Biomasses of Arthropod Taxa Differentially Increase on Nitrogen-Fertilized Willows and Cottonwoods

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1) Insects and spiders require water and nitrogen (mostly in proteins) to grow and reproduce.

2) Plant-feeding insects (11% N) obtain water and nitrogen from their host plants (3% N).

3) Greater water and nitrogen concentrations in plants generally increase populations of plant-feeding insects.

For example:

-- many ‘watery’ crops like lettuce and apples are eaten by large numbers of insects

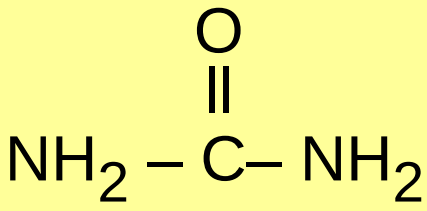
-- applying N fertilizer to a crop or ornamental frequently increases insect-pest abundance

-- egg-laying MacNeill’s sootywings select quailbrush shrubs with high water and N contents (which are correlated)

Insectivorous wildlife require spiders and insects for food.

Can populations of insects or spiders be increased by N-fertilizing trees and shrubs planted for wildlife habitat?

I fertilized 1 year old *Salix exigua* shrubs and *Populus fremontii* trees at PVER during 2008 with urea (aka carbamide):



46% N

1.1 kg (2.4 lb) applied once in early April to the base of each plant

Decomposes in soil to ammonia and nitrate

1) 4 rows in 2 blocks were selected that crossed both species

2) 8 plants of each species in each row were flagged & alfalfa cleared

Flagged plants in 2 rows were fertilized

- in each sp., 16 plants fertilized and 16 plants not fertilized

3. 2 plants of each species in each row were sampled
   once in May, June, July, and August

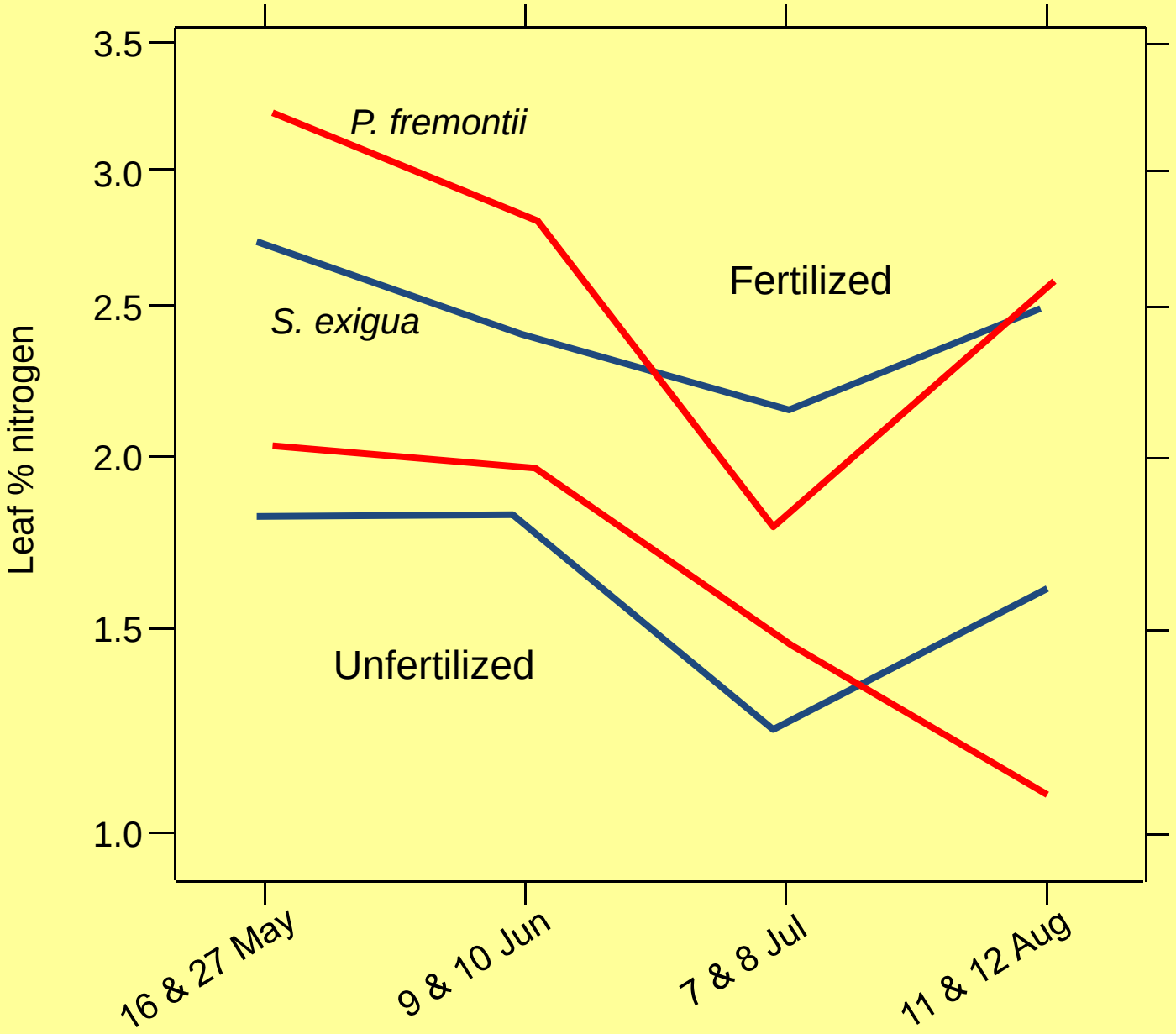
4. 1 branch at trunk was:
   -- enclosed in a fine-mesh bag
   -- fumigated with household insecticide-fogger (N-free)
      and shaken to collect spiders and insects into vial
   -- cut from tree and weighed with spring scale

