

# The effect of grazing intensity on grasslands and cattle performance in south-central North Dakota

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## Abstract

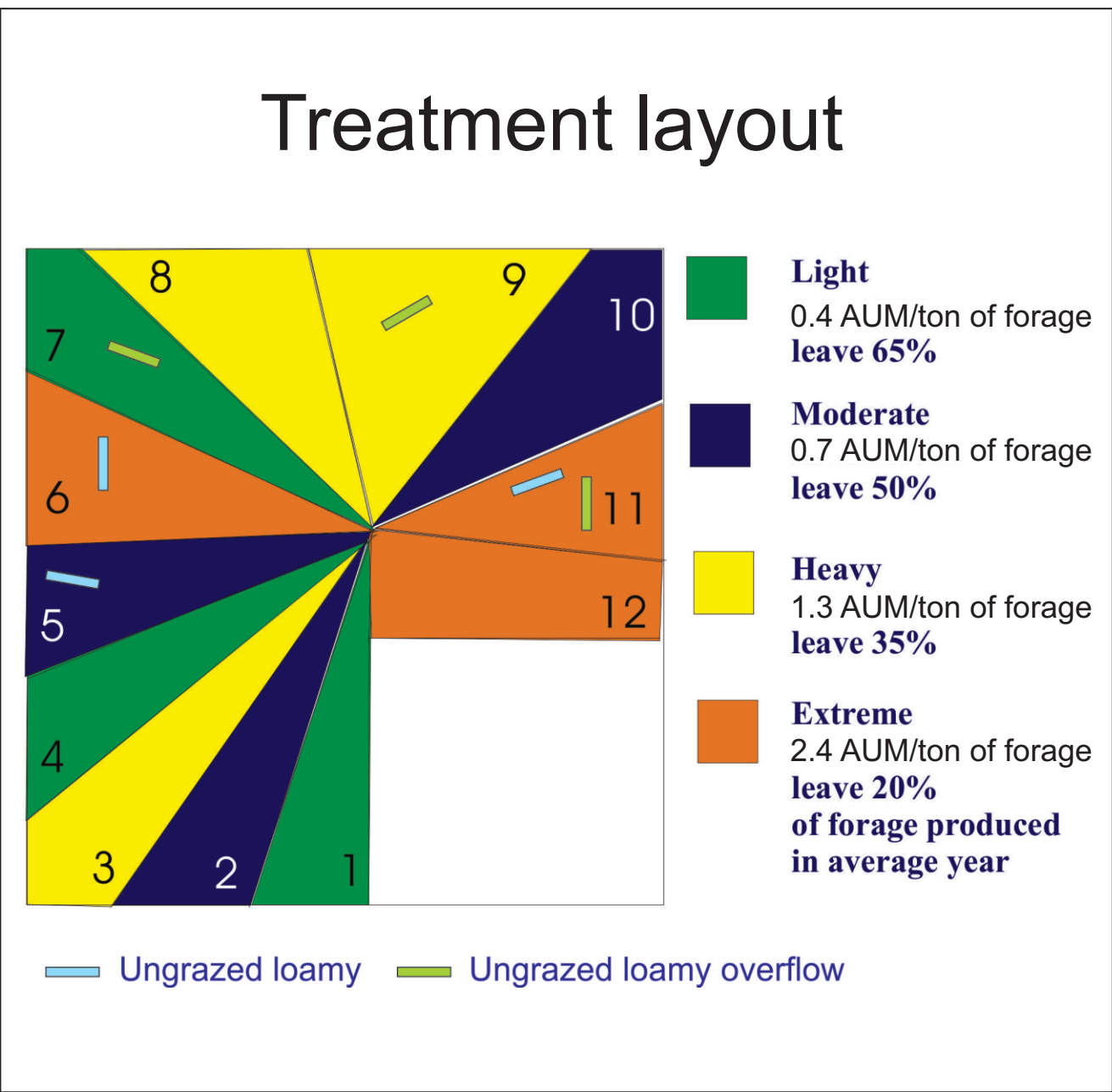
A grazing intensity study began at CGREC in 1989 to determine ecological and economic effects of season-long cattle grazing. Five treatments - no grazing, light, moderate, heavy, and extreme grazing - are each replicated three times. Thirty-acre pastures are stocked so that when the cattle are removed in the fall, 65, 50, 35, and 20% of the forage remains on the light, moderate, heavy, and extreme grazing treatments respectively. The no grazing treatment consists of six 0.3-acre enclosures.

On loamy sites, forage production is highest under light grazing. On loamy overflow sites, production does not differ between light, moderate, and heavy grazing, but ungrazed and extreme treatments produce significantly less forage.

Of the 165 plant species found on the loamy sites, 38% have shown a response to grazing based on frequency, density, or basal cover. On the loamy overflow sites, 29% of the 175 species have responded to grazing. Of these species, the majority are favored by a moderate or heavy level of grazing.

Since 1990, average daily gain and animal body condition scores have decreased with increasing grazing intensity. Initially, gain/ton of available forage increases as the stocking rate increases, but declines at higher stocking rates.

We cannot predict which stocking rate will give the maximum gain/ton of forage in a particular year. However, at 2.49 AUM/ton, gain/ton from 1991-2011 would have averaged 77.2 lbs/ton. The stocking rate with the maximum return/ton over the last 21 years would be 1.91 AUM/ton, with an average annual return of \$30.19/ton.

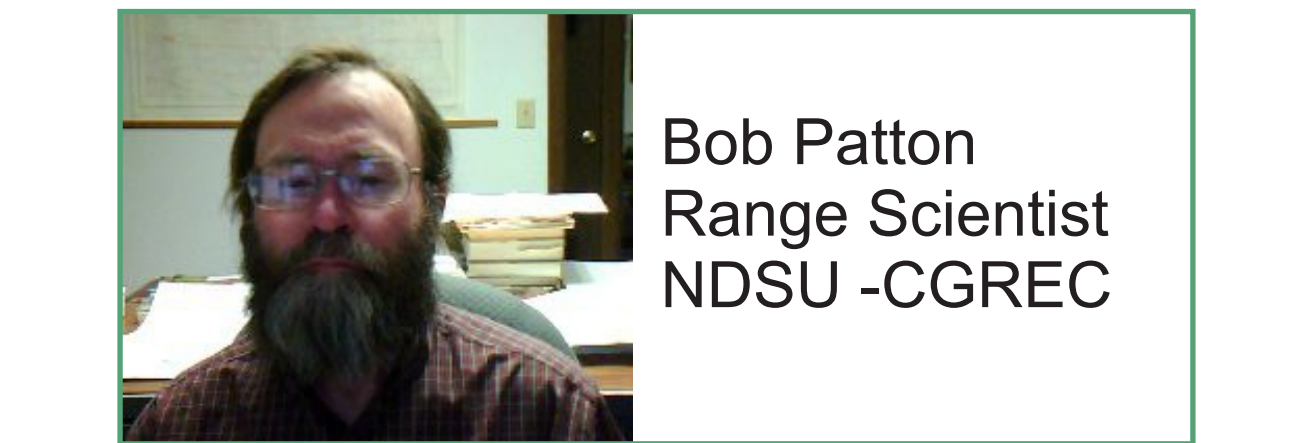


## Forage Production

On the **loamy ecological site**, the greatest forage production is on the light treatment.

Average above ground biomass production by grazing treatment on loamy ecological sites from 1992 to 2011.				
Treatment	Above ground biomass (lbs/acre)			
	Beginning of season	Middle of season	Peak yield	End of season
Ungrazed	1,261 b <sup>1</sup>	2,542 b	2,808 c	2,661 b
Light	1,327 a	2,851 a	3,243 a	3,113 a
Moderate	1,190 c	2,641 b	3,033 b	2,925 a
Heavy	915 d	2,217 c	2,489 d	2,402 c
Extreme	734 e	1,898 d	2,261 e	2,215 c
LSD (0.05)	57	153	192	210

<sup>1</sup>Means in the same column followed by the same letter are not significantly different at P=0.05.



