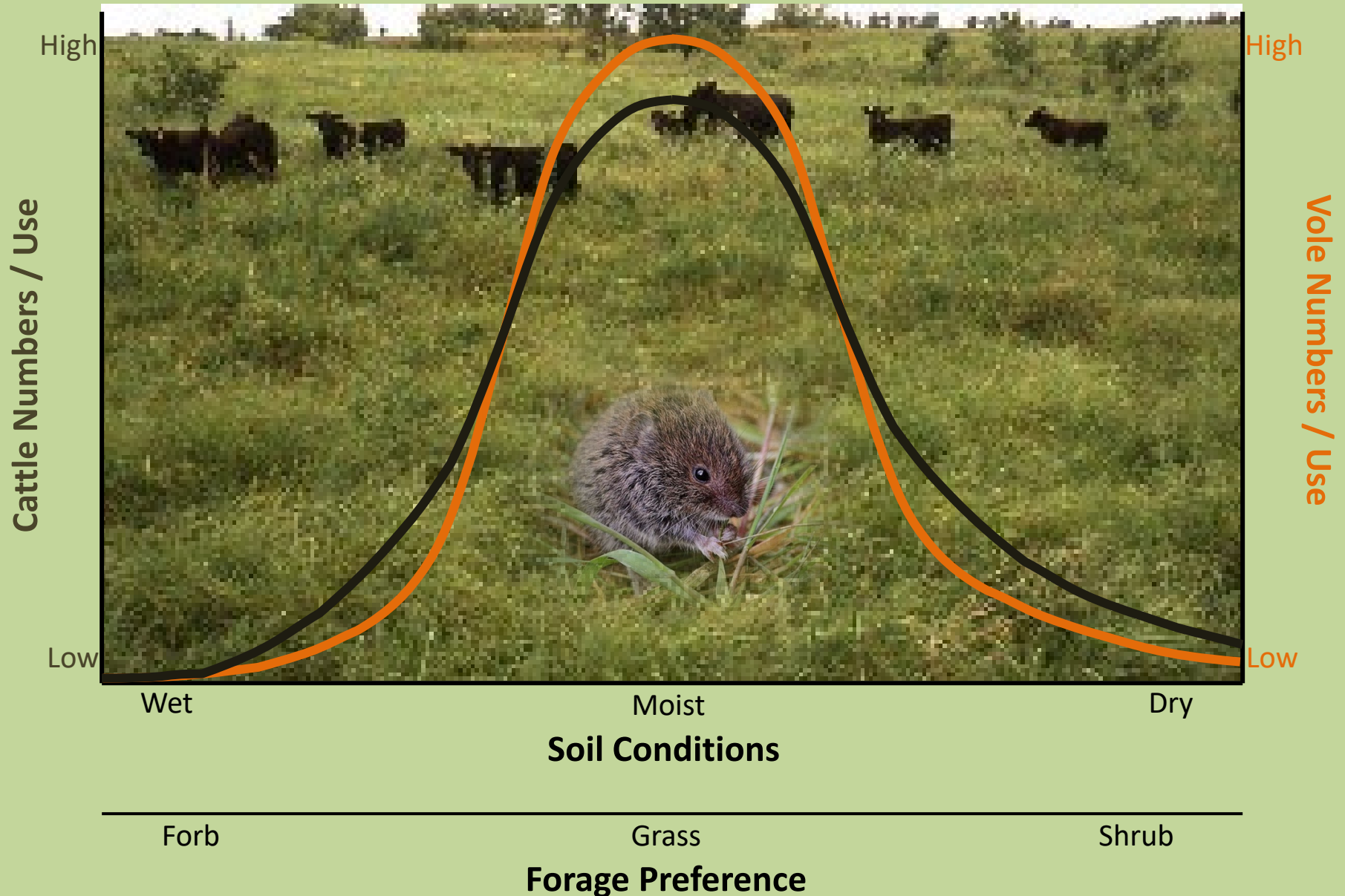
Ground / Litter Layer

- Well developed, e.g., relatively deep
- High moisture retention
- Numerous spaces between plant material

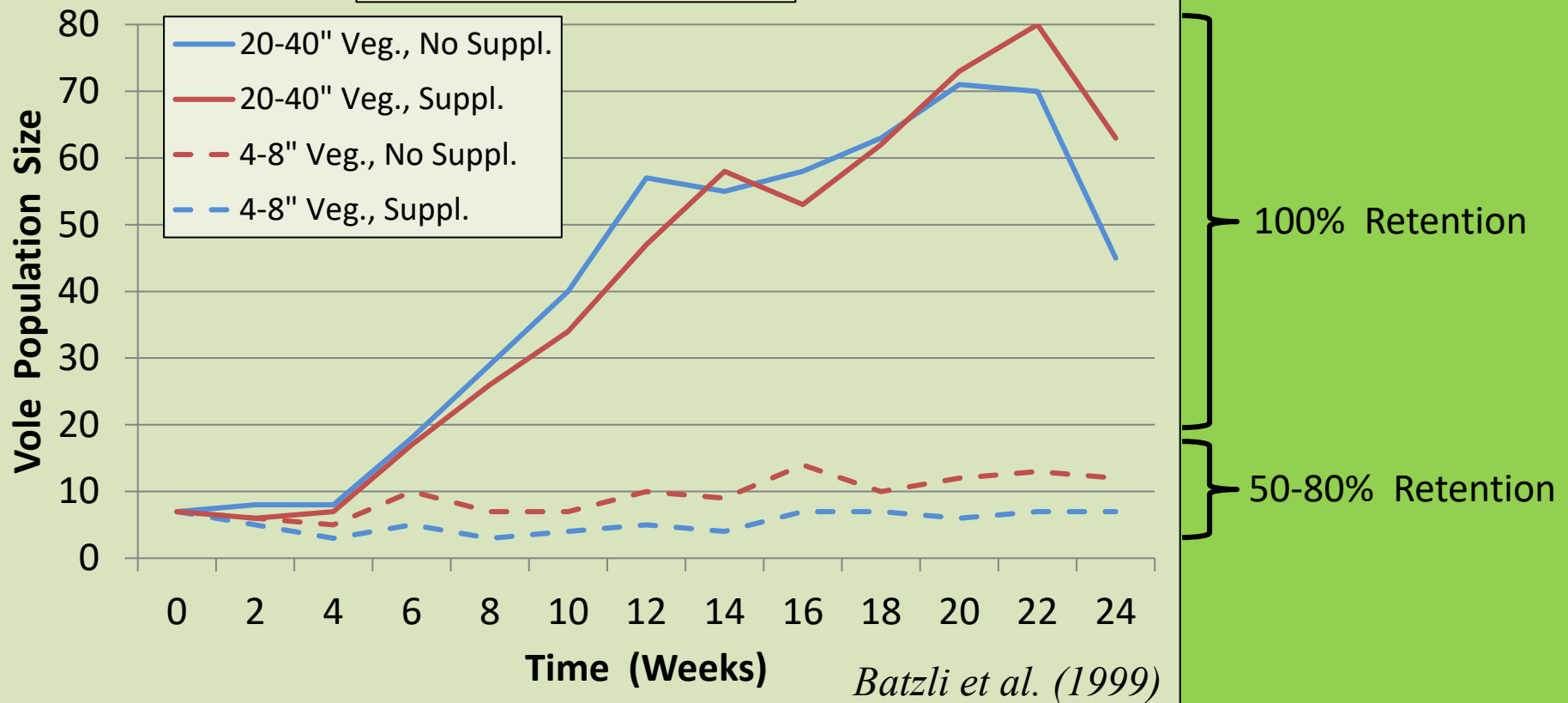
Upper Soil Layer

- High organic content
- Loose soil structure
- High moisture retention
- Temperature moderation

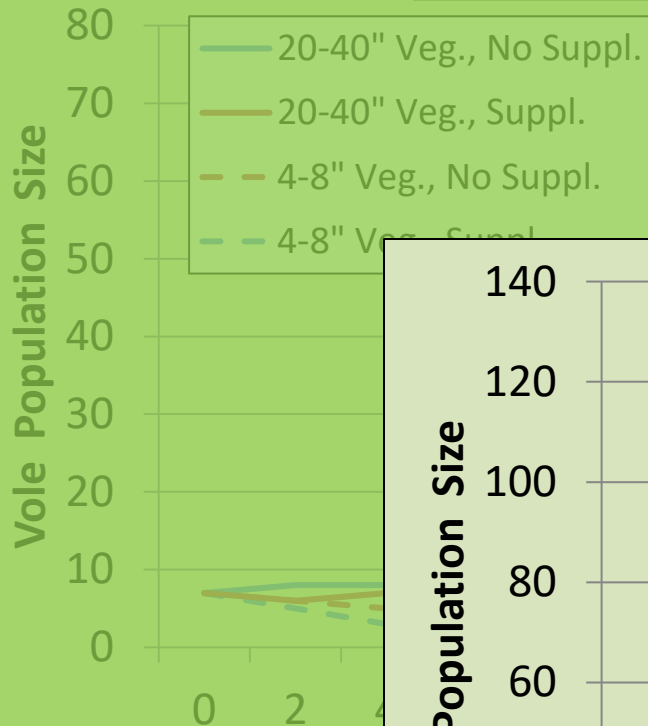
Comparison of Cattle and Vole Preferences



