Approaches for assessing local and regional impacts of the stem mining weevil *Mecinus janthinus* on exotic toadflax and the wider vegetation community in western N.A. rangelands and forests

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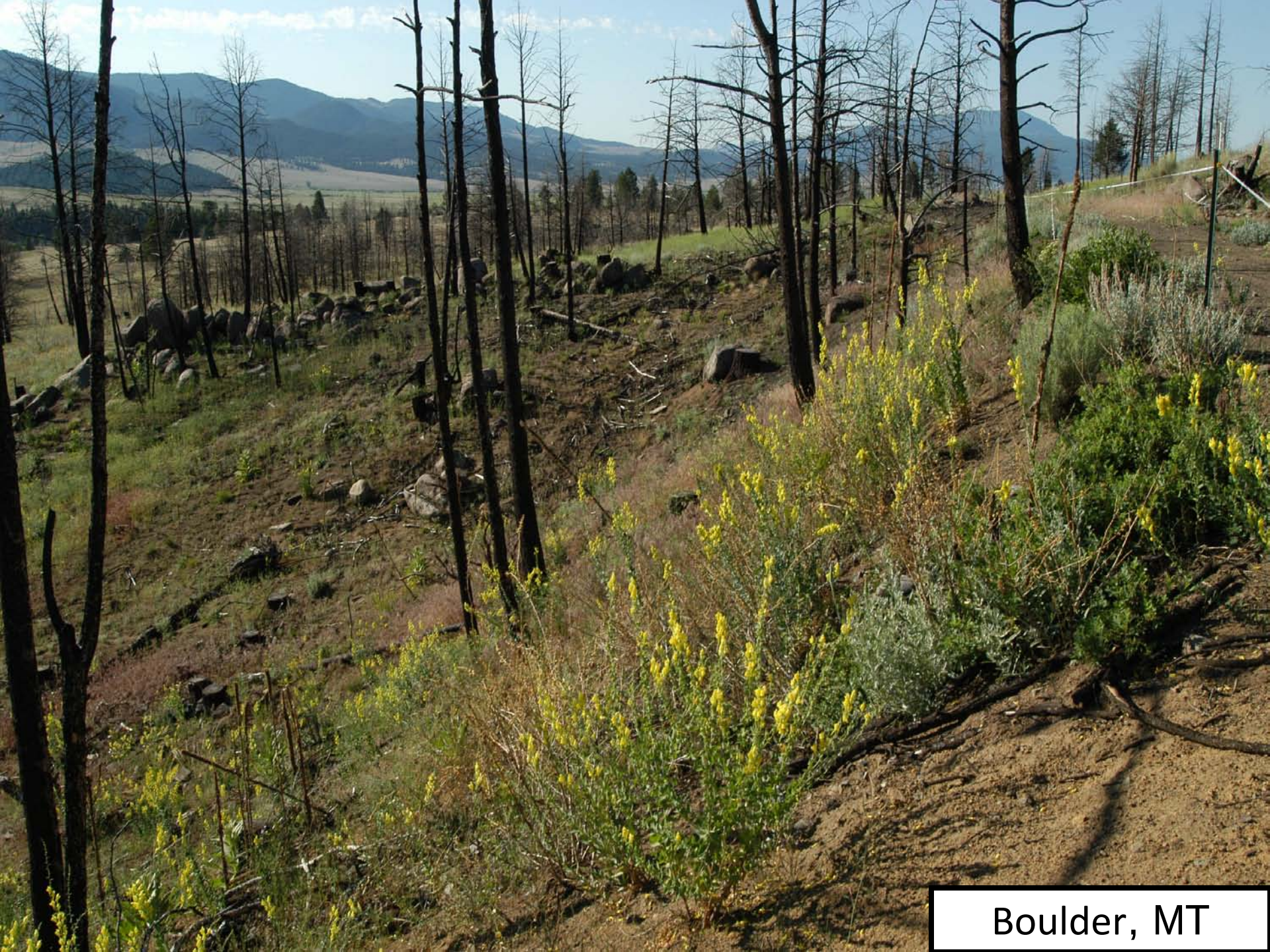
Dalmatian toadflax