On the **loamy overflow ecological site**, forage production does not differ between the light, moderate, and heavy treatments, but ungrazed and extreme produce significantly less forage.

Average above ground biomass production by grazing treatment on loamy overflow ecological sites from 1993 to 2011.				
Treatment	Above ground biomass (lbs/acre)			
	Beginning of season	Middle of season	Peak yield	End of season
Ungrazed	1,000 c <sup>1</sup>	3,297 c	3,451 b	3,042 b
Light	1,161 b	3,975 a	4,261 a	4,033 a
Moderate	1,244 a	3,743 ab	4,208 a	4,075 a
Heavy	1,204 ab	3,645 b	4,037 a	4,001 a
Extreme	835 c	2,287 d	2,678 c	2,600 c
LSD (0.05)	77	250	262	274

<sup>1</sup>Means in the same column followed by the same letter are not significantly different at P=0.05.

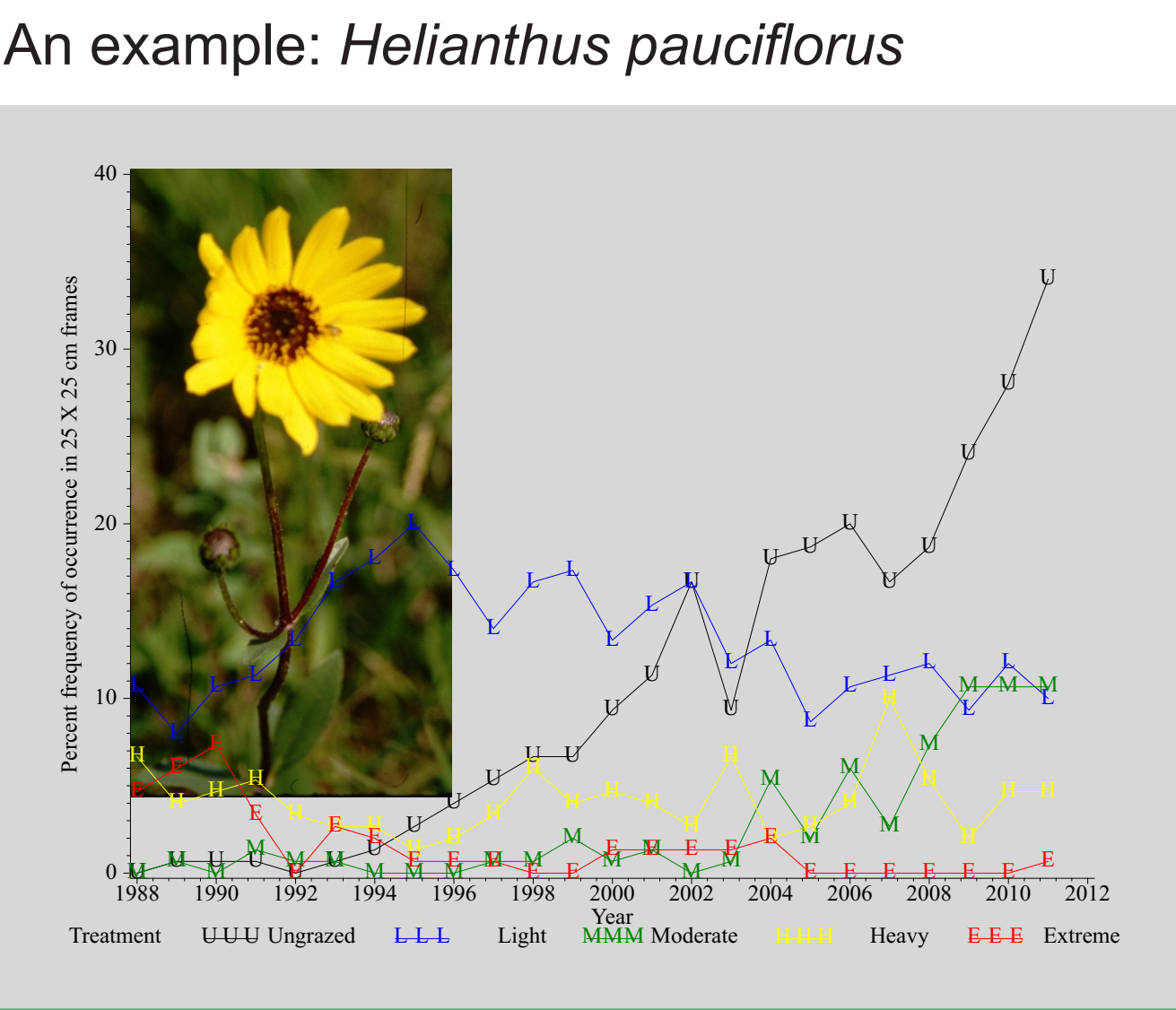
## Plant Community Dynamics

### Loamy Sites

Of the 165 plant species on loamy ecological sites, 63 have shown a response to grazing (listed in order of dominance).

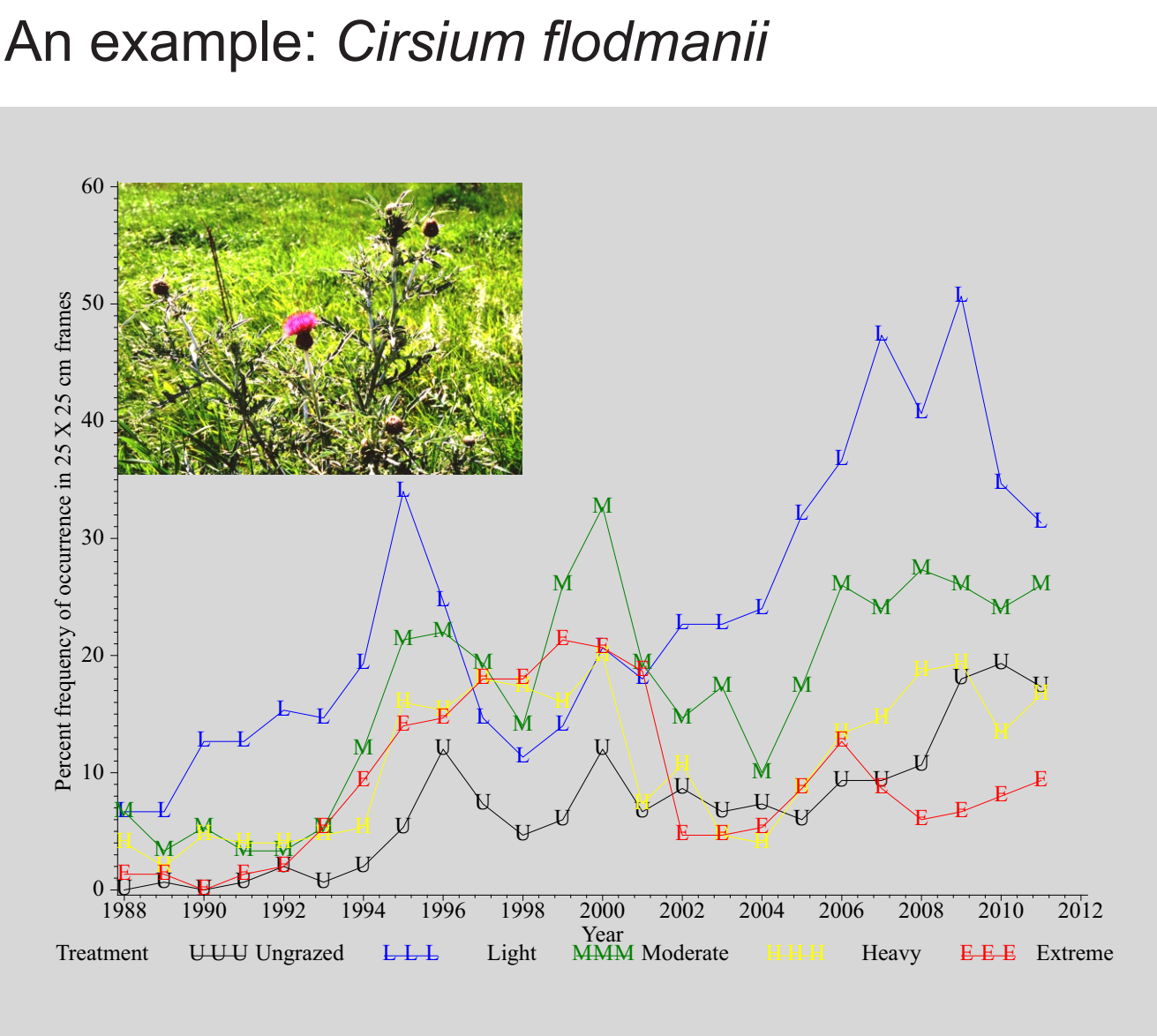
Species that **decrease** under grazing:

- Poa pratensis* - Kentucky bluegrass
- Lotus purshianus* - deer vetch
- Helianthus pauciflorus* - stiff sunflower
- Artemisia absinthium* - wormwood
- Tragopogon dubius* - goat's beard
- Psoralea esculenta* - breadroot scurf-pea



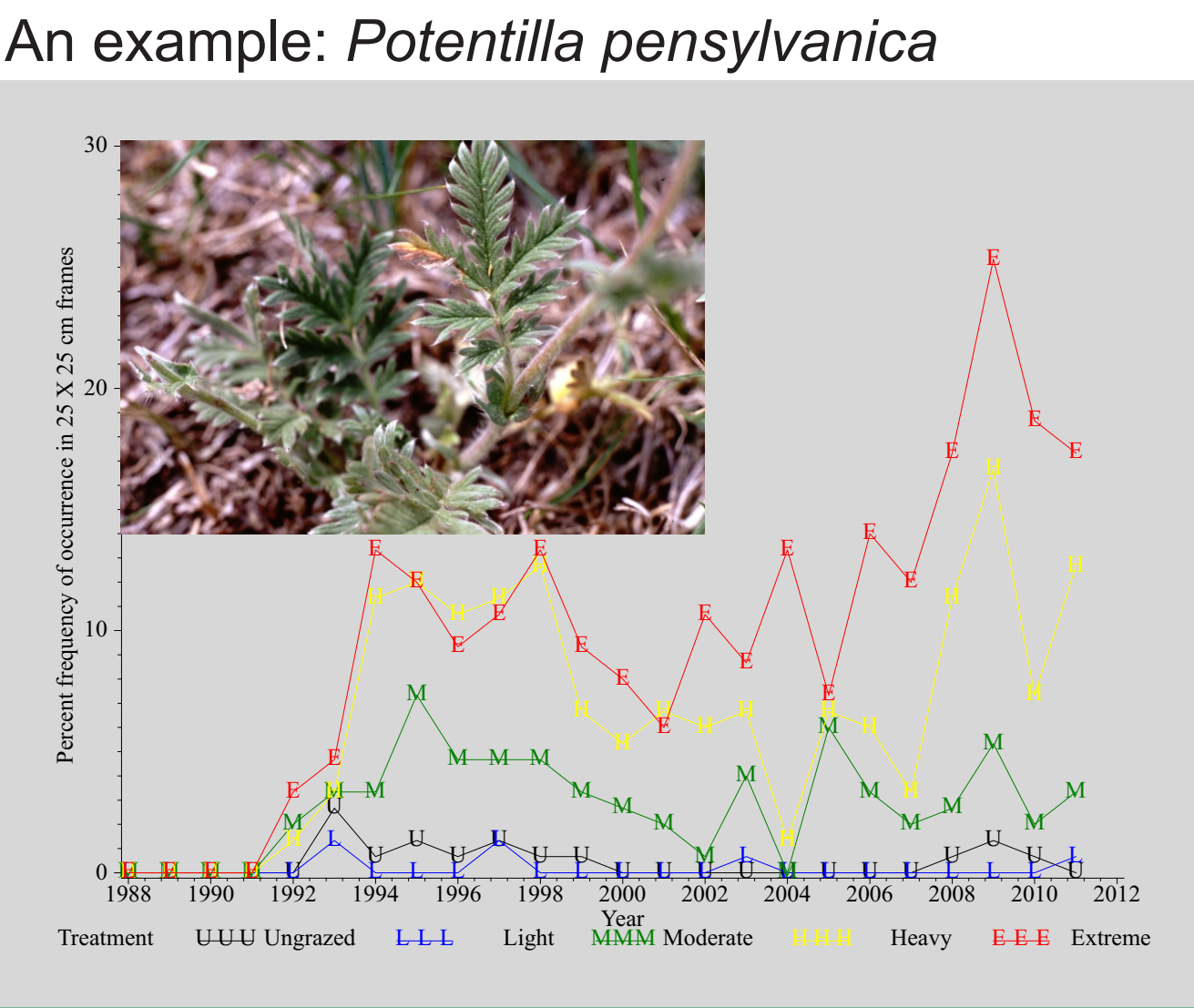
Some species favored by **moderate** grazing:

- Symphotrichum ericoides* - heath aster
- Artemisia ludoviciana* - cudweed sagewort
- Hesperostipa curti-seta* - western porcupine grass
- Ambrosia psilostachya* - western ragweed
- Dichanthelium wilcoxianum* - Wilcox dichanthelium
- Cirsium flodmanii* - Flodman's thistle



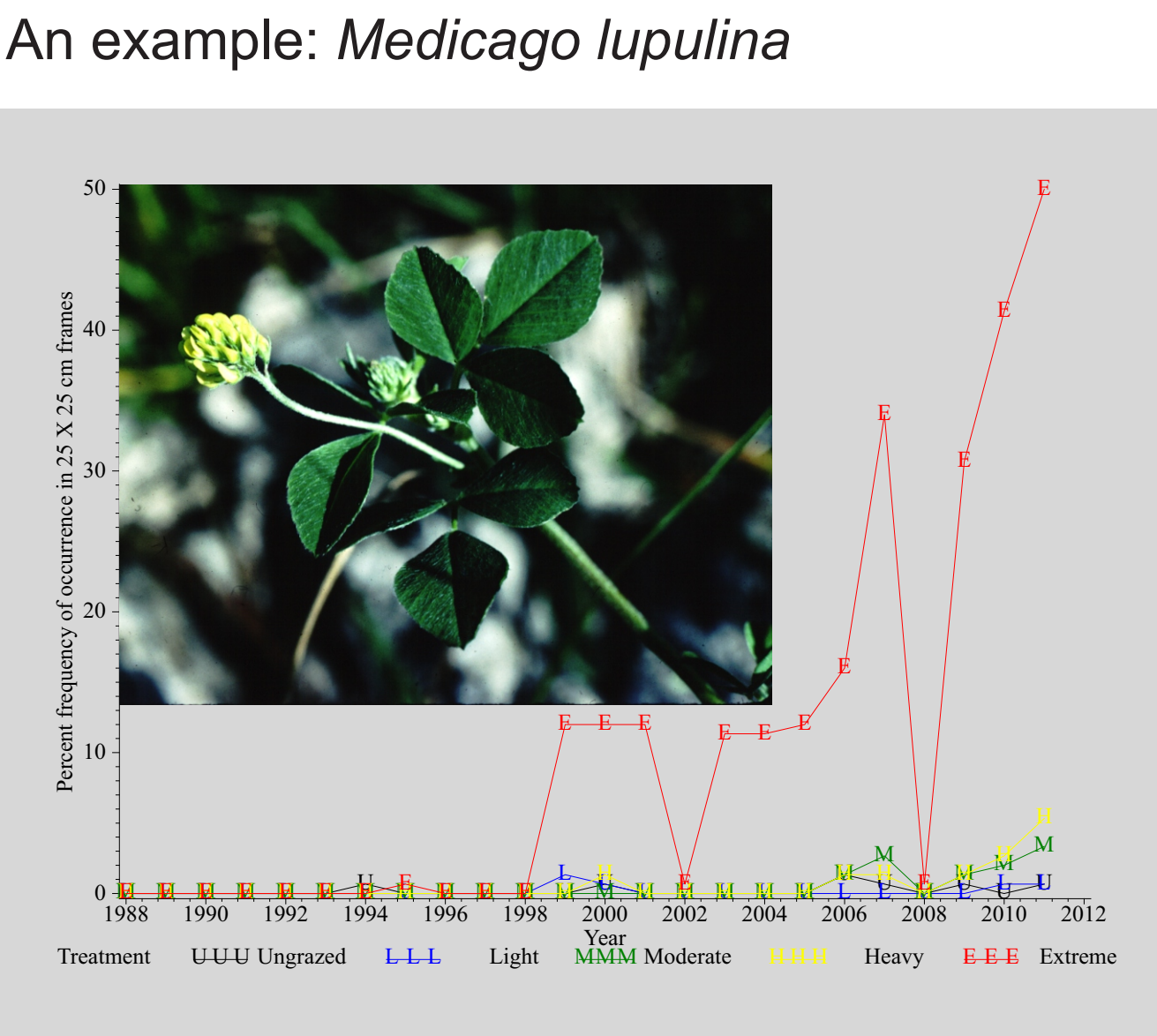
Some species that **increase** under grazing:

- Pascopyrum smithii* - western wheatgrass
- Carex inops* ssp. *heliophila* - sun sedge
- Nassella viridula* - green needlegrass
- Achillea millefolium* - western yarrow
- Taraxacum officinale* - common dandelion
- Bouteloua gracilis* - blue grama
- Artemisia frigida* - fringed sagewort



Species that appear **only after heavy** grazing:

- Medicago lupulina* - black medic
- Agrostis hyemalis* - ticklegrass
- Juncus interior* - inland rush
- Trifolium repens* - white clover
- Polygonum ramosissimum* - bushy knotweed

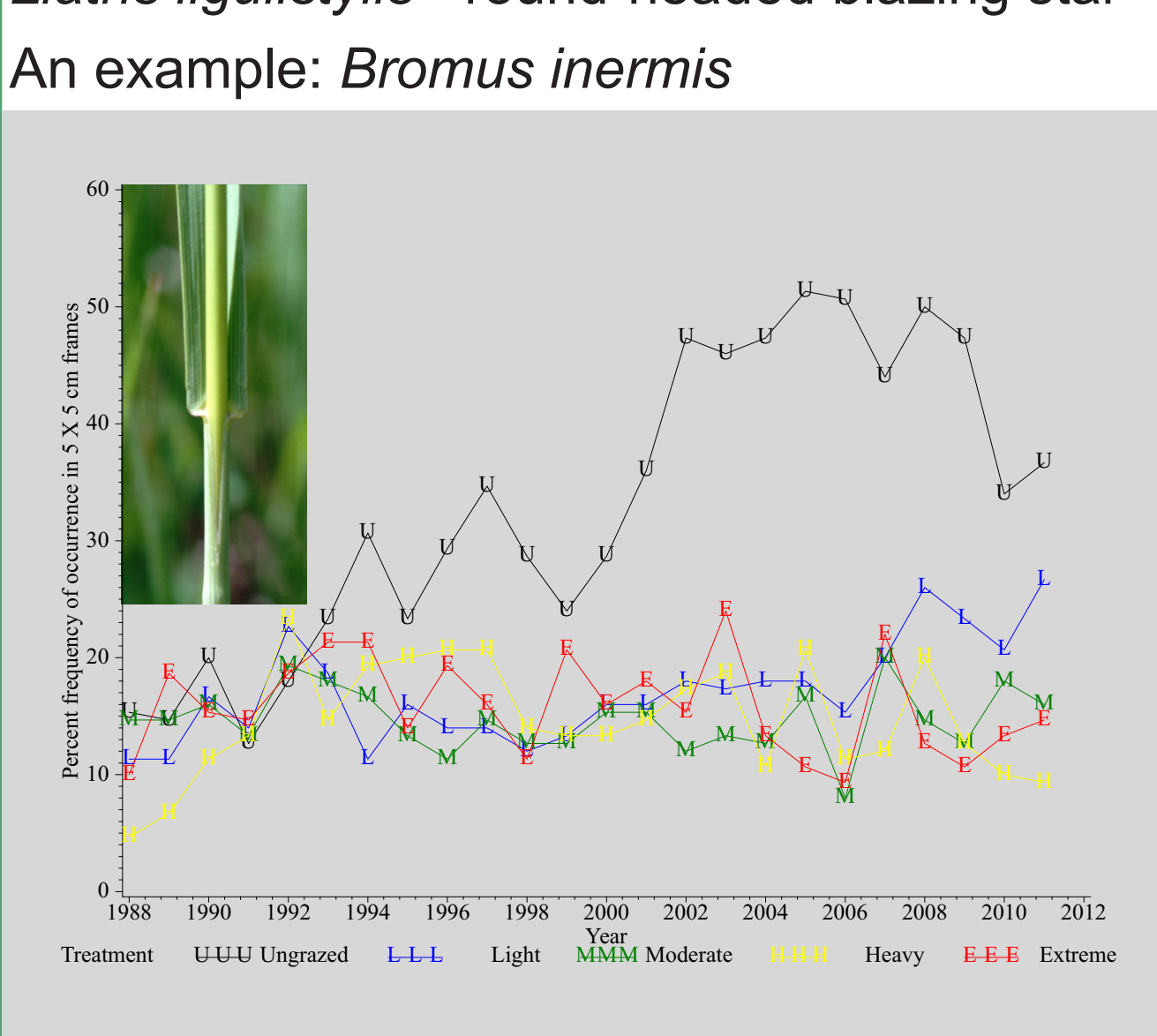


## Loamy Overflow Sites

Of the 175 plant species on loamy overflow ecological sites, 51 have shown a response to grazing.