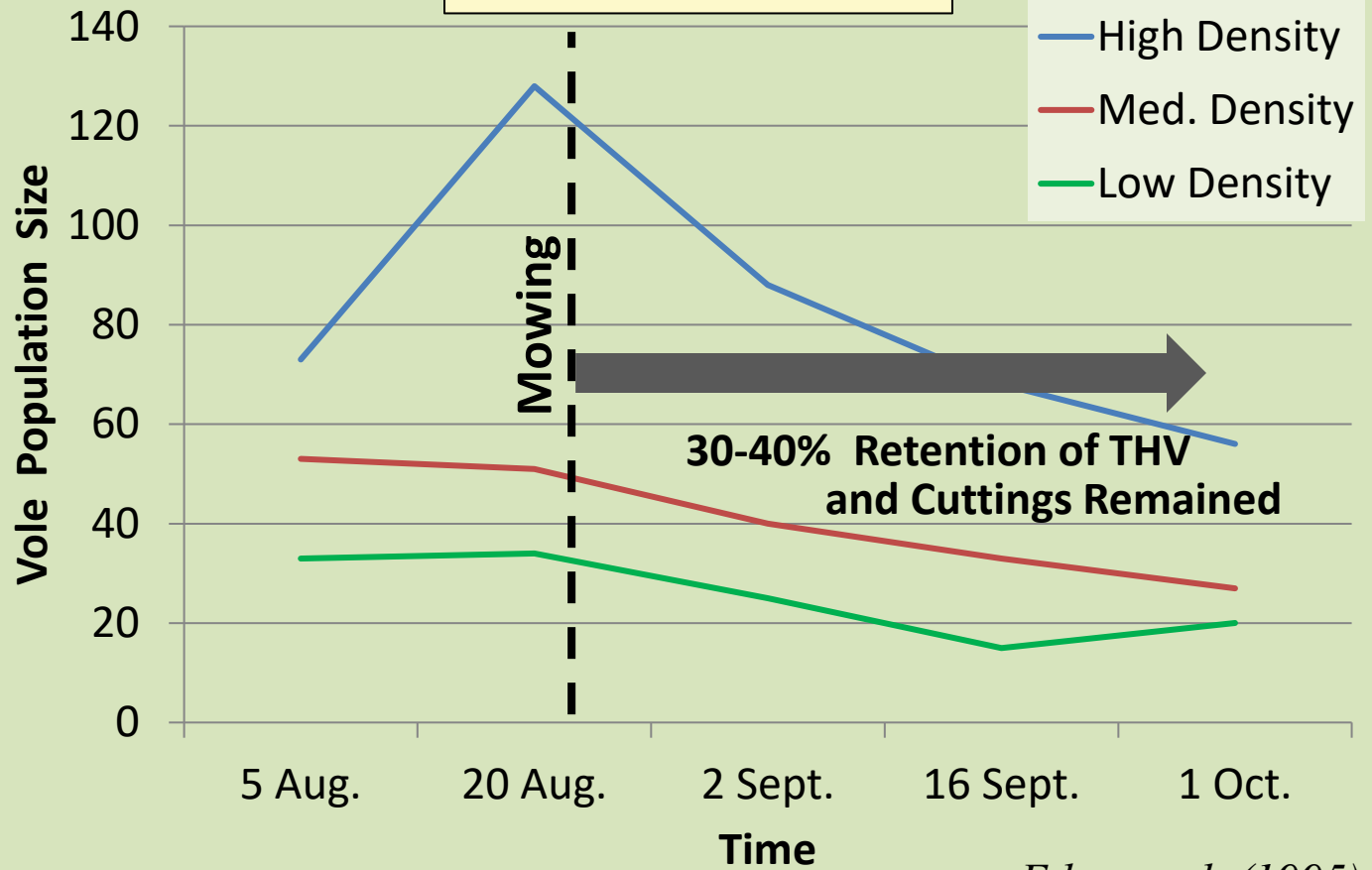
Meadow Voles



Meadow Voles



Long-tailed Voles



Edge et al. (1995)

Prairie Voles

— ungrazed
 - - - grazed

Voles / Acre

60
50
40
30
20
10
0

May Jun Jul Aug Sep Oct

Month

4000

≈100% herb retention

3500

3000

2500

2000

Veg. Pounds / Acre

est. 50-55% herb retention

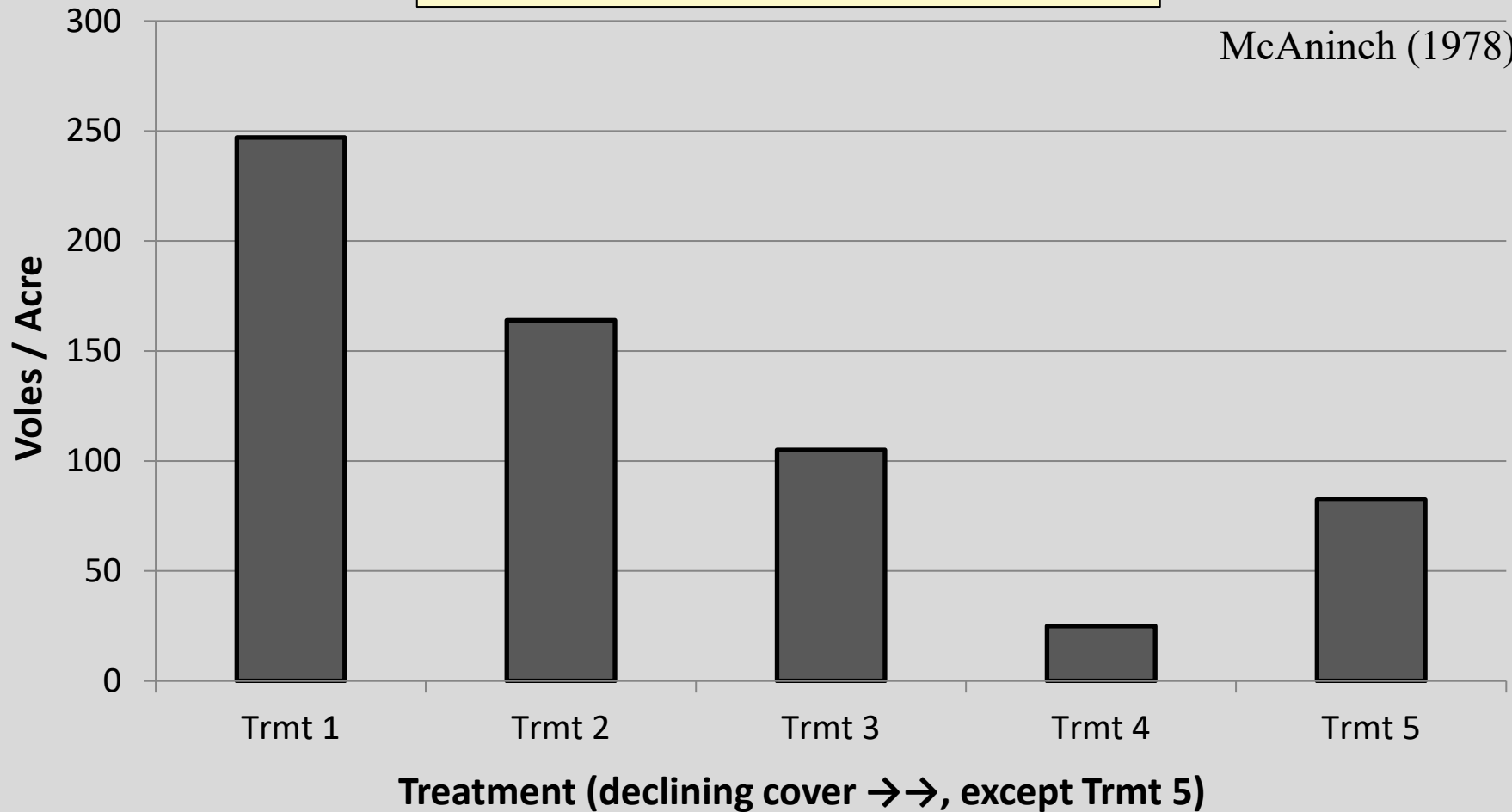
Birney et al. (1995)

Time

Edge et al. (1995)

Meadow, Montane, and Pine Voles

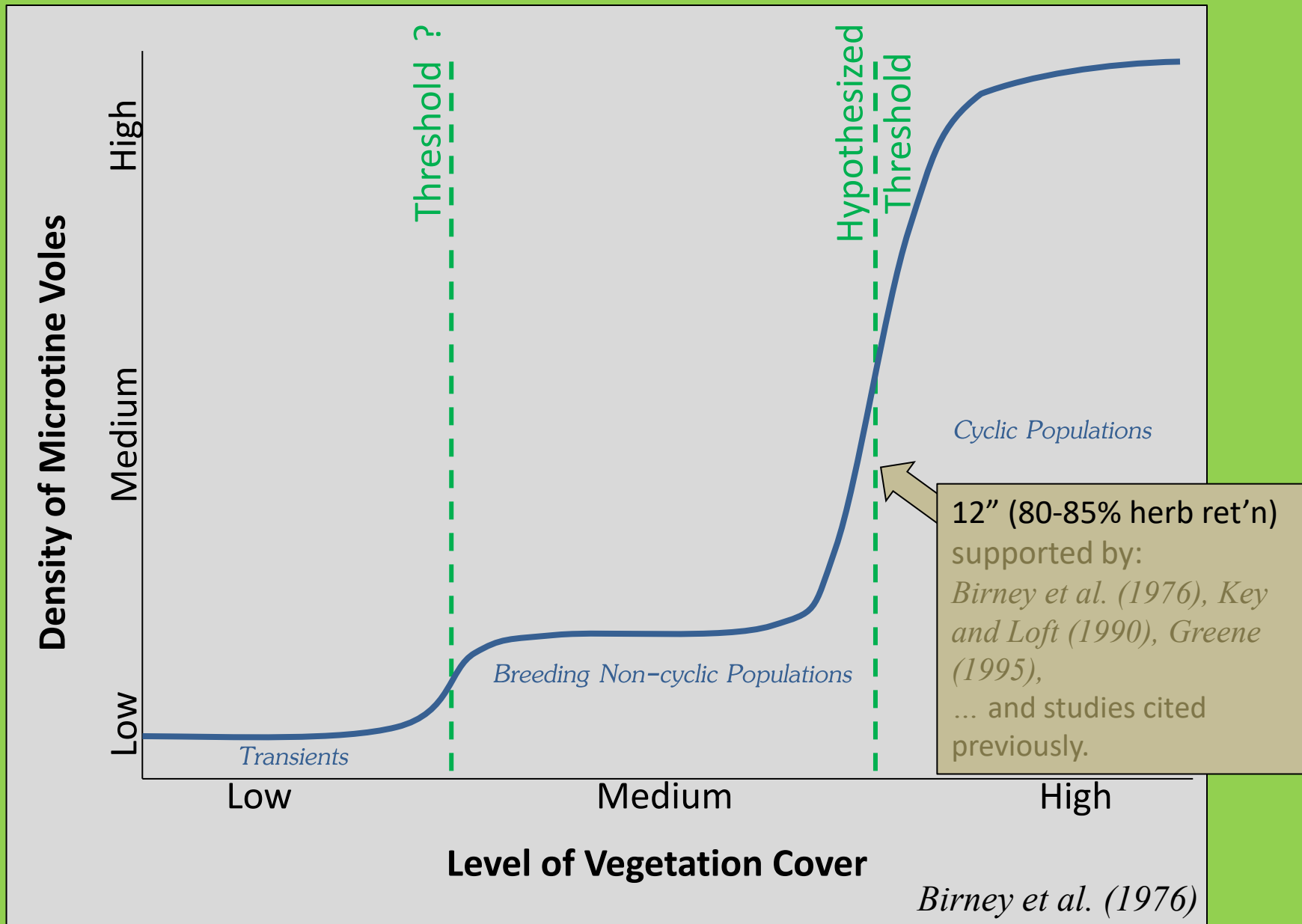
McAninch (1978)