- short-lived perennial of Eurasian origin
- mature plants capable of producing up to 500,000 seeds
- seeds persist up to 10 years in seedbank
- *introduced to NA in late 1800s as an ornamental; earliest authenticated specimen 1920 (CA)
- chemical control expensive - results unpredictable
- presence highly correlated with disturbance


Boulder, MT


Melstone, MT

History: Toadflax BC in NA

- 3 adventively-introduced herbivores:

Brachypterolus pulicarius (ovary-feeding beetle); *Rhinusa antirrhini* and *R. neta* (seed capsule-feeding weevils)

- classical bc program for toadflax initiated late 1960s w/ intentional release of *Calophasia lunula* (defoliating moth)
- 4 additional agents approved & released late 1990s: *Eteobalea intermediella* and *E. serratella* (root-boring moths); a *Rhinusa linariae* (root-galling weevil); and *Mecinus janthinus* (stem-mining weevil)

Mecinus janthinus:

- stem-mining weevil
- native range: central and southern Europe, southern Russia
- first North American releases - 1991
- adults: attack foliage and flower buds, reduce flowering and may kill upper stem
- larvae: mine stems, may interfere with translocation of plant nutrients
- one generation per year
- adults develop and over-winter in stems from eggs laid in late spring

Mecinus janthinus Germar

Local assessment

Field methods - local impact:

- study plots:
  - 50 x 50m (121 sample points)
  - 30 x 30m (49 sample points)
  - data recorded at 5m intervals
  - sample points permanently marked with plastic survey markers (‘road hairs’)
  - vegetation evaluated within Daubenmire frame (0.10 m^2)
  - 12 MT sites evaluated 2002-2007
  - included burned and unburned sites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Toadflax demographic data:

- stem counts
  - ‘plant’ status ambiguous without excavation
- stems categorized by life stage
  - mature (=reproductive) or immature stems
  - stem counts, heights (tallest, shortest, average)
- percent cover (basal)

Toadflax injury data:

- foliar adult weevil feeding
  - produces distinctive damage
    - ‘pinholes’
    - occurs in leaf interior not margins
- injury rating
  - based on percent total foliage damaged

Vegetation data:

- data attributes
  - percent cover (basal) by life form of
    - grasses
    - forbs
    - woody plants
    - select noxious weed species

Agent data:

- all of previous year's (dead) stems collected from each sample point bagged and labeled
- stems dissected to estimate:
  - emerged adults
  - dead adults, pupae and larvae
  - parasitism

Issues to consider - general:

- total veg cover low on many sites
- Dalmatian toadflax cover typically very low
  - 40% cover considered unusually high
  - 5-20% cover 'normal'
- irregular density and spatial arrangement of Dalmatian toadflax patches
  - lots of sample points within the patch have no toadflax
- data subject to influence of year-to-year climatic variability

Issues to consider – agent:

- MT establishment slow and difficult to detect
  - assessments made on sites where agent already present but in very low densities
- non-destructive sampling method can be unreliable
  - dissection of previous year's stems
    - unlikely to find and collect all live stems counted from previous year
  - weevil-infested stems weaker
    - prone to being moved by passing animals, wind
  - presence/absence of adult weevil feeding damage

Longitudinal data analysis:

- Used to study change over time, taking into account:
  - within-subject changes over time
    - not limited to comparison with baseline
    - informed by attribute value at previous time step
  - between subject changes over time
  - reduced frequency of measurements taken on large number of subjects (opposite of time series analysis)