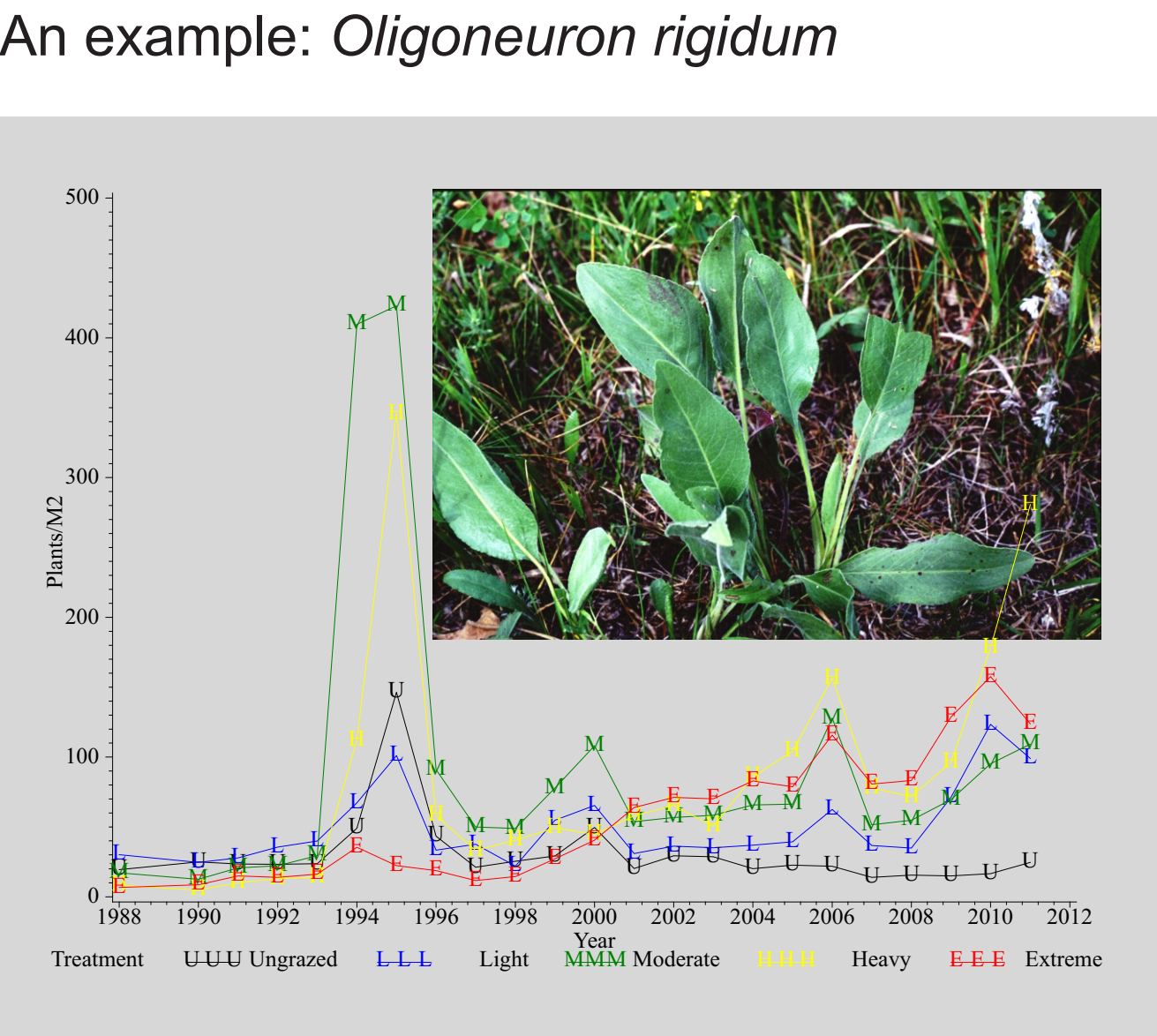
Species that **decrease** under grazing:

- Symphoricarpos occidentalis* - buckbrush
- Bromus inermis* - smooth brome
- Helianthus pauciflorus* - stiff sunflower
- Rosa arkansana* - prairie rose
- Sonchus oleraceus* - field sow thistle
- Liatris ligulistylis* - round-headed blazing star



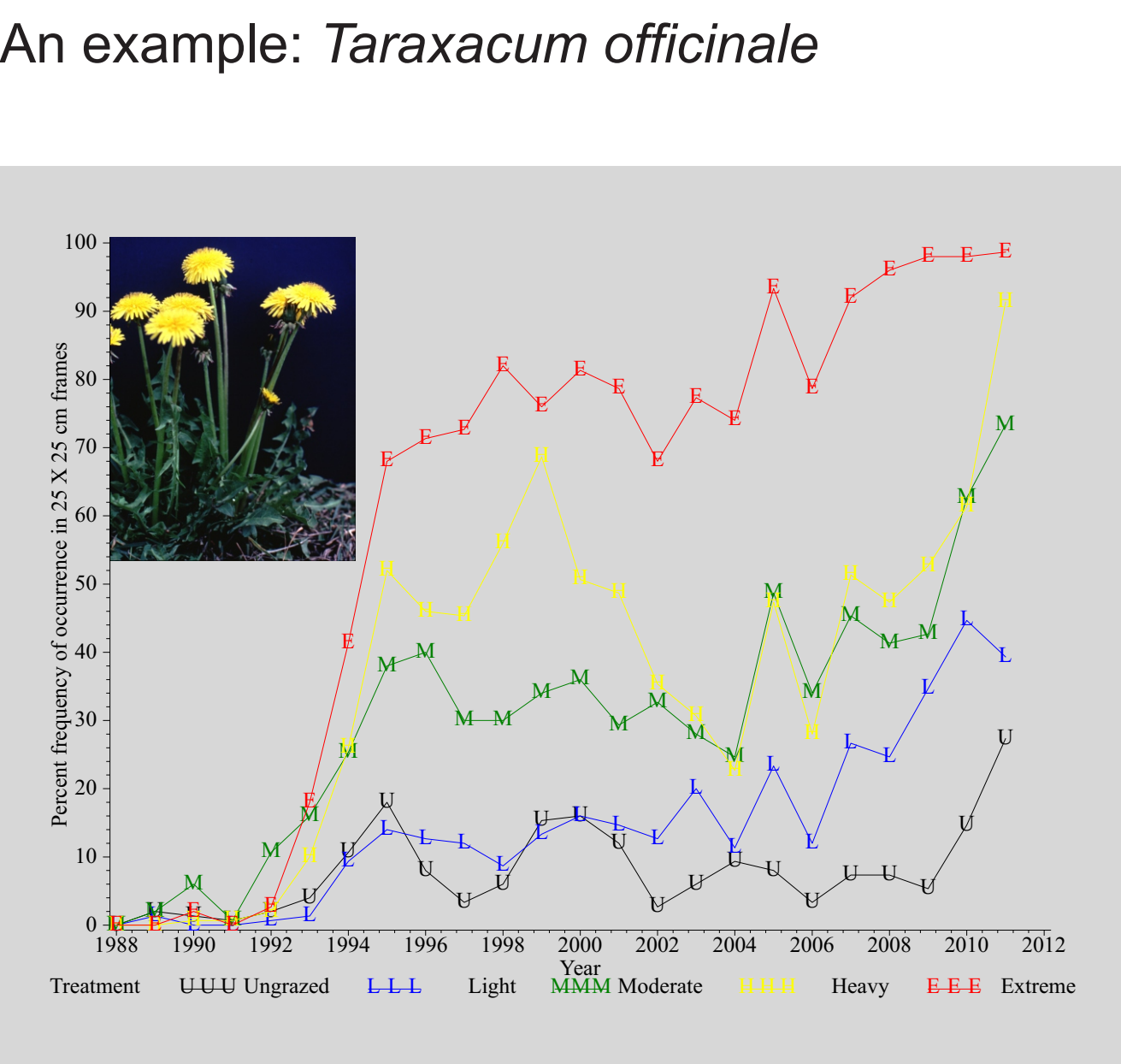
Some species favored by **moderate** grazing:

- Oligoneuron rigidum* - stiff goldenrod
- Ambrosia psilostachya* - western ragweed
- Solidago canadensis* - Canada goldenrod
- Glycyrrhiza lepidota* - wild licorice
- Solidago mollis* - soft goldenrod
- Carex lanuginosa* - wooly sedge