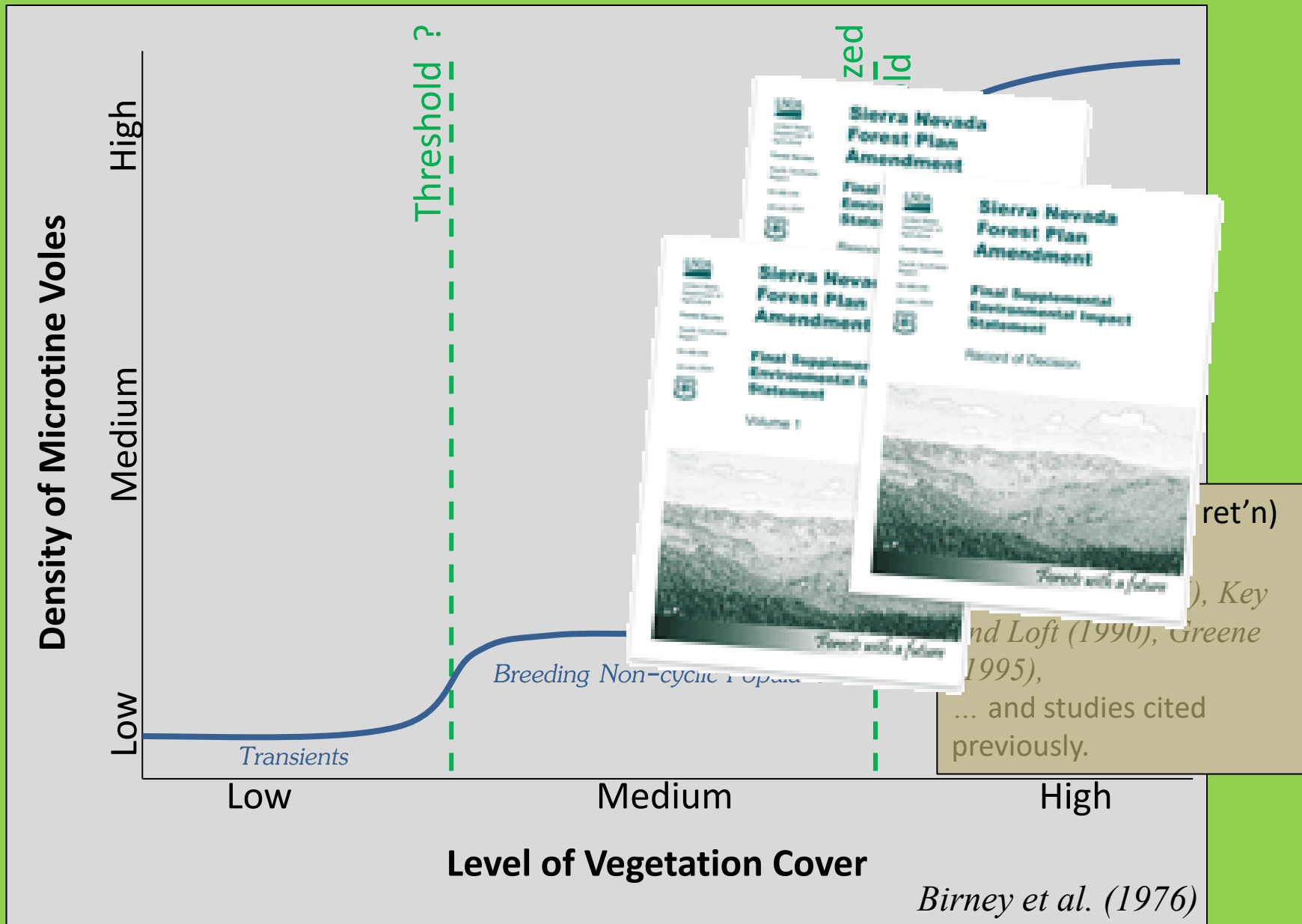
Year 1:	Mowed, Fall	Unmowed	Unmowed	Unmowed	Unmowed
Year 2:	Unmowed	Mowed*, May	Mowed* 2x (June & July)	Mowed/Bailed 2x (June & July)	Unmowed (<u>Sparse</u>)

* Cut vegetation was left on site.

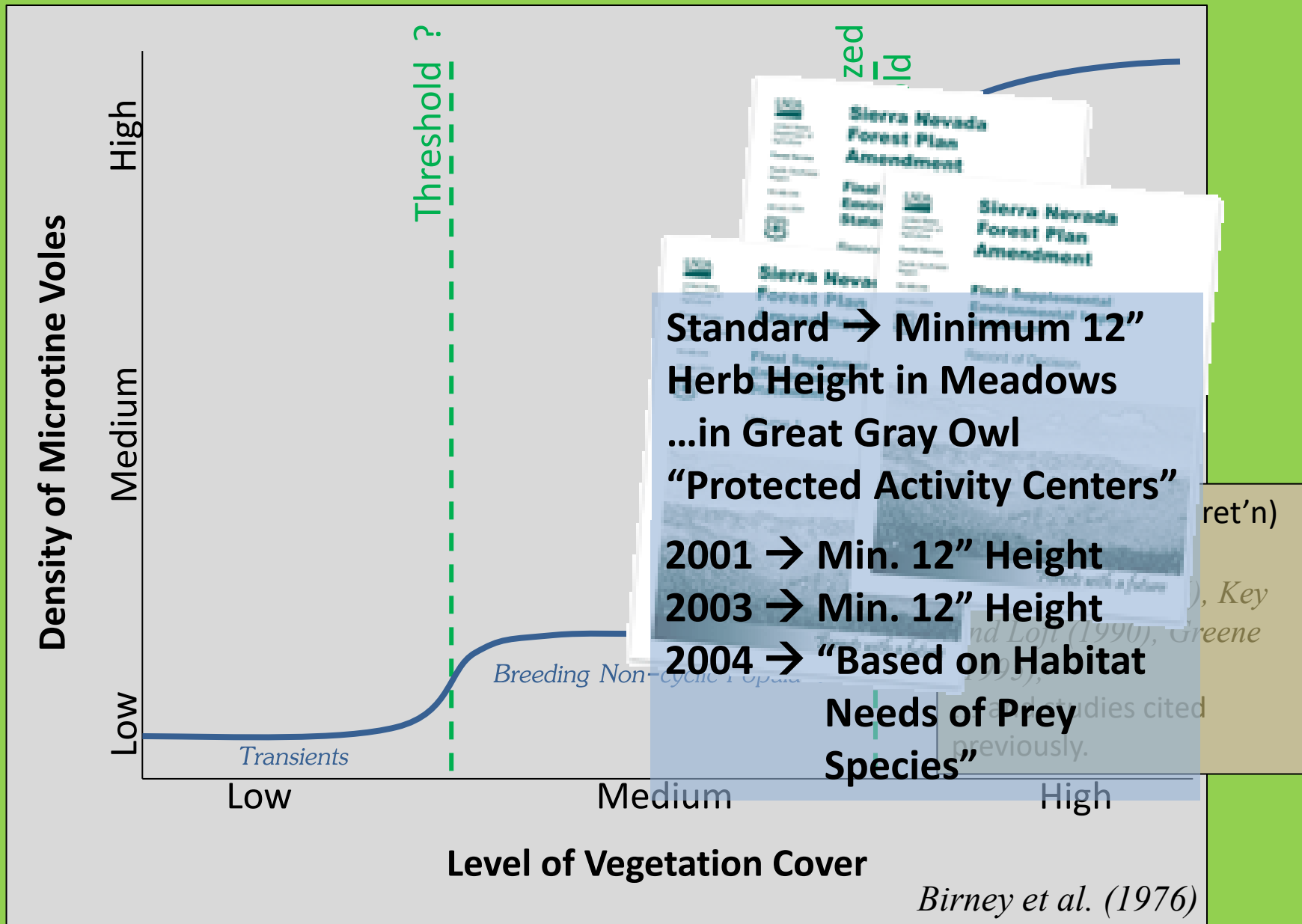
Relationship between Herbaceous Cover and Vole Densities



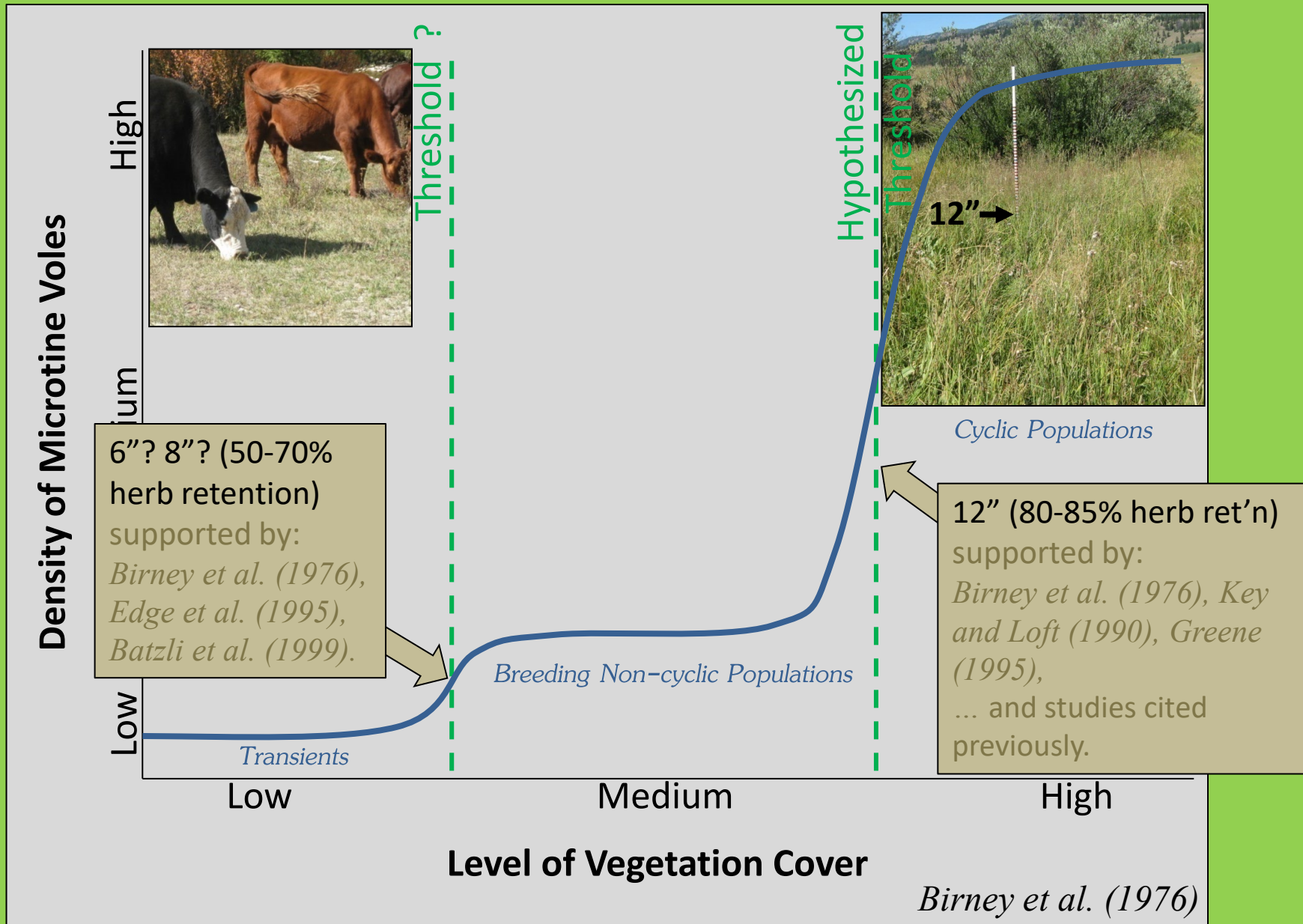
Relationship between Herbaceous Cover and Vole Densities