5. I measured: branch % water
   leaf % N with Kjeldahl digestion

6. I calculated per arthropod taxon: abundance -- *n* / branch kg
   mass -- wet mg / branch kg

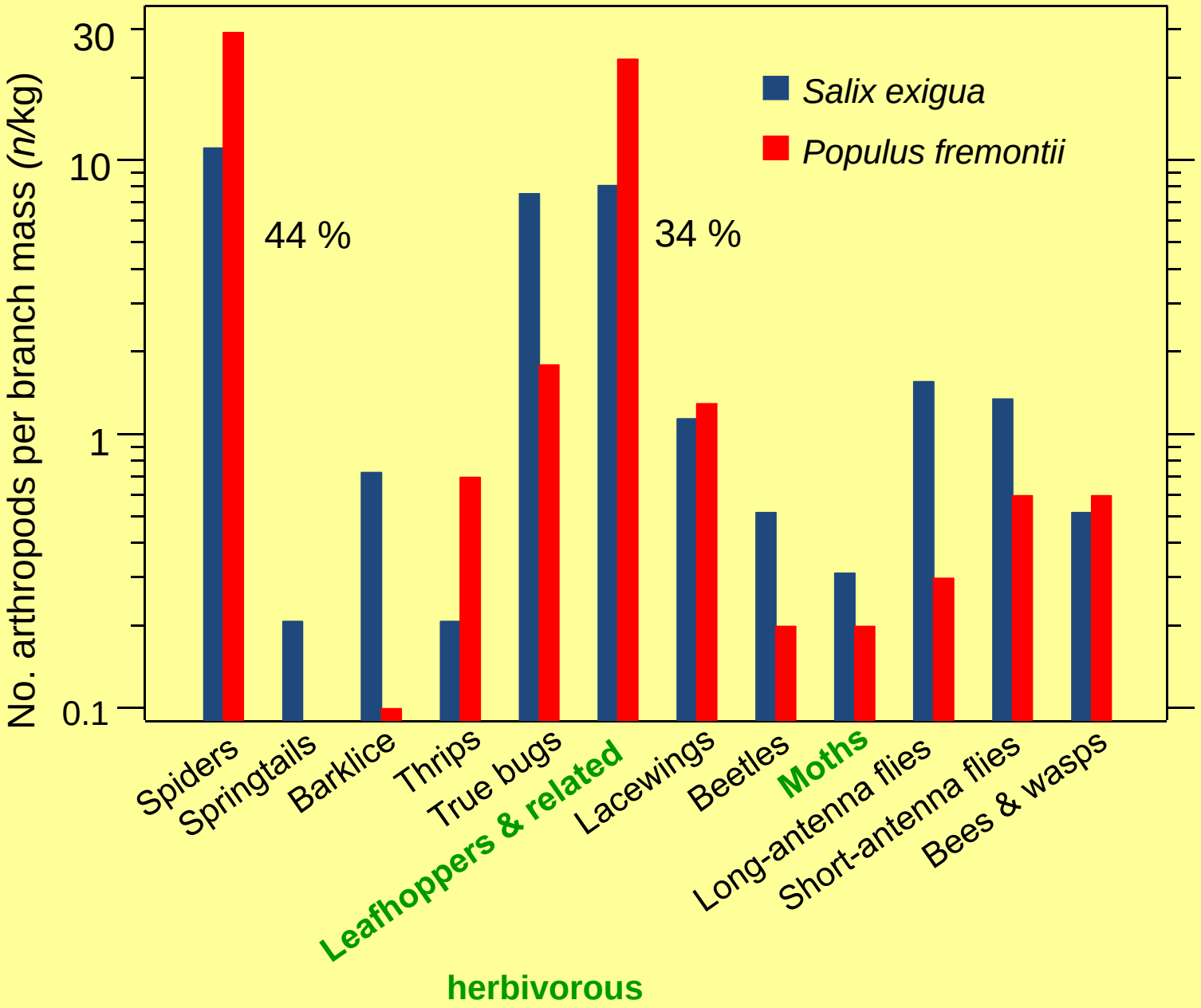
N-Fertilizer Effects on Plant Water and Nitrogen