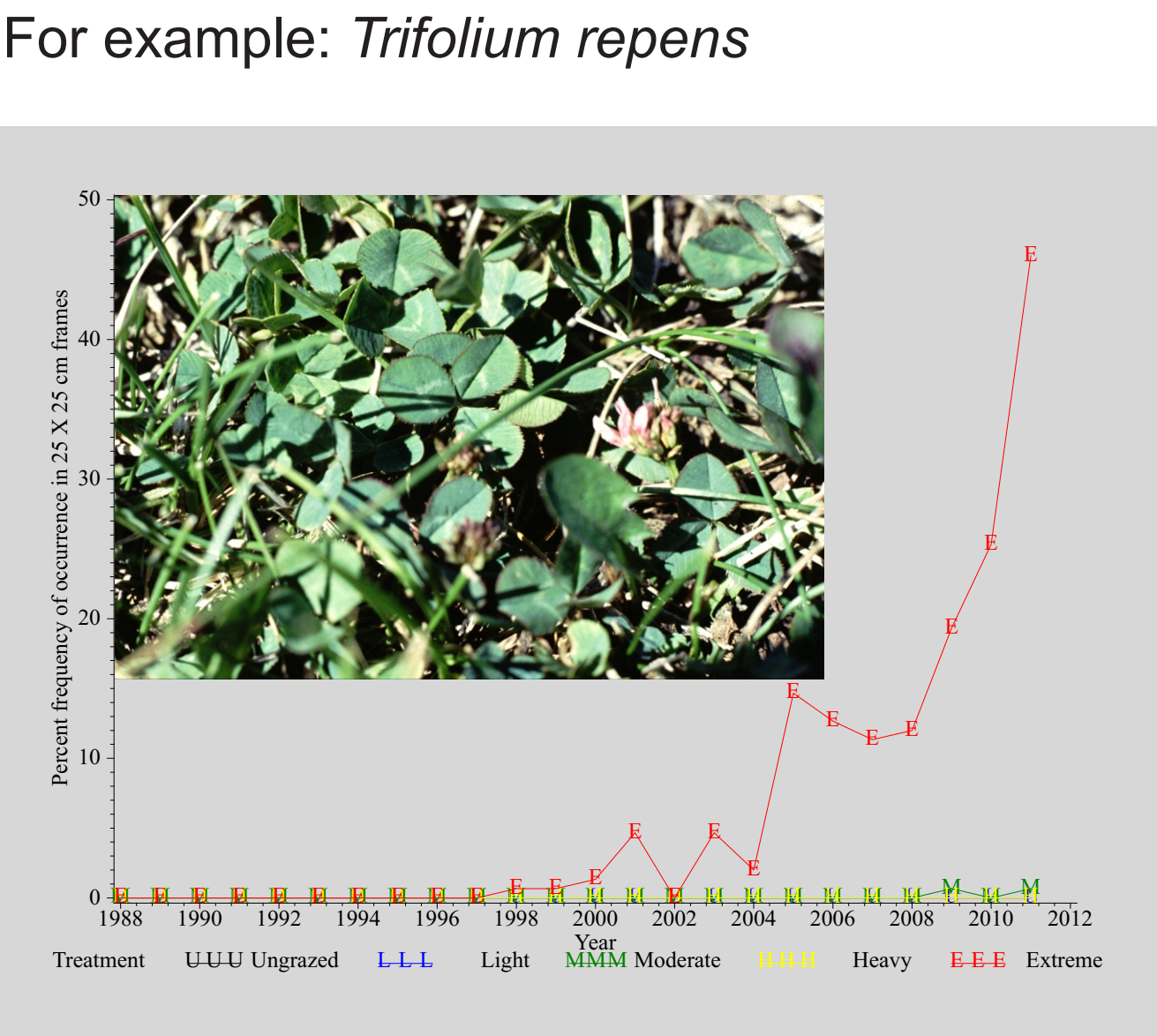
Some species that **increase** under grazing:

- Poa pratensis* - Kentucky bluegrass
- Symphotrichum ericoides* - heath aster
- Artemisia ludoviciana* - cudweed sagewort
- Carex obtusata* - obtuse sedge
- Achillea millefolium* - western yarrow
- Carex inops* ssp. *heliophila* - sun sedge



Species that appear **only after heavy** grazing:

- Medicago lupulina* - black medic
- Trifolium repens* - white clover
- Polygonum ramosissimum* - bushy knotweed
- Lithospermum incisum* - yellow puccoon
- Lepidium densiflorum* - peppergrass



## Livestock Response

Average daily gain and condition scores decrease as grazing intensity increases. Gain per ton of forage initially goes up as grazing intensity increases, but there is a point beyond which gain per ton decreases with increasing grazing intensity.

Average daily gains, gains per acre, gain per ton of forage and condition scores from different stocking intensities.						
Desired Grazing Intensity	Average Daily Gains (lbs./head/day)					Average 1991-2011
	2007	2008	2009	2010	2011	
Light	1.36	1.75a <sup>1</sup>	2.05a	1.54	1.59	1.40a
Moderate	1.22	1.58ab	1.99a	1.29	1.32	1.28a
Heavy	1.33	1.35b	1.48b	1.09	1.30	1.11b
Extreme	1.16	0.95c	1.09b	1.02	1.17	0.87c
LSD (0.05)	NS <sup>2</sup>	0.38	0.42	NS	NS	0.13