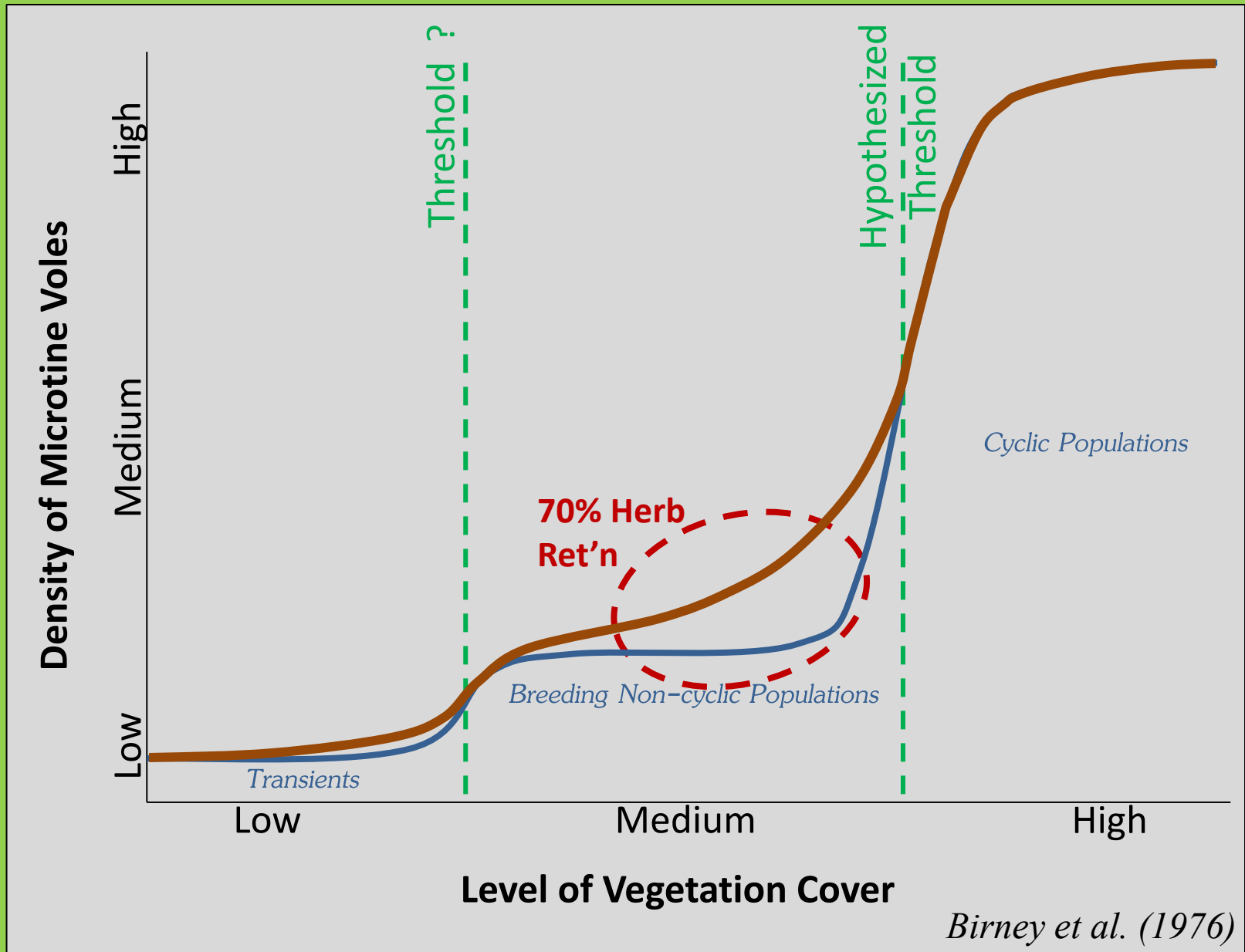
Relationship between Herbaceous Cover and Vole Densities



Relationship between Herbaceous Cover and Vole Densities



Relationship between Herbaceous Cover and Vole Densities



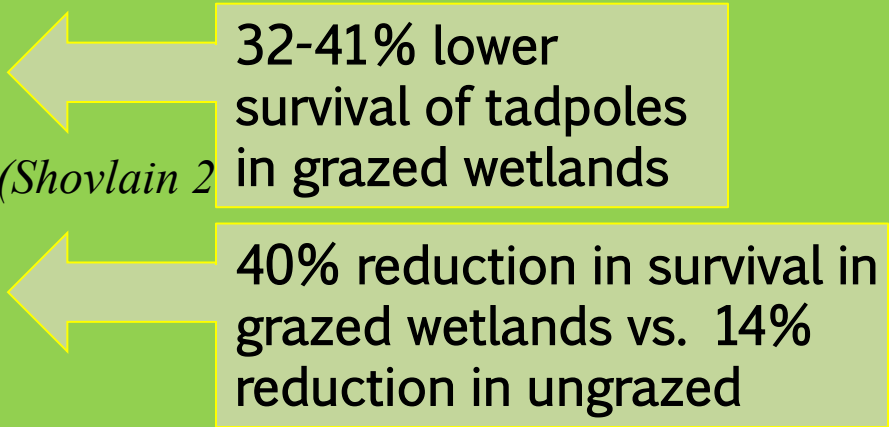
Spotted Frogs and Boreal Toads



Studies on Livestock Grazing & Amphibians

(% retention was estimated based on info. provided)

No effects on adult and tadpole occurrence, abundance, and/or survival were detected* where retention averaged:

- **~75-85%** (*Roche et al. 2012a, Roche et al. 2012b, McIlroy et al. 2013*)
 - **~80%** (*Bull & Hayes 2000*)
 - **High levels (i.e., light grazing)** (*Shovlain 2000*)
 - **~50-60%** (*Adams et al. 2009*)
- 
- 32-41% lower survival of tadpoles in grazed wetlands
- 40% reduction in survival in grazed wetlands vs. 14% reduction in ungrazed

* This does not mean there were no effects.

Studies on Livestock Grazing & Amphibians

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- **~75-85%** (*Roche et al. 2012a, Roche et al. 2012b, McIlroy et al. 2013*)
- **~80%** (*Bull & Hayes 2000*)
- **High levels** (i.e., light grazing) (*Shovlain 2006*)
- **~50-60%** (*Adams et al. 2009*)

Adult and tadpole occurrence and/or abundance were statistically lower where retention averaged:

- **~80%** (*Munger et al. 1994*) → Sim. Results by *Munger et al. (1996)*
- **~70-85%** (*Schmutzer et al. 2008, Burton et al. 2009*)
- **Low levels** (i.e., heavy grazing) (*Shovlain 2006*)

* This does not mean there were no effects.

Studies on Livestock Grazing & Amphibians

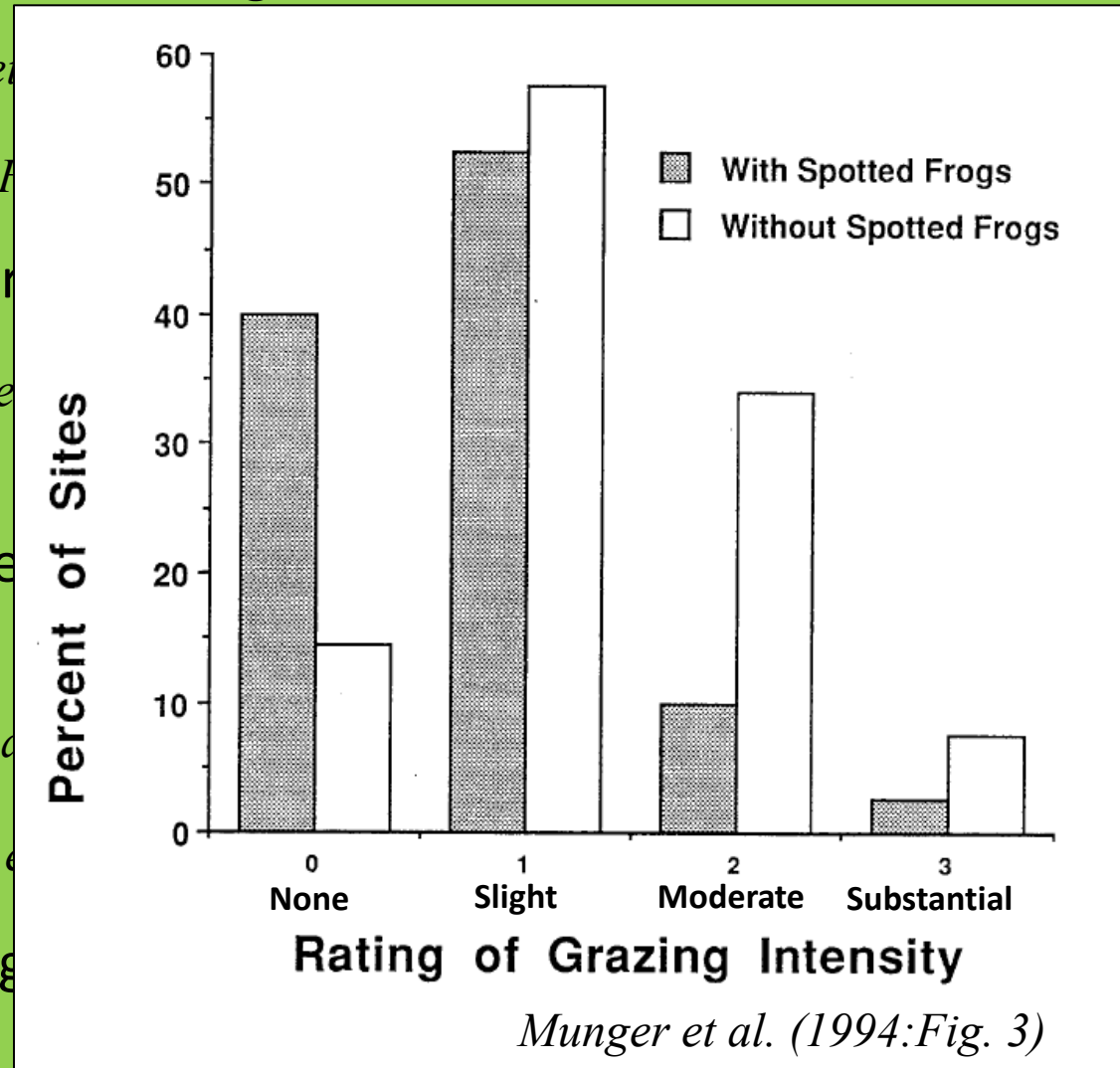
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Adult and tadpole occurrence were not affected where retention averaged:

- ~80% (Munger et al. 1994)
- ~70-85% (Schmutzer et al. 1994)
- Low levels (i.e., heavy grazing)



Factors Considered in Determining Suitable Retention Level

A. Habitat Elements Directly Tied to Herbaceous Retention

1. Humidity Retention & Temperature Moderation
2. Shading & Protection from Sun
3. Hiding & Escape Cover
4. Forage for Tadpoles
5. Invertebrate Forage, Cover, & Substrate
6. Open (Sunny) Patches

B. Habitat & Survival Elements Tied to Grazing Intensity

1. Water Quality
2. Surface-water Retention in Small Wetlands
3. Survival as Affected by Livestock Trampling
4. Soil Looseness & Porosity
5. Integrity of Burrows