	Salix exigua		*Populus fremontii*	
	Fertilizer Application	**Fertilizer X Month**	**Fertilizer Application**	**Fertilizer X Month**
Branch % water	***P* < 0.001** **64.4 to 66.5%**	***P* = 0.030**	***P* = 0.001** **68.1 to 70.1%**	***P* = 0.75**
Leaf % N	***P* = 0.001** **1.6 to 2.4%**	***P* = 0.91**	***P* < 0.001** **1.6 to 2.4%**	***P* = 0.087**


Leaf % nitrogen
3.5
3.0
2.5
2.0
1.5
1.0
P. fremontii
S. exigua
Fertilized
Unfertilized
16 & 27 May
9 & 10 Jun
7 & 8 Jul
11 & 12 Aug

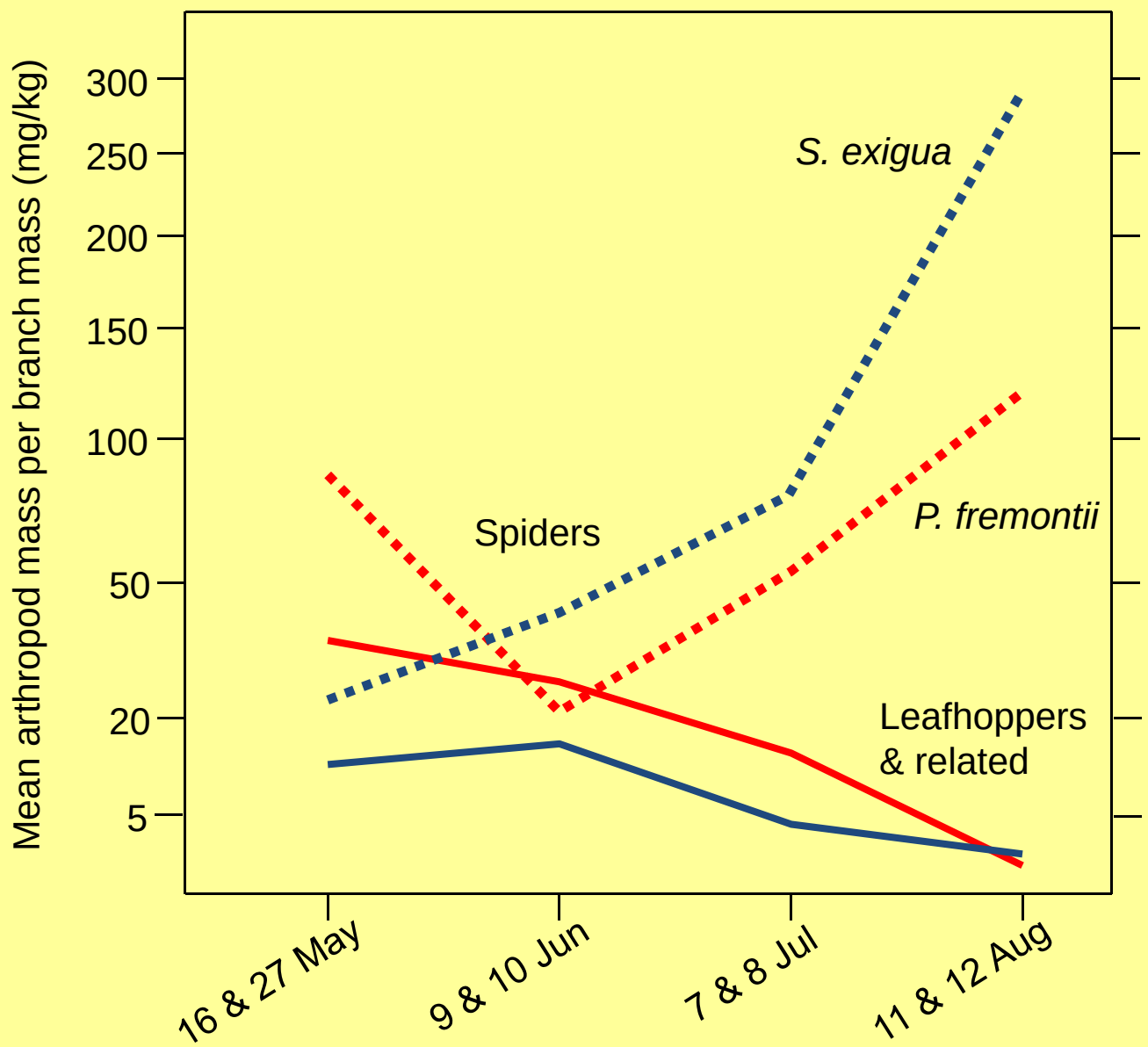
Salix exigua branch, 462 g, not fertilized, 10 June 2008