Site name	jurisdiction	grid size (m)	sample number	2007 sample date
Barry's Meadow	Beaverhead-Deerlodge NF	50 x 50	121	6/12/2007
Bison Range	USFWS	50 x 50	121	7/16/2007
Cole's Point	Gallatin NF - Gardiner RD	50 x 50	121	7/10/2007
Crazy Creek	Lolo NF	30 x 30	49	7/19/2007
Crow	BIA	30 x 30	49	6/21/2007
Durnham Meadows	Gallatin NF - Bozeman RD	50 x 50	121	7/27/2007
Hardy Bridge	BLM/State Park	30 x 30	49	7/13/2007
Kingsberry Gulch	Helena NF - Helena RD	30 x 30	49	7/11/2007
Madison Arm	Gallatin NF - Hebgen Lake RD	30 x 30	49	7/23/2007
Madison Fork	Gallatin NF - Hebgen Lake RD	30 x 30	49	7/23/2007
Melstone	BLM/private	50 x 50	121	7/2/2007
Mount Helena	City of Helena/Helena NF	50 x 50	121	7/9/2007
Park City	City of Helena/Helena NF	50 x 50	121	6/13/2007
Radersburg 1	Helena NF - Townsend RD	50 x 50	121	6/19/2007
Radersburg 2	Helena NF - Townsend RD	30 x 30	49	6/20/2007
Rex Coulee	Gallatin NF - Gardiner RD	50 x 50	121	6/18/2007
Skytop East	Beaverhead-Deerlodge NF	50 x 50	121	n/a
Skytop West	Beaverhead-Deerlodge NF	50 x 50	121	n/a
Snowshoe Lane - L	Lolo NF	30 x 30	49	7/18/2007
Snowshoe Lane - U	Lolo NF	50 x 50	121	7/18/2007

Contribution of Dalmatian toadflax to total veg cover - Crow:

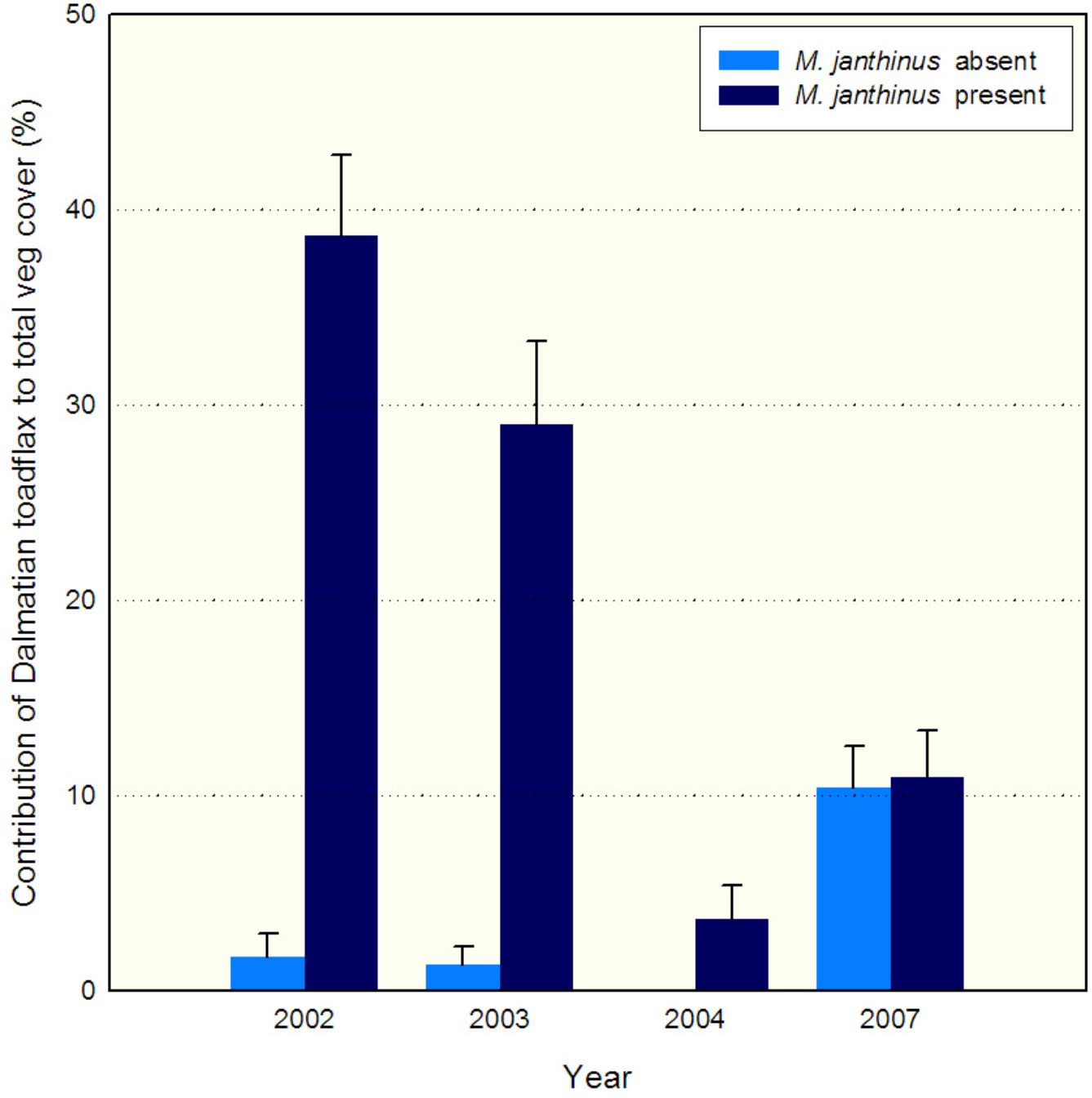
Mecinus janthinus initially absent:

- 2002 - Dalmatian toadflax made no contribution to total veg cover
- contribution of Dalmatian toadflax to total veg cover in these quadrats increased (2002-2007) at an annual rate of 2.5%

Contribution of Dalmatian toadflax to total veg cover - Crow:

Mecinus janthinus initially present:

- 2002 - Dalmatian toadflax contribution to total veg cover was 37.2%
- contribution of Dalmatian toadflax to total veg cover decreased (2002-2007) at an annual rate of 10.9%


50
40
30
20
10
0
Contribution of Dalmatian toadflax to total veg cover (%)
M. janthinus absent
M. janthinus present
2002
2003
2004
2007
Year

Contribution of Dalmatian toadflax to total forb cover - Crow:

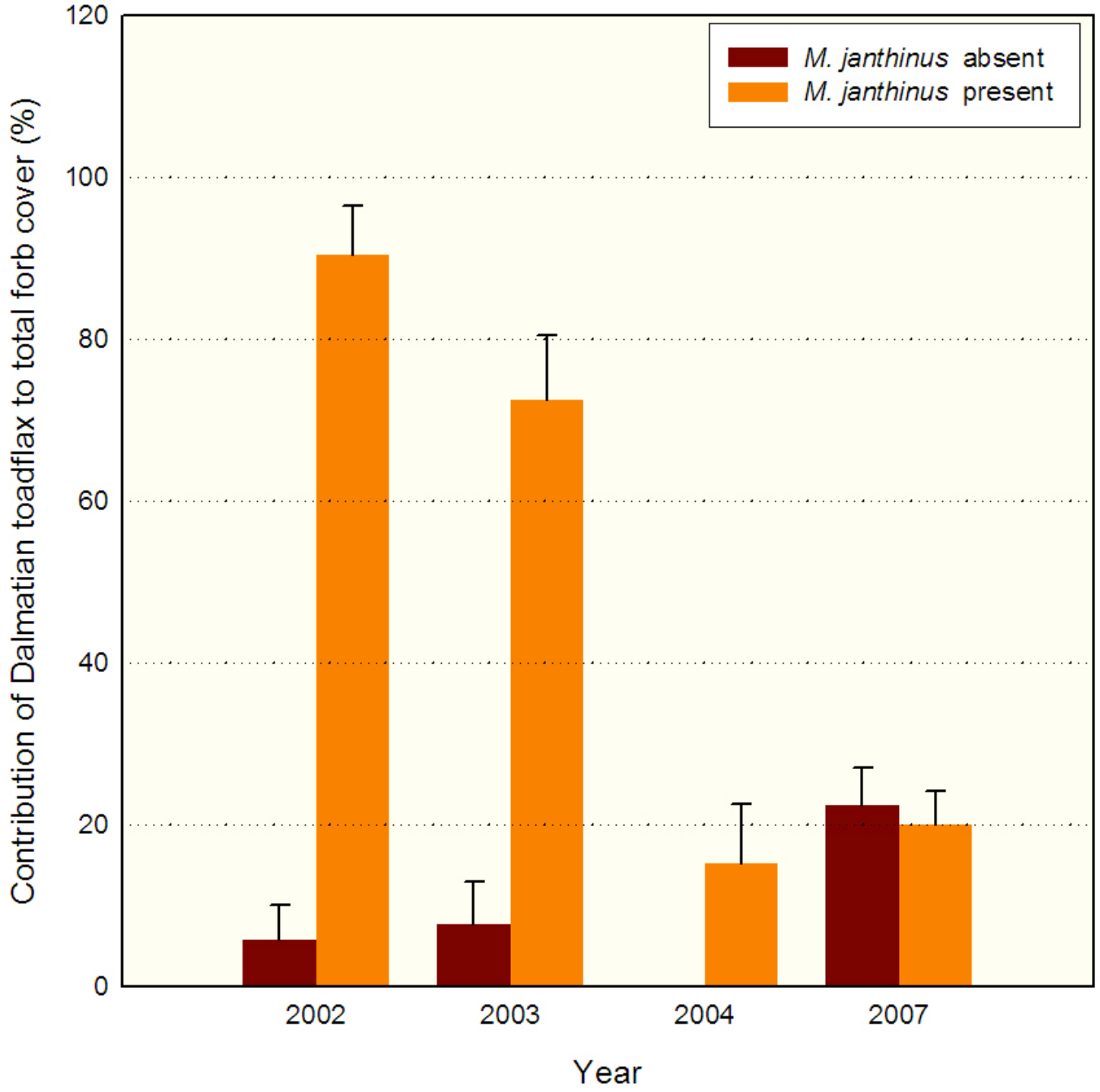
Mecinus janthinus initially absent:

- 2002 - Dalmatian toadflax contribution to total forb cover was 2.6%
- contribution of Dalmatian toadflax to total forb cover in these quadrats increased (2002-2007) at an annual rate of 4.2%

Contribution of Dalmatian toadflax to total forb cover - Crow:

Mecinus janthinus initially present:

- 2002 - Dalmatian toadflax contribution to total forb cover was 89.8%
- contribution of Dalmatian toadflax to total forb cover decreased (2002-2007) at an annual rate of 26.9%


120
100
80
60
40
20
0
Contribution of Dalmatian toadflax to total forb cover (%)
M. janthinus absent
M. janthinus present
2002
2003
2004
2007
Year

Summary – local impact

- *M. janthinus* feeding damage evident in 2002 - sharp decrease in toadflax contribution to total veg and total forb cover
- toadflax contribution to total veg and forb cover increased where feeding damage not evident in 2002
  - suggests agent affinity for high density infestations

Regional assessment

1996 – before release

1999 – after release

Field methods - regional impact:

- study location:
  - 40,000 km^2 in southeast British Columbia
  - Montane Cordillera Ecozone
  - 176 *M. janthinus* releases (1994-2002)
- comparison release vs. non-release sites:
  - 21 release patches
  - 21 non-release patches (@ 4.99 km from known release)
  - 23 reference release patches (sampled 1994, 1999 and 2000)

Toadflax demographic data:

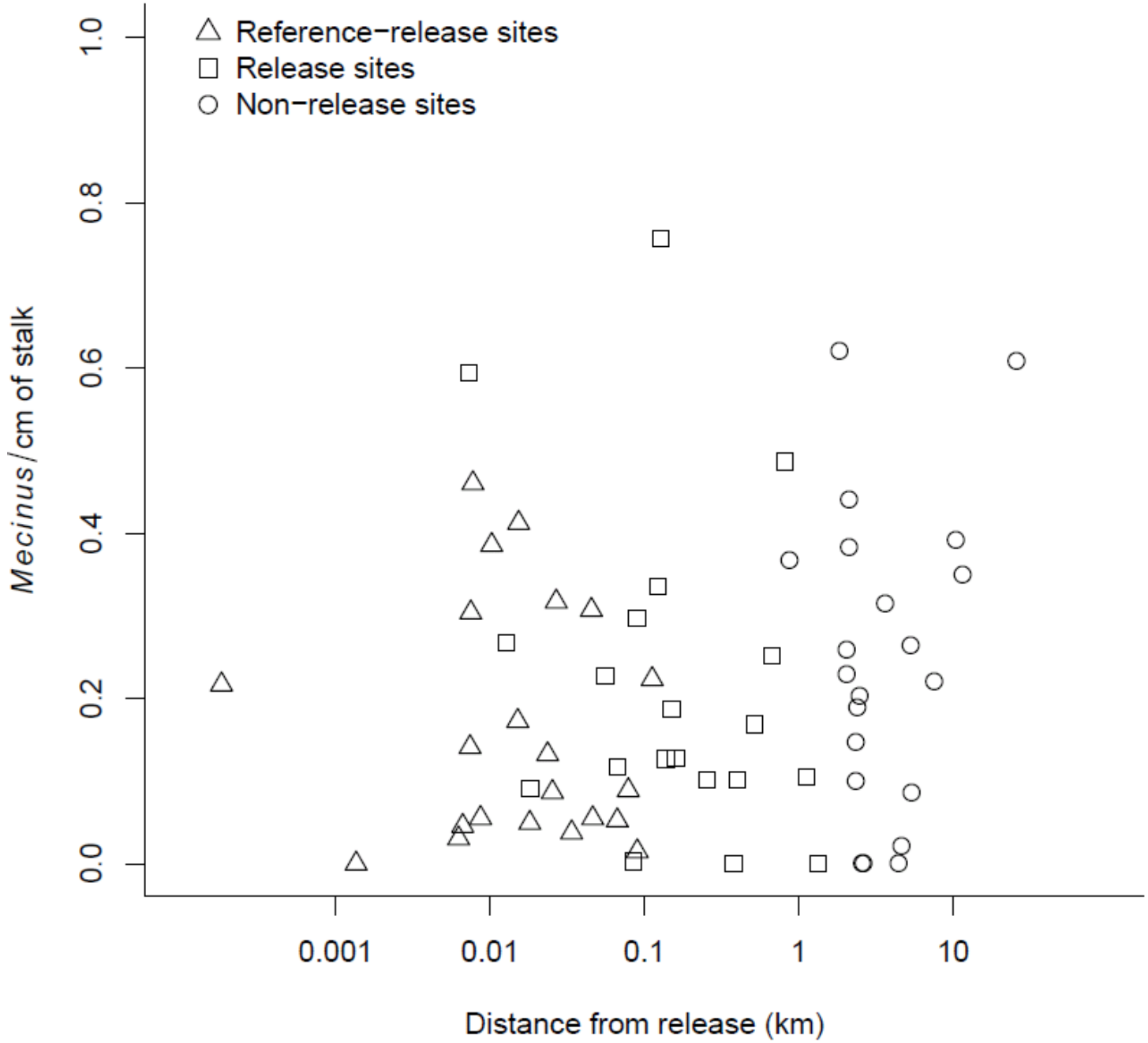
- toadflax distribution code
  - scale 1-9
  - incorporates density and spatial distribution
  - lower value=less dense, more sporadic occurrence
  - higher value=high density, more continuous
- additional data
  - percent cover, toadflax plant vigor, percent flowering (per 0.25m^2)

Agent data

- 5 intact stems collected for each hectare of patch area (max. 25) randomly collected to estimate weevil density
- stem lengths recorded before dissection to determine number and life-stage of weevils present