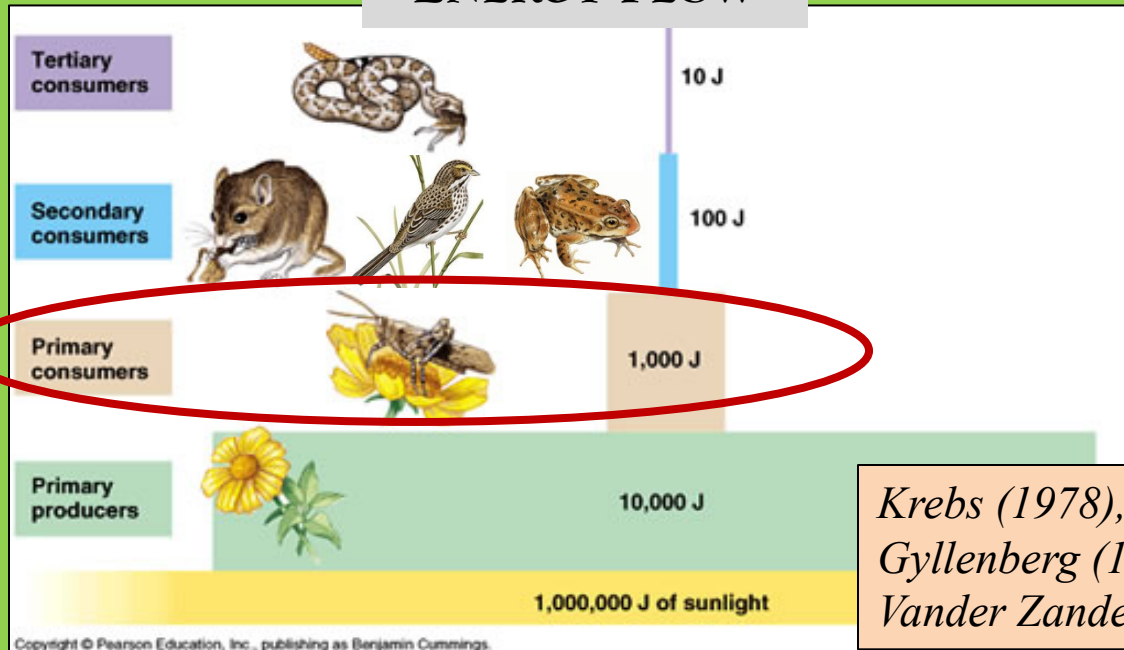
**Suitable
Percent
Retention**

Invertebrates

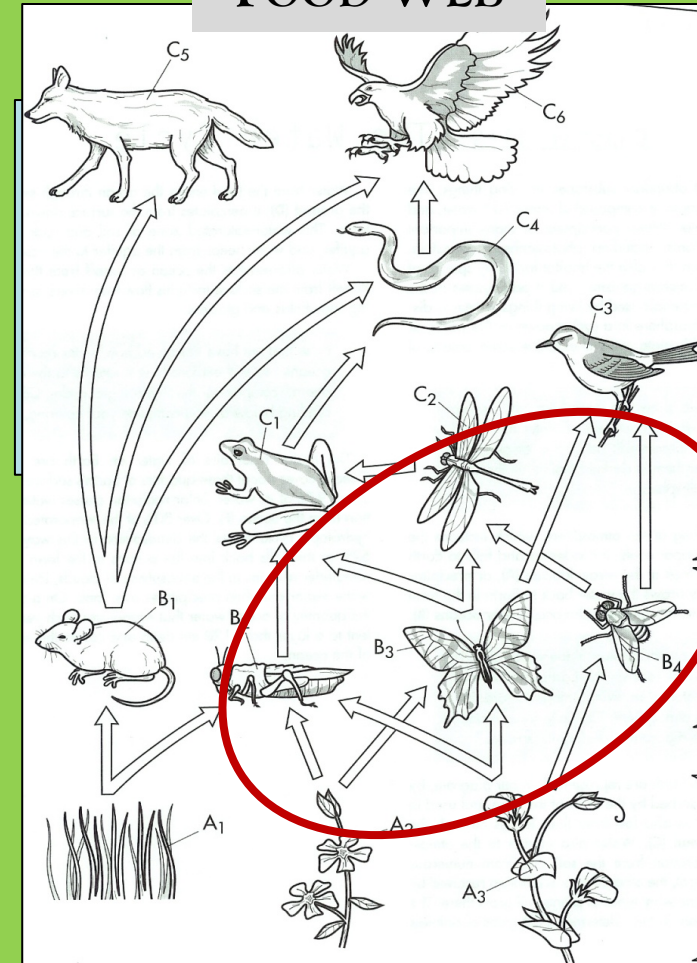
Invertebrates are highly important to a wide range of ecological functions:

- Pollination
- Decomposition and nutrient cycling
- Soil aeration
- Herbivory
- Major food source for vertebrates
- Natural control of other invertebrates

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Krebs (1978), Ricklefs (1979), Andrzejewska and Gyllenberg (1980), Kajak (1980), Samways (2005), Vander Zanden (2006), Nat'l Research Council (2007)

Healthy and diverse invertebrate communities are crucial for sustaining migratory bird, shrew, bat, amphibian, and reptile communities.

Humphrey (1982), Ehrlich et al. (1988), Vickery et al. (2001), Weisser and Siemann (2004), Patla and Keinath (2005), Samways (2005), Losey and Vaughan (2006)

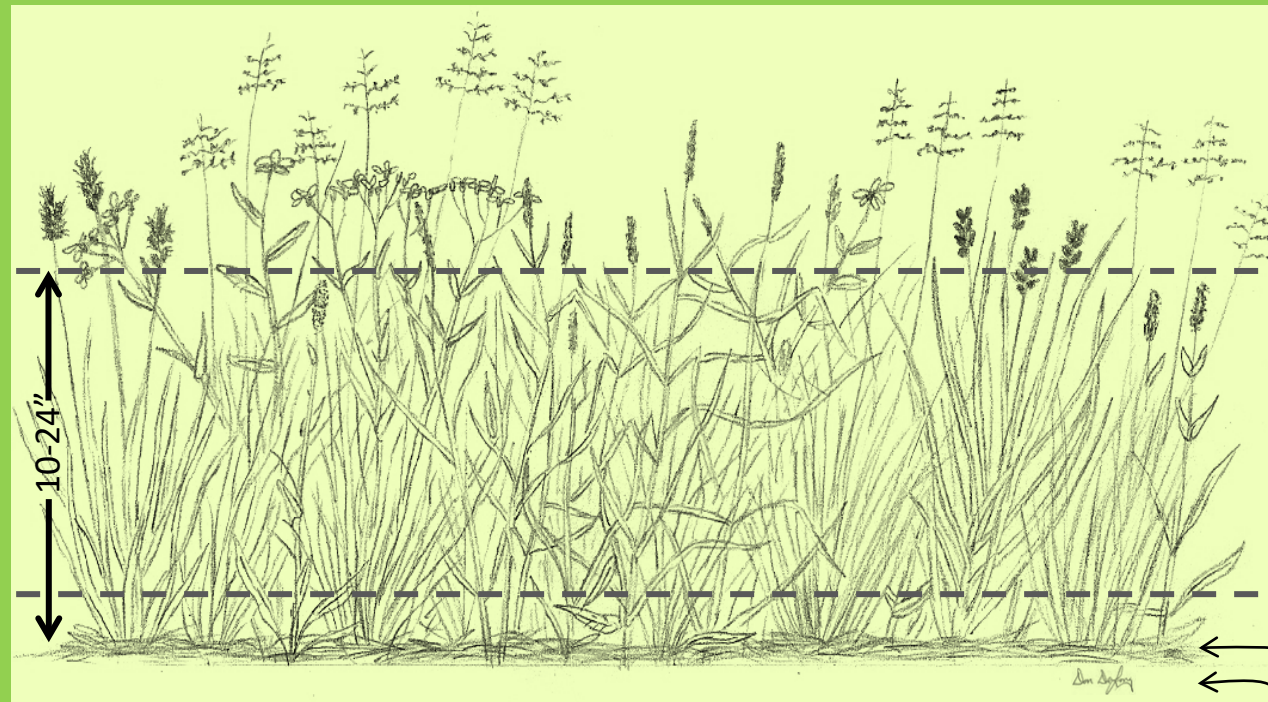
Invertebrate diversity is paramount because:

- 55-65 vertebrate insectivorous wildlife species — meadows & rangelands
- Wide ranging physiological adaptations
- Widely different size requirements
- Wide range of habitats & microhabitats
- Wide range of foraging locations — soil to air
- Seasonality of invertebrates
- Seasonality of vertebrate needs
- Different nutritional requirements

The best way to conserve all insectivores is to approximate a natural diversity of invertebrates.

Reid and Miller (1989), Keystone (1991), Noss and Cooperider (1994), Hunter (1996), Hughes et al. (2000), Cooperrider (2002), New (2004), Samways (2005), DeBano (2006), and 2012 Planning Rule

Vertical Biophysical Layers in Meadow Habitat



Upper Layer

- Fully exposed to ambient climate
- High light, virtually no shade
- Low Visual Obstruction
- Abundance of Flower and Seed Forage
- Species composition fully realized
- Abundance of Substrate

Middle Layer

- Moderate humidity, little wind
- Somewhat moderated temperatures
- Reduced light, moderate shade
- Moderately high visual obstruction
- Meets behavioral attachment to dense overhead canopy
- High diversity of forage and substrate types
- Abundance of leaf forage and substrate

Lower Layer

- High humidity, moderated temperature
- No wind
- Deep shade, little light
- High visual obstruction
- Some basal leaf forage

Litter Layer

- Well developed, e.g., relatively deep
- High moisture retention
- Numerous spaces between plant material

Below-Ground Layer

- High organic content
- Loose soil structure
- High moisture retention
- Temperature moderation

Different invertebrate species / guilds inhabit different layers.

Andrzejewska (1965), Denno (1980) Körner (1994), Morris (2000)

Upper layers drive conditions in lower layers.

Numerous studies (in next several slides)

General rule — as herbaceous height and/or canopy cover decline, most invertebrate species decline.

Research results are consistent across many taxa and guilds:

- Moths and Butterflies
- Bees
- Beetles
- Leafhoppers and Planthoppers
- Cicadas
- True Bugs
- Grasshopper (many species)
- Flies
- Dragonflies and Damselflies
- Millipedes and Centipedes
- Leaf Miners
- Parasitic Wasps and Bees
- Foliar Arthropods in general
- Seed Predators, Stem Borers, Gall Makers, and Sap Suckers
- Roundworms and Springtails
- Spiders

<i>Luff (1966),</i>	<i>Morris (1967),</i>
<i>Morris (1971),</i>	<i>Delchek and Kajak (1974)</i>
<i>King and Huthinson (1976)</i>	<i>Hawkins et al. (1979)</i>
<i>Hutchinson and King (1980)</i>	<i>Morris (1983)</i>
<i>Morris and Plant (1983)</i>	<i>Sugden (1985)</i>
<i>Welch et al. (1991)</i>	<i>Gibson et al. (1992)</i>
<i>Sterling et al. (1992)</i>	<i>Bell et al. (2001)</i>
<i>Kruess and Tschardt (2002)</i>	<i>Vazquez and Simberloff (2003)</i>
<i>Ringwood et al. (2004)</i>	<i>Foote and Hornung (2005)</i>
<i>Samways (2005)</i>	<i>Nat'l Res. Council (2005)</i>
<i>DeBano (2006)</i>	<i>Batary et al. (2007)</i>
<i>Gomez and Gonzales-Megias (2007)</i>	
<i>Wallis et al. (2007)</i>	<i>Dennis et al. (2008)</i>
<i>Littlewood (2008)</i>	<i>Gardiner and Hassal (2009)</i>
<i>New (2009)</i>	<i>Black et al. (2011)</i>
<i>Cizek et al. (2012)</i>	<i>Kimoto et al. (2012)</i>
<i>Weis et al. (2013)</i>	

The threshold for declines appears to be about 80% herb retention (85%?, 90%?).

East and Pottinger (1983), Foote and Hornung (2005), Kimoto et al. (2012), van Klink et al. (2015)
And intensive examination of habitat elements...