Populus fremontii branch, 417 g, fertilized, 27 May 2008

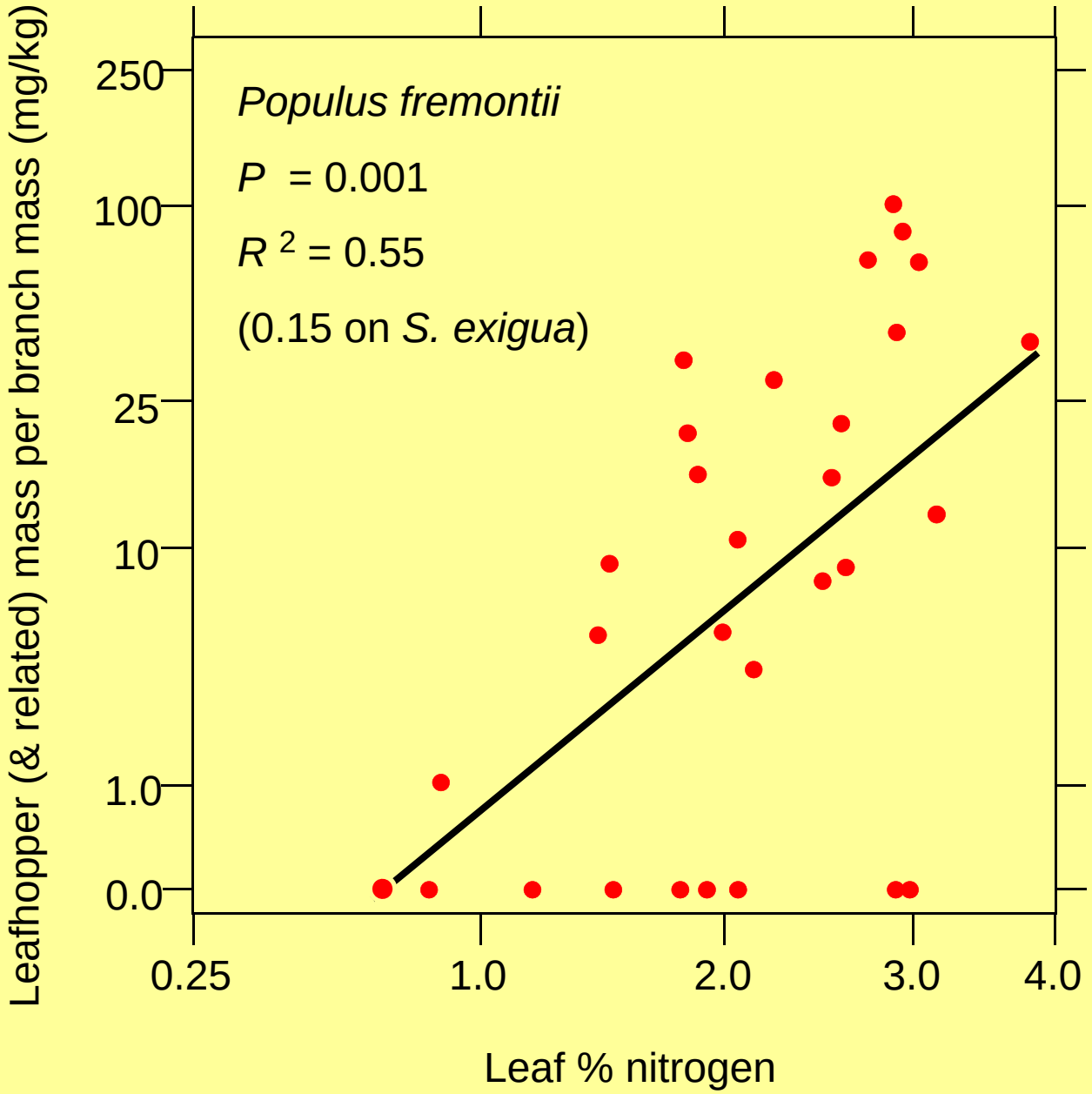

No. arthropods per branch mass (n/kg)
30
10
1
0.1
Salix exigua
Populus fremontii
44 %
34 %
Spiders
Springtails
Barklice
Thrips
True bugs
Leafhoppers & related
Lacewings
Beetles
Moths
Long-antenna flies
Short-antenna flies
Bees & wasps
herbivorous