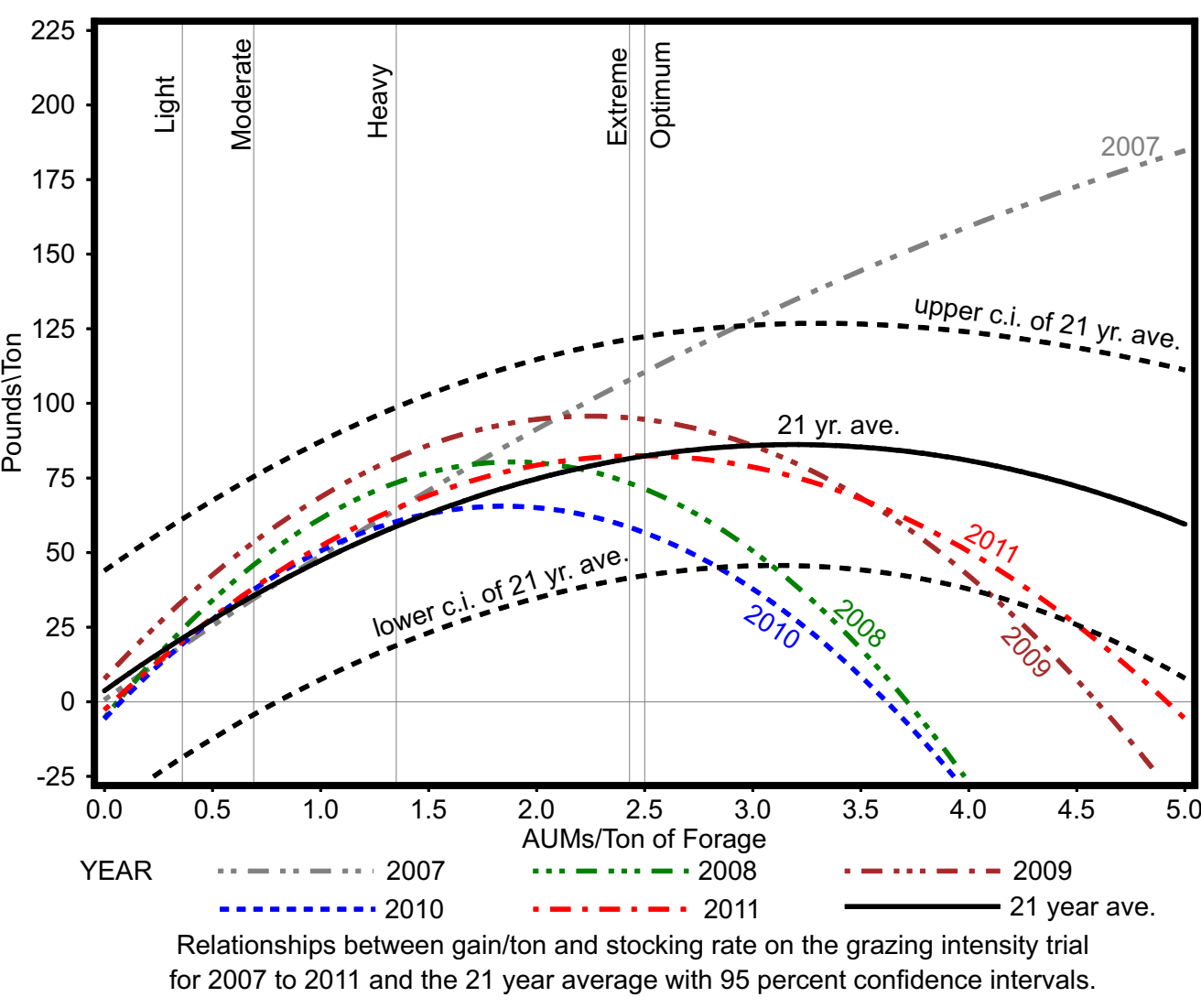
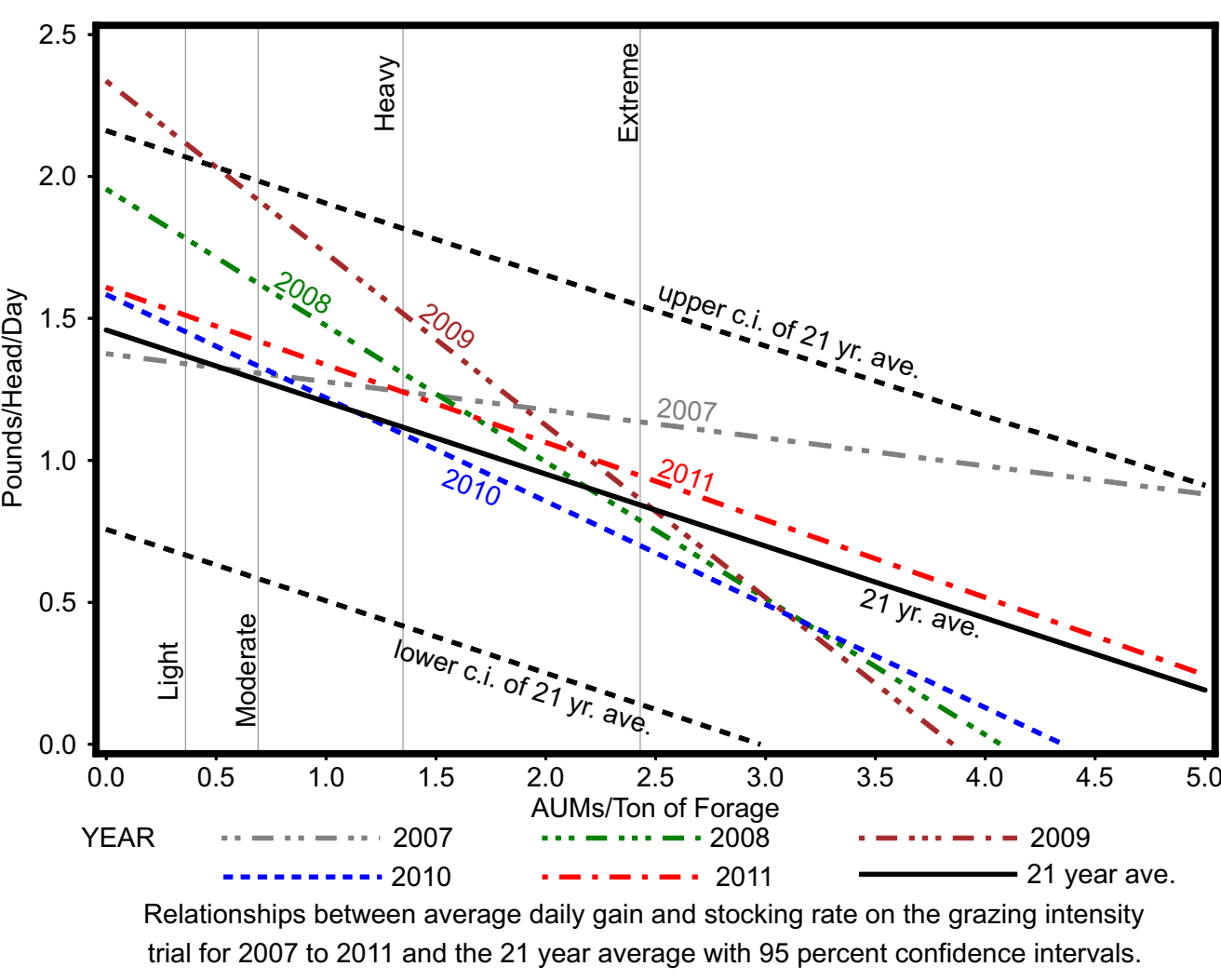
Average Gain (lbs./acre)						
Treatment	2007	2008	2009	2010	2011	Average 1991-2011
	44.41c	39.73b	47.37b	41.58	51.55c	31.05d
Light	69.27bc	68.61ab	90.63a	68.95	83.22bc	56.53c
Moderate	107.47ab	82.15a	92.72a	84.55	121.11ab	78.58b
Heavy	122.96a	76.10a	90.79a	104.70	140.29a	89.73a
Extreme	42.67	29.04	34.31	NS	54.49	9.95
LSD (0.05)						

Average Gain (lbs./ton of forage)						
Treatment	2007	2008	2009	2010	2011	Average 1991-2011
	23.19c	27.11c	33.80b	19.01c	21.69b	19.63d
Light	39.26bc	51.13b	62.10ab	31.24bc	32.82b	35.07c
Moderate	64.56ab	70.51ab	77.50a	52.54ab	58.61a	59.18b
Heavy	82.26a	78.22a	92.90a	64.87a	74.00a	73.44a
Extreme	27.81	22.96	33.78	27.37	22.96	7.63
LSD (0.05)						

Condition Score						
Treatment	2007	2008	2009	2010	2011	Average 1994-2011
	5.60	6.99a	5.77	5.24	5.41	5.47a
Light	5.50	6.51b	5.52	5.19	5.33	5.36ab
Moderate	5.54	6.98b	5.46	5.16	5.42	5.25b
Heavy	5.41	5.82c	4.97	5.05	5.25	4.99c
Extreme	NS	0.39	NS	NS	NS	0.17
LSD (0.05)						

<sup>1</sup>Means in the same column followed by the same letter are not significantly different at p=0.05.

<sup>2</sup>Means not significantly different.