Literature Reviews

Significant negative effects on arthropod diversity with increasing grazing intensity found across 24 studies reviewed.

van Klink et al. (2015)



<u>% of Species</u>	<u>% of Families</u>	<u>Population Response to Increasing Stocking Rate</u>
73	78	Decline
16	11	Initial Increase, then Decline
11	11	Increase

East and Pottinger (1983)

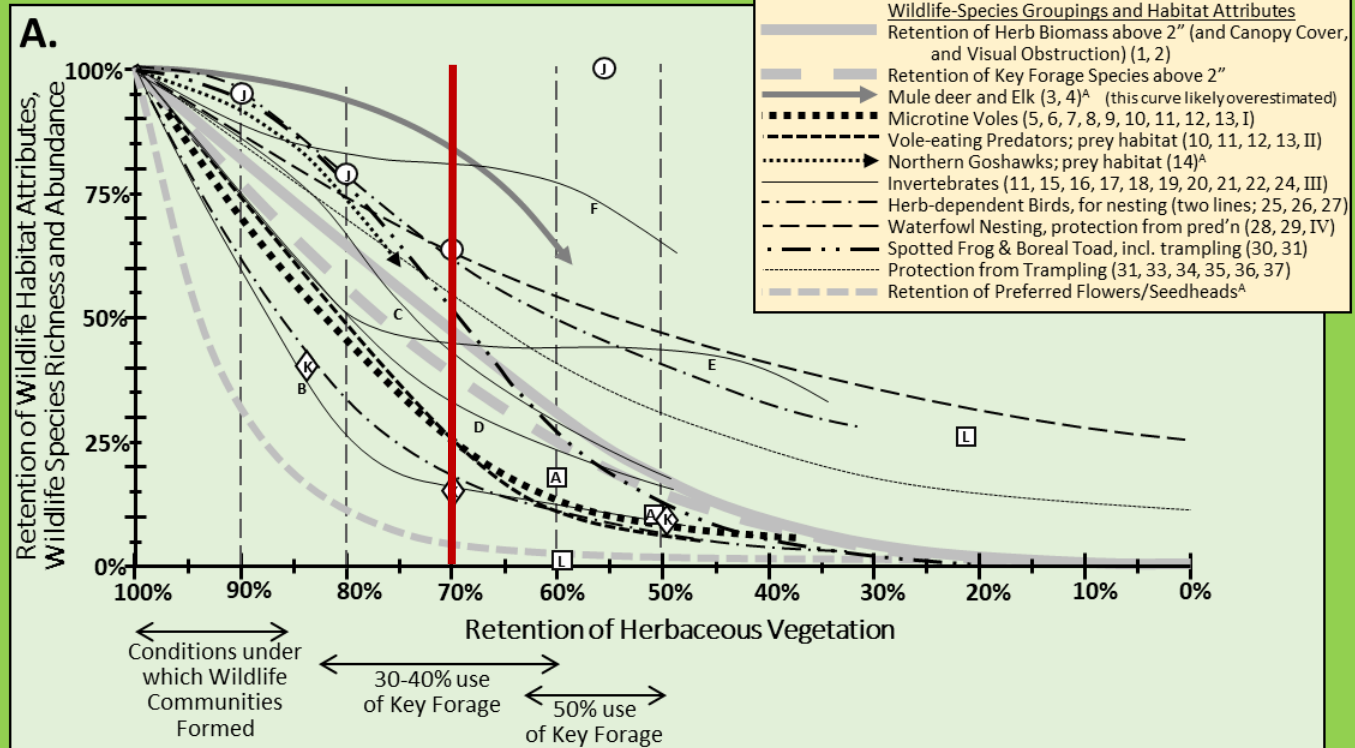


Nearly all studies cited by Morris (2000) demonstrated that reductions in veg. structure (livestock grazing) negatively impacted most invert. Species.

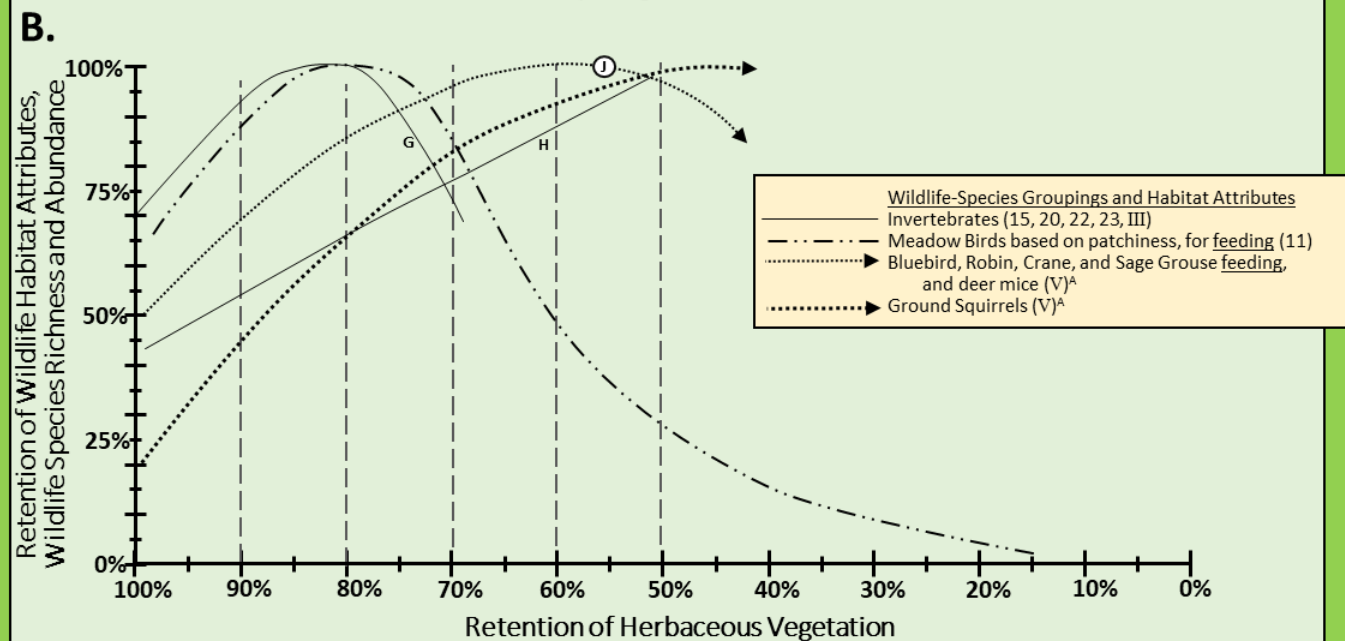
Basis

— A.2 Summary of Species' Groups —

Species Negatively Affected by Grazing



Species Positively Affected by Grazing



Basis

— B. Deconstruction of Habitat and Survival Elements —

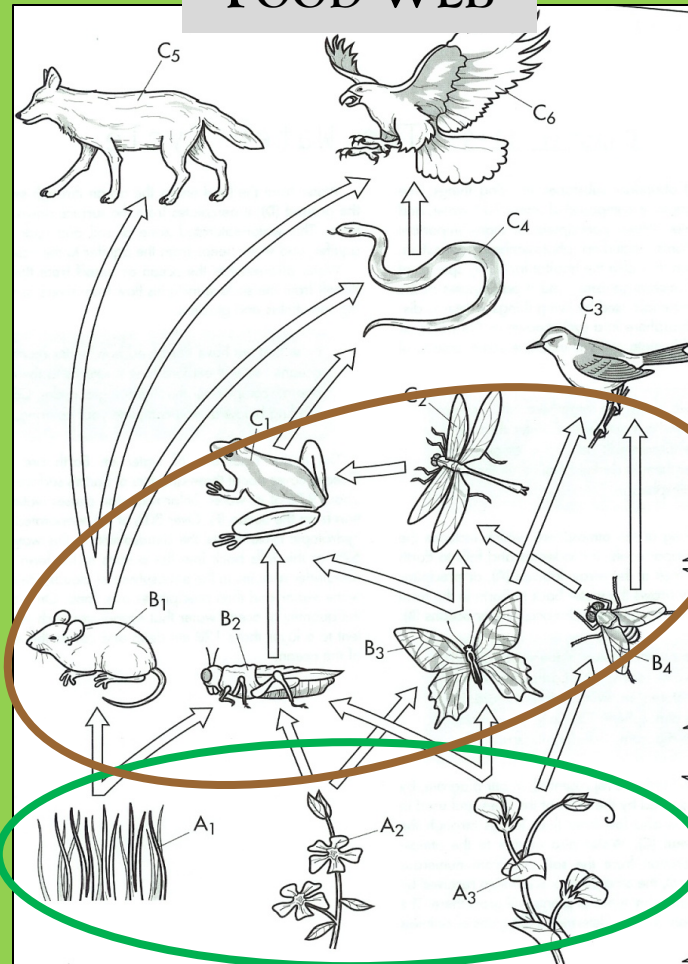
[Details... similar to Amphibian Presentation]