N-Fertilizer Effects on Spider & Insect Mass

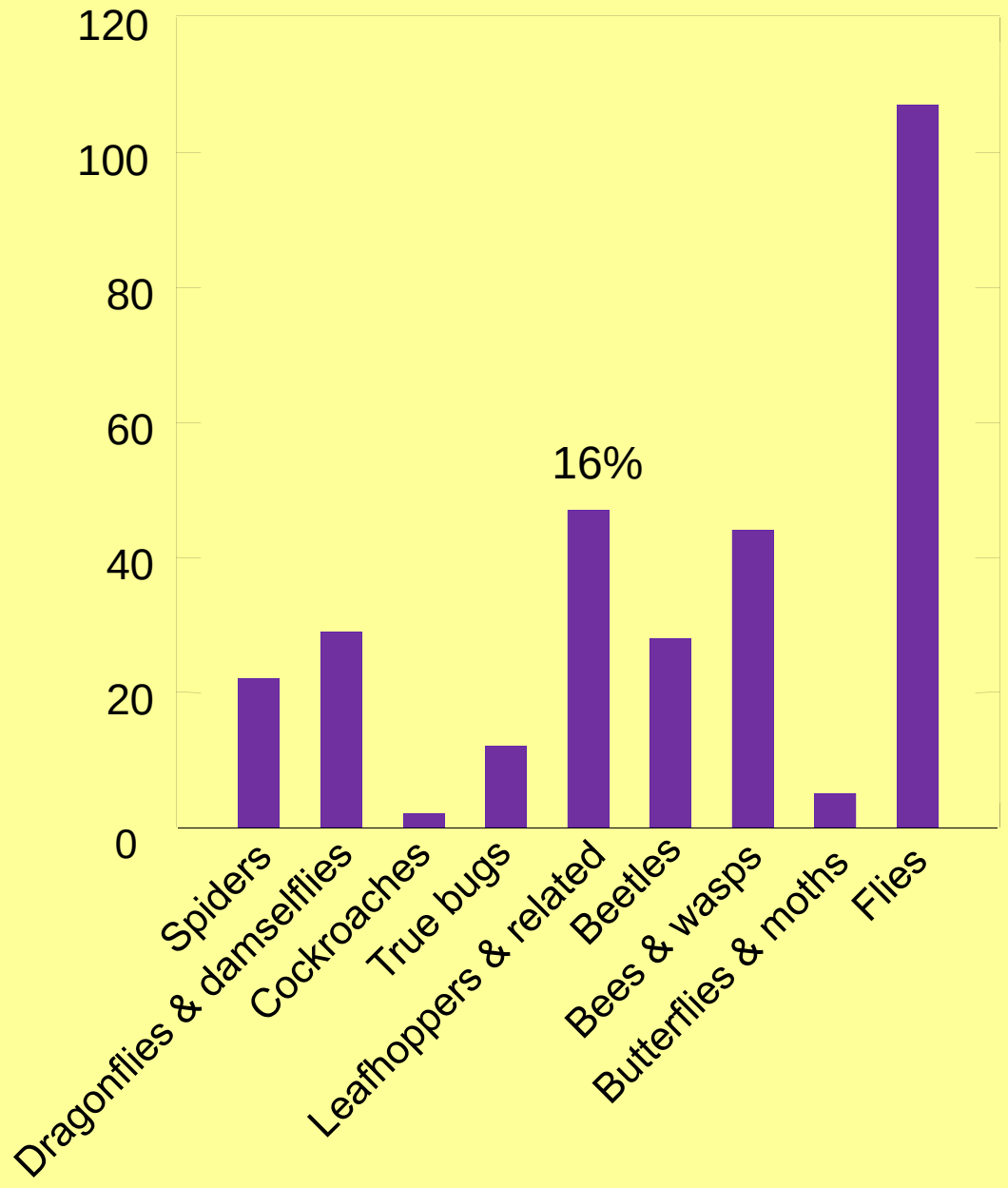
	Salix exigua		***Populus fremontii***	
	Fertilizer Application	**Fertilizer X Month**	**Fertilizer Application**	**Fertilizer X Month**
Spiders & Insects	***P* = 0.65**	***P* = 0.98**	***P* = 0.34**	***P* = 0.09**
Leafhoppers & related	***P* = 0.008** **197% increase**	***P* = 0.88**	***P* = 0.024** **228% increase**	***P* = 0.40**


Mean arthropod mass per branch mass (mg/kg)
300
250
200
150
100
50
20
5
S. exigua
P. fremontii
Spiders
Leafhoppers
& related
16 & 27 May
9 & 10 Jun
7 & 8 Jul
11 & 12 Aug

Populus fremontii branch, 416 g, fertilized, 16 May 2008


Leafhopper (& related) mass per branch mass (mg/kg)
250
100
25
10
1.0
0.0
0.25
1.0
2.0
3.0
4.0
Leaf % nitrogen
Populus fremontii
P = 0.001
R 2 = 0.55
(0.15 on S. exigua)

Number of spiders & insects found in fecal samples from willow flycatchers at Mesquite NV and Pahranagat & Havasu NWR's in 2004



Conclusions

1. Applying N-fertilizer increases abundances and masses of leafhoppers and related aphids & psyllids -- insects that are eaten by birds.

2. Overall spider & insect abundances and masses were not increased by applying N-fertilizer.

3. Unexpectedly – applying N-fertilizer slightly but significantly increased branch water content.

Acknowledgement – I thank Amy Stephenson at BR's Boulder City Lab for helping with N analyses