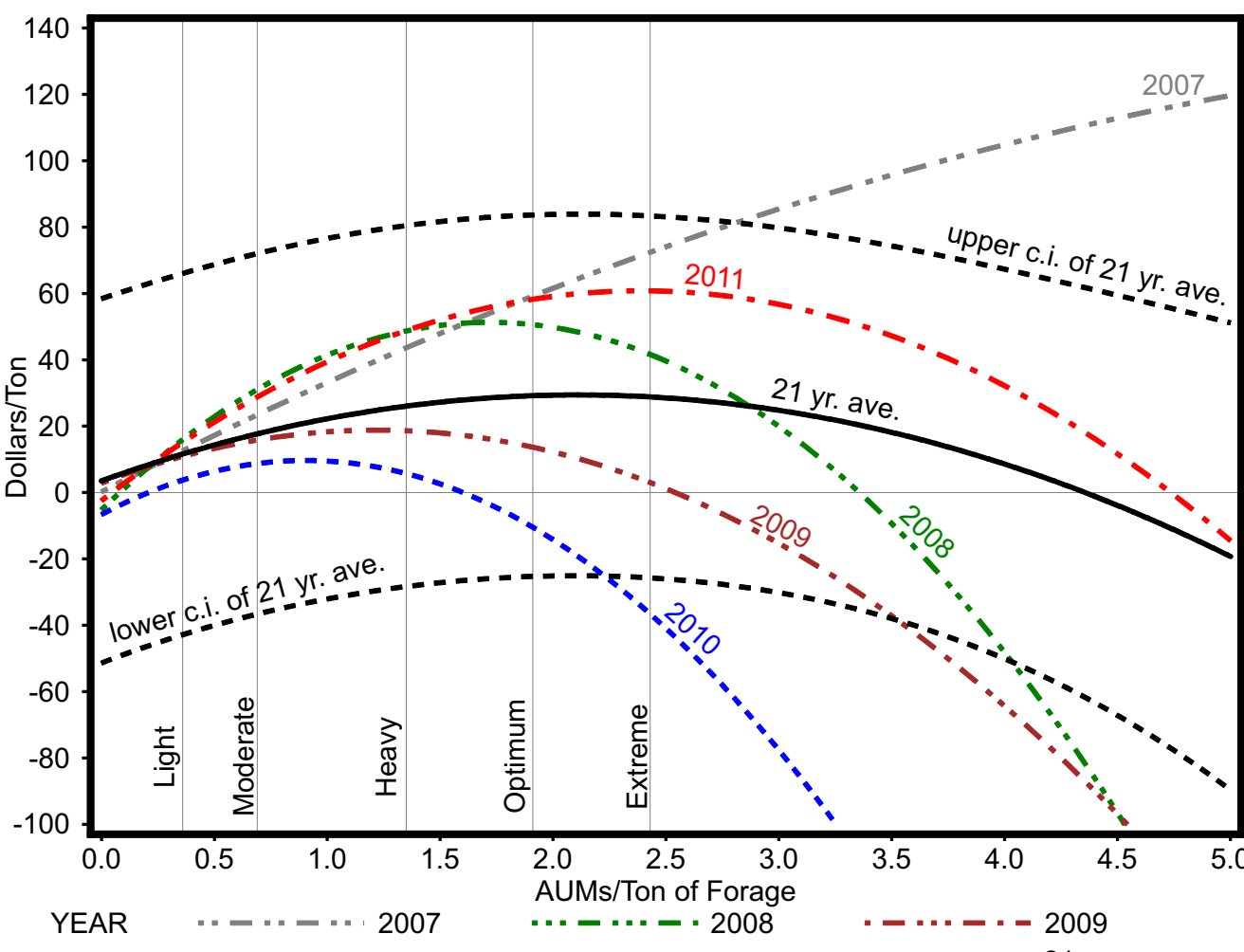


Comparison of gain in pounds per ton of forage from selected stocking rates.						
Year	Stocking rate in AUMs/ton of forage that would result in the maximum gain/ton in each year.		Stocking rate in AUMs/ton of forage that if held constant would result in the maximum gain/ton over the twenty one year period.		Gain/ton over the twenty one year period if stocking rate were held constant at 0.69 AUMs/ton of forage, the average of the moderate treatment over this period.	
	AUMs/ton of forage	Gain/ton	AUMs/ton of forage	Gain/ton	AUMs/ton of forage	Gain/ton
1991	0.42	1.81	1.91	56.4	0.69	27.4
1992	*	*	1.91	56.4	0.69	56.3
1993	1.42	\$59.35	1.91	\$52.33	0.69	\$43.97
1994	0.29	\$1.04	1.91	(\$14.68)	0.69	\$0.07
1995	0.86	\$0.53	1.91	(\$6.88)	0.69	\$0.33
1996	2.57	\$32.88	1.91	\$30.59	0.69	\$14.64
1997	1.13	\$15.53	1.91	\$6.00	0.69	\$12.60
1998	0.63	\$0.31	1.91	(\$11.67)	0.69	\$0.28
1999	3.53	\$55.20	1.91	\$43.10	0.69	\$18.23
2000	2.06	\$16.15	1.91	\$16.05	0.69	\$8.13
2001	*	*	1.91	\$43.17	0.69	\$18.32
2002	0.00	\$12.93	1.91	(\$18.36)	0.69	(\$3.52)
2003	*	*	1.91	\$83.05	0.69	\$34.61
2004	1.98	\$83.72	1.91	\$83.58	0.69	\$42.53
2005	1.47	\$11.28	1.91	\$10.22	0.69	\$7.92
2006	*	*	1.91	\$70.63	0.69	\$27.71
2007	*	*	1.91	\$59.09	0.69	\$23.49
2008	1.72	\$51.30	1.91	\$50.63	0.69	\$31.14
2009	1.22	\$18.82	1.91	\$13.72	0.69	\$15.85
2010	0.90	\$9.67	1.91	(\$10.28)	0.69	\$8.77
2011	2.39	\$60.81	1.91	\$58.21	0.69	\$28.88
21-year avg.	1.41	\$36.36	1.91	\$30.15	0.69	\$17.63

\* The regressions for 1992, 2001, 2003, 2006 and 2007 were not suitable to project the peak in returns to land, labor and management.

## Economics

If cattle prices were constant, then return/ton would peak at a stocking rate somewhere below maximum gain/ton, with the exact point depending on carrying costs. The change in cattle prices over the season determines the stocking rate with the maximum return/ton. The stocking rate with the maximum return/ton over the last 21 years would be 1.91 AUM/ton, with an average annual return of \$30.19/ton.



Comparison of return to land, labor and management from selected stocking rates.						
Year	Stocking rate in AUMs/ton of forage that would result in the maximum returns/ton to land, labor and management in each year.		Stocking rate in AUMs/ton of forage that if held constant would result in the maximum returns/ton to land, labor and management over the twenty one year period.		Returns/ton to land, labor and management over the twenty one year period if stocking rate were held constant at 0.69 AUMs/ton of forage, the average of the moderate treatment over this period.	
	AUMs/ton of forage	Dollars/ton	AUMs/ton of forage	Dollars/ton	AUMs/ton of forage	Dollars/ton
1991	0.42	\$1.81	1.91	(\$8.41)	0.69	\$1.45
1992	*	*	1.91	\$83.36	0.69	\$44.92
1993	1.42	\$59.35	1.91	\$52.33	0.69	\$43.97
1994	0.29	\$1.04	1.91	(\$14.68)	0.69	\$0.07
1995	0.86	\$0.53	1.91	(\$6.88)	0.69	\$0.33
1996	2.57	\$32.88	1.91	\$30.59	0.69	\$14.64
1997	1.13	\$15.53	1.91	\$6.00	0.69	\$12.60
1998	0.63	\$0.31	1.91	(\$11.67)	0.69	\$0.28
1999	3.53	\$55.20	1.91	\$43.10	0.69	\$18.23
2000	2.06	\$16.15	1.91	\$16.05	0.69	\$8.13
2001	*	*	1.91	\$43.17	0.69	\$18.32
2002	0.00	\$12.93	1.91	(\$18.36)	0.69	(\$3.52)
2003	*	*	1.91	\$83.05	0.69	\$34.61
2004	1.98	\$83.72	1.91	\$83.58	0.69	\$42.53
2005	1.47	\$11.28	1.91	\$10.22	0.69	\$7.92
2006	*	*	1.91	\$70.63	0.69	\$27.71
2007	*	*	1.91	\$59.09	0.69	\$23.49
2008	1.72	\$51.30	1.91	\$50.63	0.69	\$31.14
2009	1.22	\$18.82	1.91	\$13.72	0.69	\$15.85
2010	0.90	\$9.67	1.91	(\$10.28)	0.69	\$8.77
2011	2.39	\$60.81	1.91	\$58.21	0.69	\$28.88
21-year avg.	1.41	\$36.36	1.91	\$30.15	0.69	\$17.63

\* The regressions for 1992, 2001, 2003, 2006 and 2007 were not suitable to project the peak in returns to land, labor and management.

## Conclusions

After 21 years, this study has demonstrated that:

- Biomass production is greatest with a light or moderate stocking rate.
- Plant species diversity is lowest under no grazing and increases with grazing intensity, although many of the species that increase under extreme grazing are weedy or invasive.
- Individual animal daily gains and condition scores decrease with increasing grazing intensity.
- Gain per ton of available forage peaks at around 2.49 AUM/ton of forage.
- Economic return peaks at around 1.91 AUM/ton of forage.

For more information, visit the CGREC website:  
[www.ag.ndsu.edu/CentralGrasslandsREC/](http://www.ag.ndsu.edu/CentralGrasslandsREC/)