Conclusion

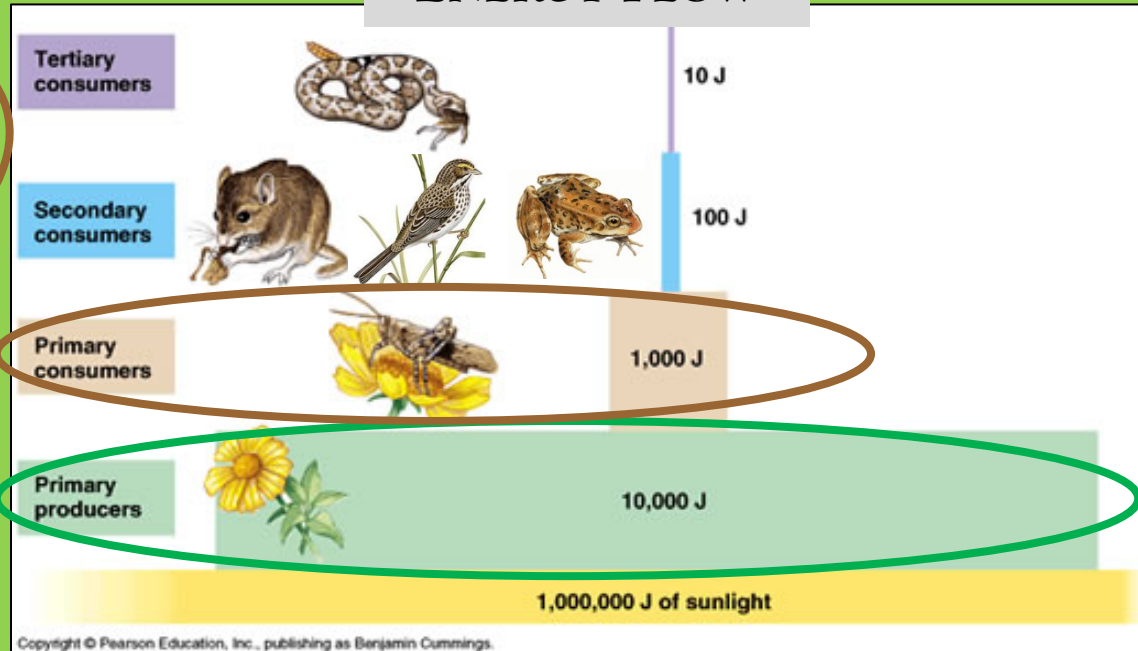
A Wildlife-Community Approach

With Heavy Consideration of Needs of Individual Species

FOOD WEB



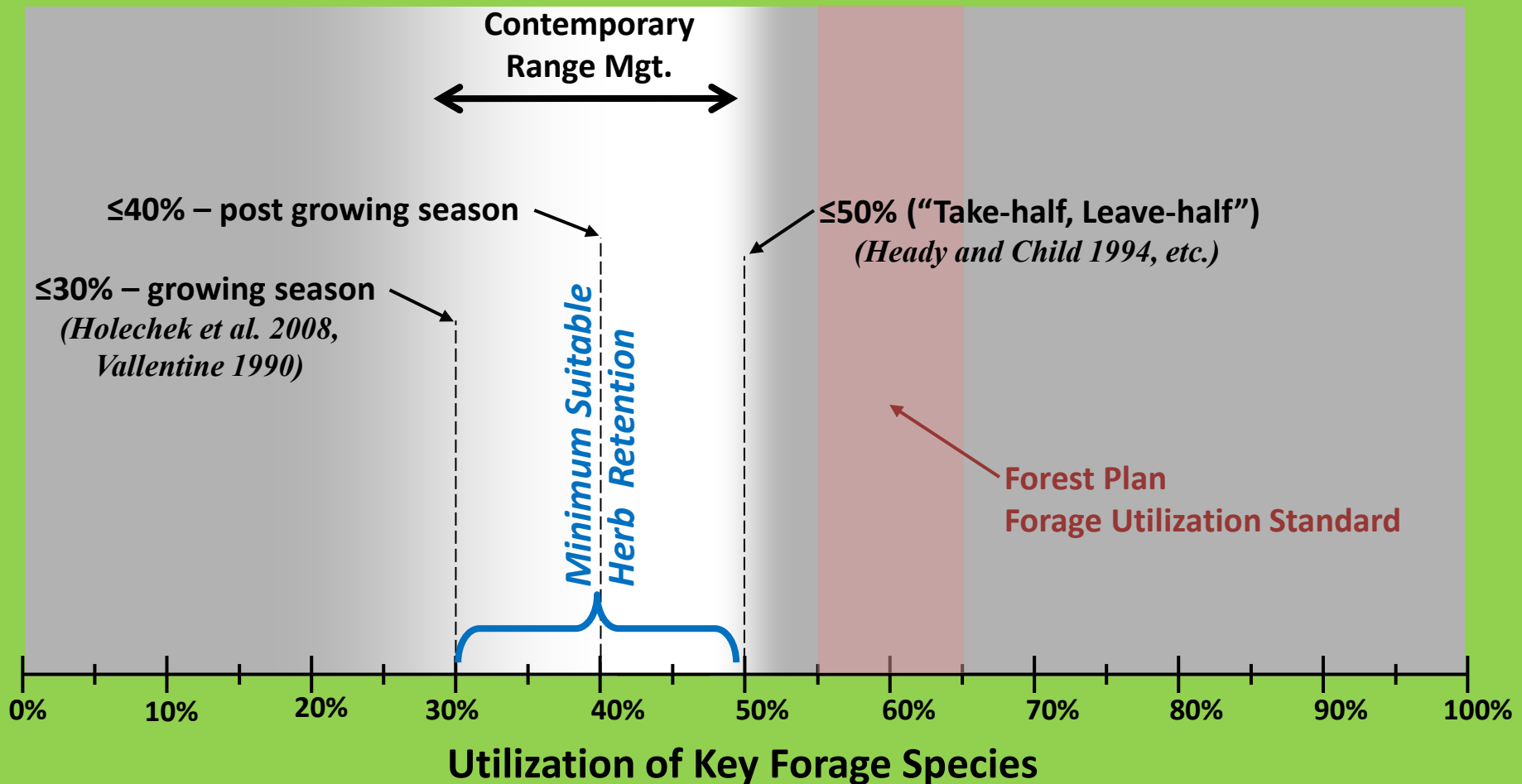
ENERGY FLOW



Upshot of Scientific Support

Retention	Scientific Support Showing Conditions are Suitable		Scientific Support Showing Conditions are Less-than-Suitable
	Direct	Indirect	
90%	Strong	Strong	None
80%	Mod.	Mod. Strong	Low
70%	Low	Mod.	Mod.
60%	Low	Low	Mod. Strong
50%	None	None	Strong
40%	None	None	Strong
30%	None	None	Strong

Some Perspective:



≥80% Retention of Herb. Veg.

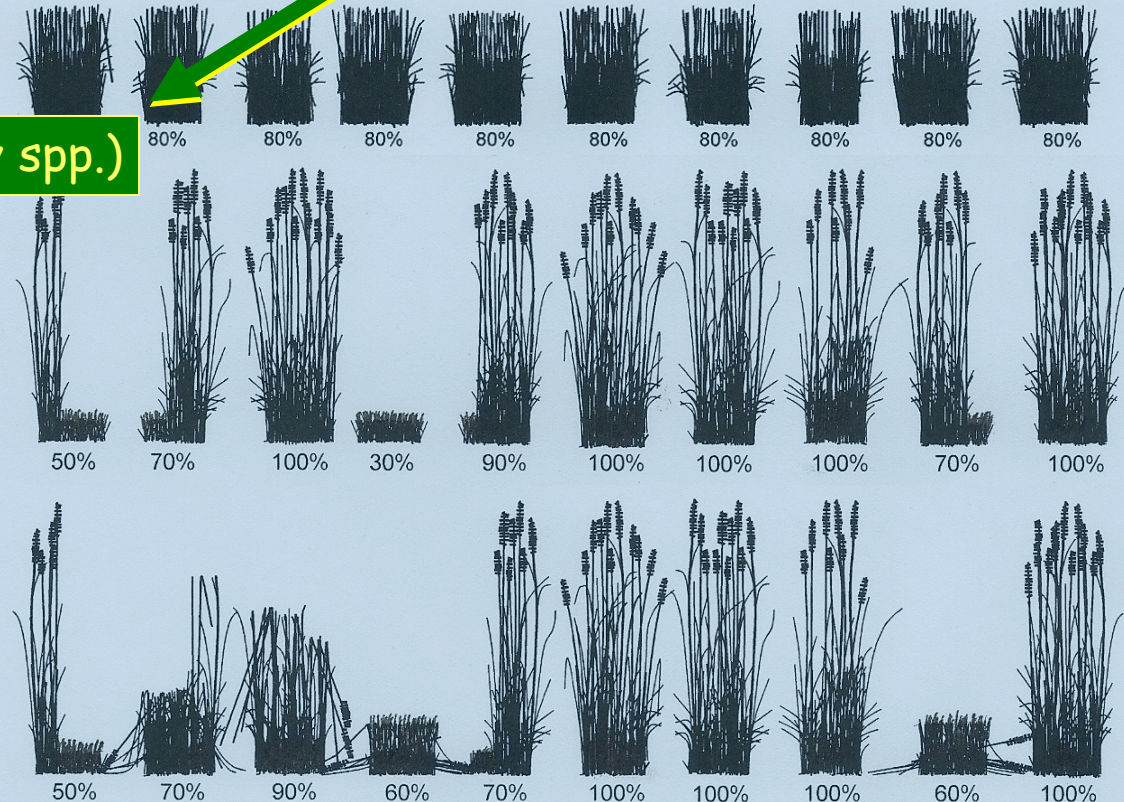
≥60-75% Retention of Key Forage Spp. (25-40% utilization)*

Mod-High - High Support for Assessment
that Retention is Sufficient to Meet Needs of:

- Elk and Mule Deer*
- Brewer's Sparrow
- Vesper Sparrow
- Savanna, Fox, & white-cr. Sparrows
- Common Snipe
- Voles, Shrews, W. Jumping Mice
- Spotted & Chorus Frogs, Boreal Toad
- Native Invertebrate-Communities

(≤30-40% use key spp.)

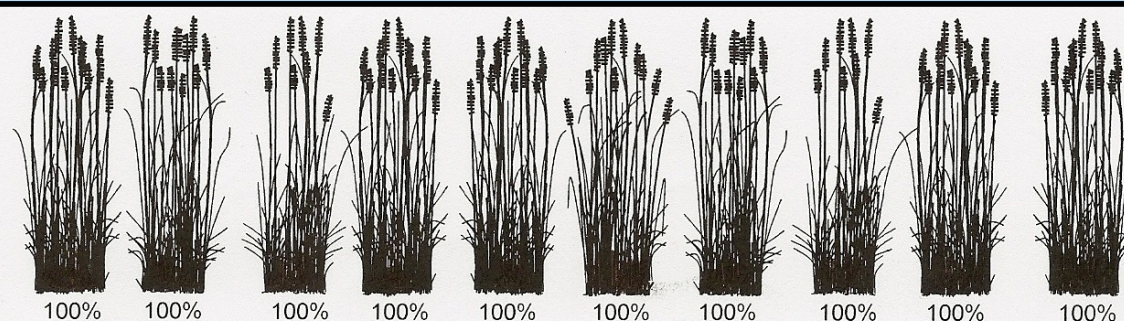
80%



Mod. Support for Assessment that
Retention is Sufficient to Meet Needs of:

- Waterfowl (nesting)
- Crane (nesting)
- Fire Spread (fine fuels)

100%



*If comp. of key forage spp. ≥ 50%

≥70% Retention of Herb. Veg.

≥55-65% Retention of Key Forage Spp. (35-50% utilization)*

High Support for Assessment that Retention is Sufficient to Meet Needs of:

- Brewer's Sparrow
- Vesper Sparrow
- Common Snipe

***Mod. to High* Support for Assess't that Retention is Sufficient to Meet Needs of:**

- Savanna, Fox, & white-cr. Sparrows

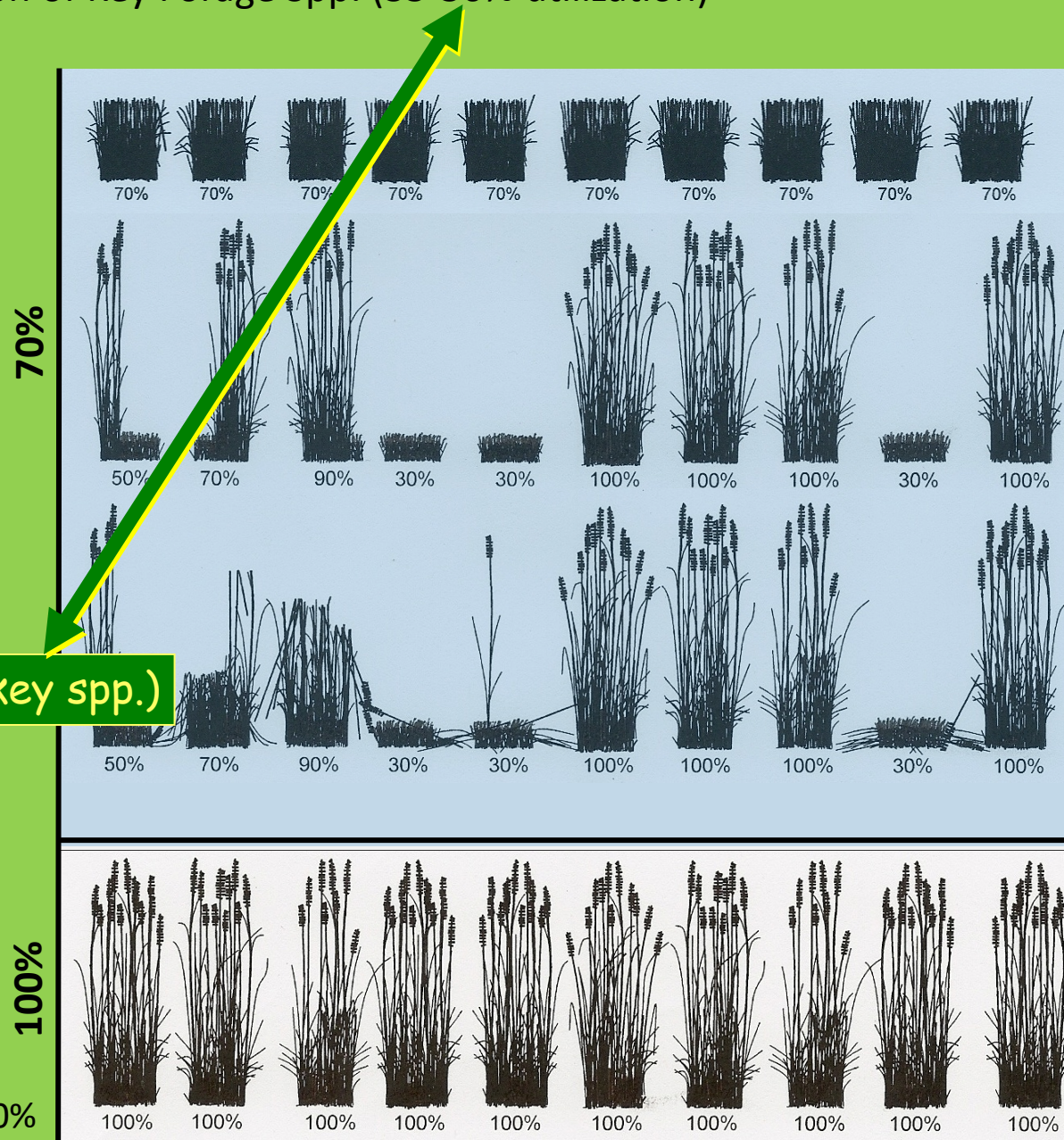
Mod. Support for Assessment that Retention is Sufficient to Meet Needs of:

- Elk and Mule Deer*
- Voles, Shrews, W. Juv **(≤30-40%**
- Spotted & Chorus Frogs, Boreal Toad
- Native Invertebrate-Communities

Low Support for Assessment that Retention is Sufficient to Meet Needs of:

- **Waterfowl (nesting)**
- **Fire Spread (fine fuels)**

*If comp. of key forage spp. $\geq 60\%$



≥60% Retention of Herb. Veg.

≥30% to 55% Retention of Key Forage Spp. (45 to >70% utilization)

Mod. to High Support for Assessment that Retention is Sufficient to Meet Needs of:

- Brewer's Sparrow
- Common Snipe

Mod. Support for Assessment that Retention is Sufficient to Meet Needs of:

- Vesper Sparrow
- Savanna & Fox Sparrows (low to mod.)

Low Support for Assessment that Retention is Sufficient to Meet Needs of:

- Elk and Mule Deer
- Voles, Shrews, W. Junco
- Spotted & Chorus Frogs, Boreal Toad
- Native invertebrate-communities

No Support for Assessment that Retention is Sufficient to Meet Needs of:

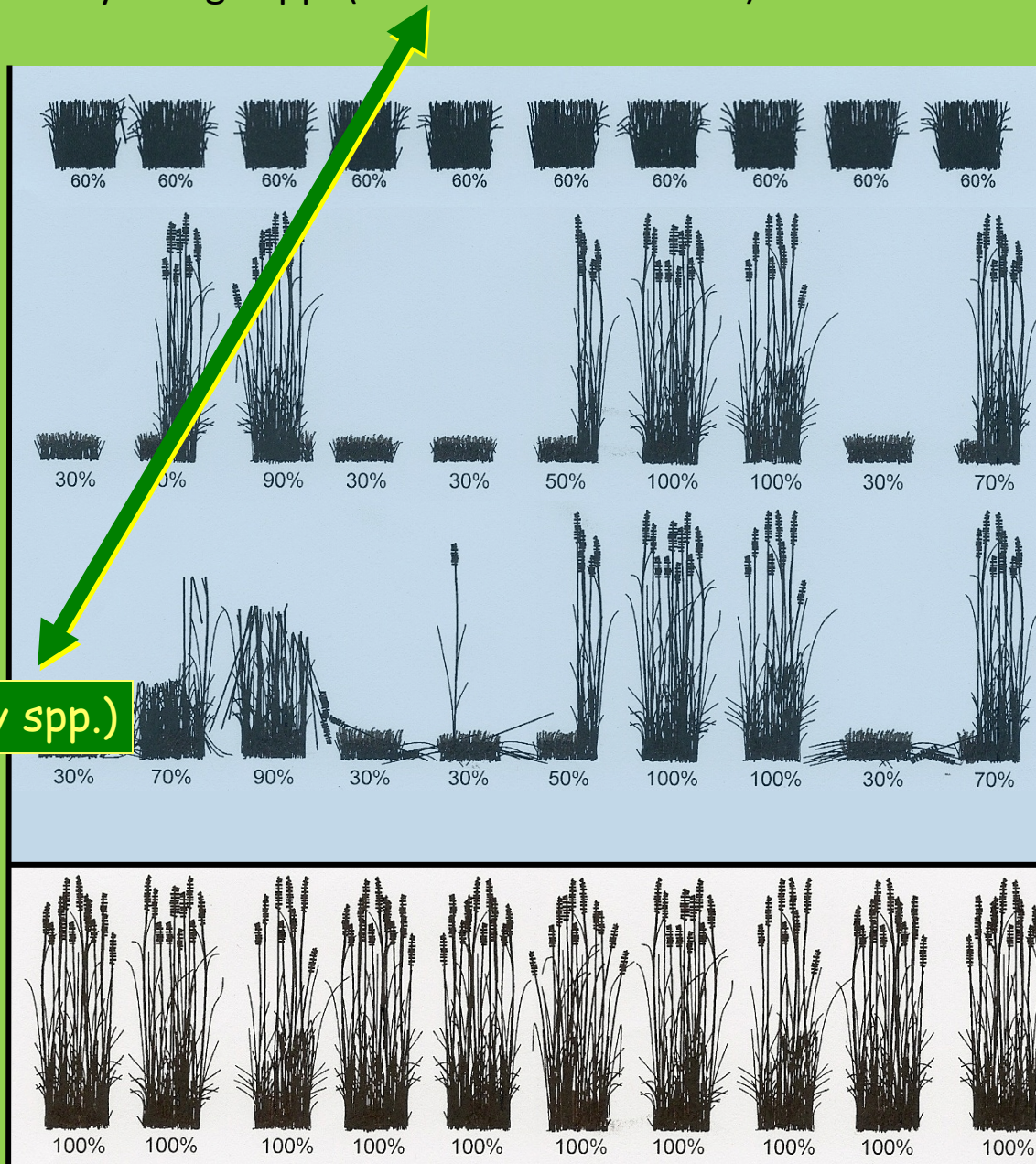
- Waterfowl (nesting)
- Fire Spread (fine fuels)

*Depends on comp. of key forage spp.

60%

100%

(≤30-40% use key spp.)



≥50% Retention of Herb. Veg.

≥20% to 45% Retention of Key Forage Spp. (55 to >80% utilization)*

High Support for Assessment that Retention is Sufficient to Meet Needs of:

- Species like robins, mtn. bluebirds, deer mice

Mod. Support for Assessment that Retention is Sufficient to Meet Needs of:

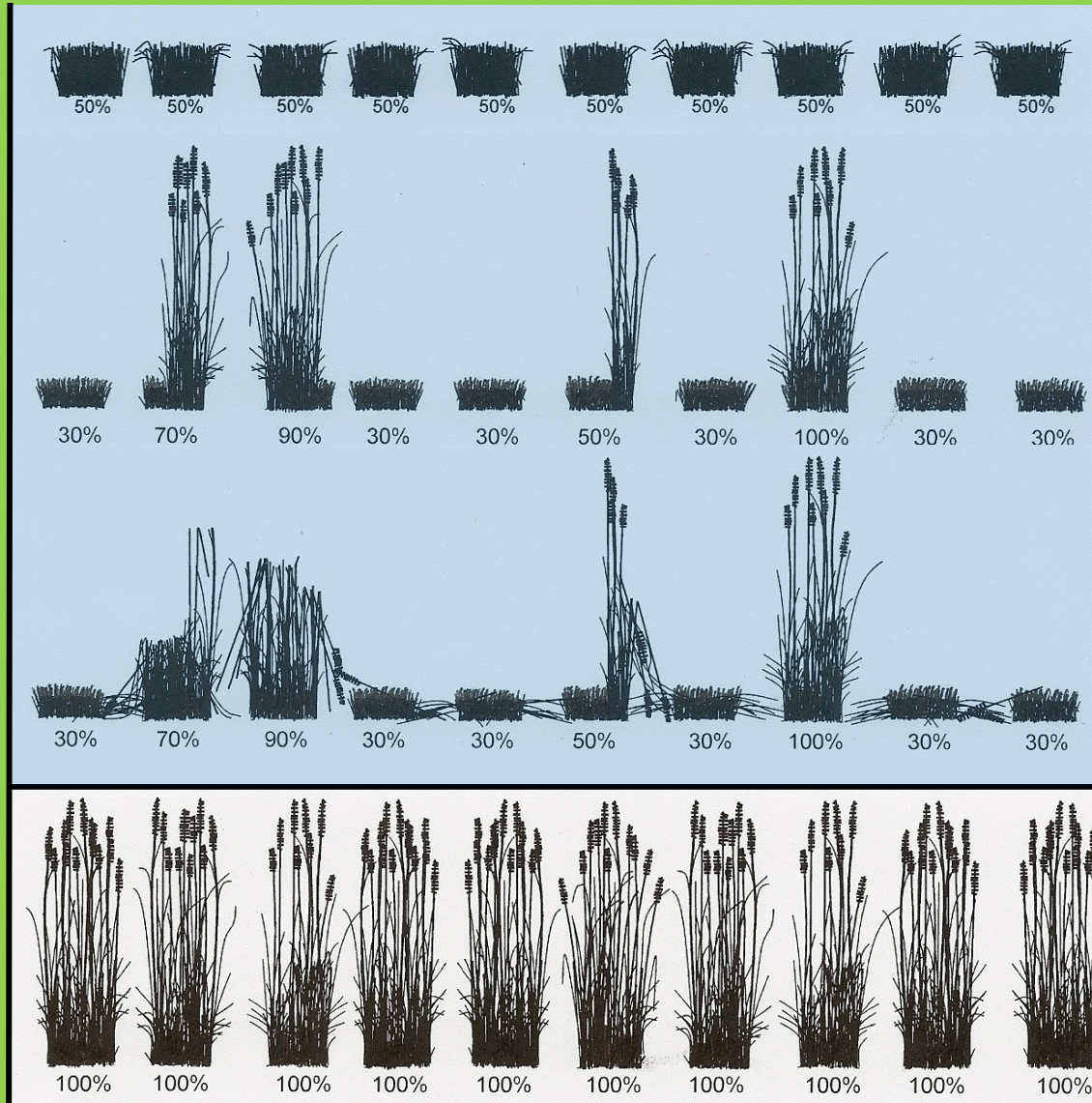
- Brewer's Sparrow
- Sandhill Crane (feeding)

No or Low Amount of Information Showing Retention is Sufficient to Meet Needs of:

- Elk and Mule Deer
- Voles, Shrews, W. Jumping Mice
- Spotted & Chorus Frogs, Boreal Toad
- Native Invertebrate-Communities
- Waterfowl (nesting)
- Fire Spread (fine fuels)

50%

100%



*Depends on comp. of key forage spp.