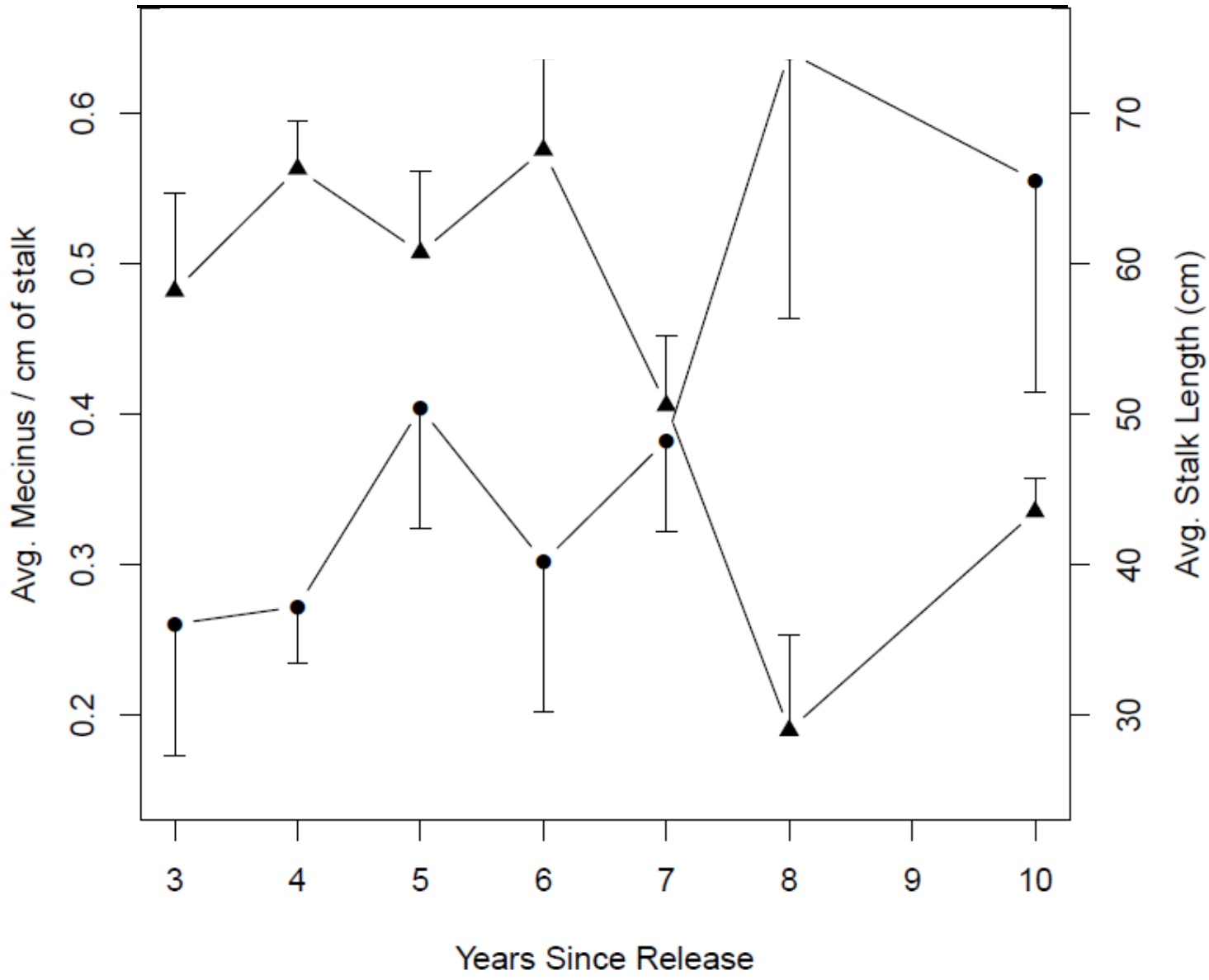
Data analysis:

- extent of MJ dispersal:
  - influence of distance from known release point on MJ density
  - linear regression of log transformed mean weevil density (weevils/cm of stem) against distance from release site


Reference−release sites
Release sites
Non−release sites
Mecinus/cm of stalk
0.0
0.2
0.4
0.6
0.8
1.0
0.001
0.01
0.1
1
10
Distance from release (km)

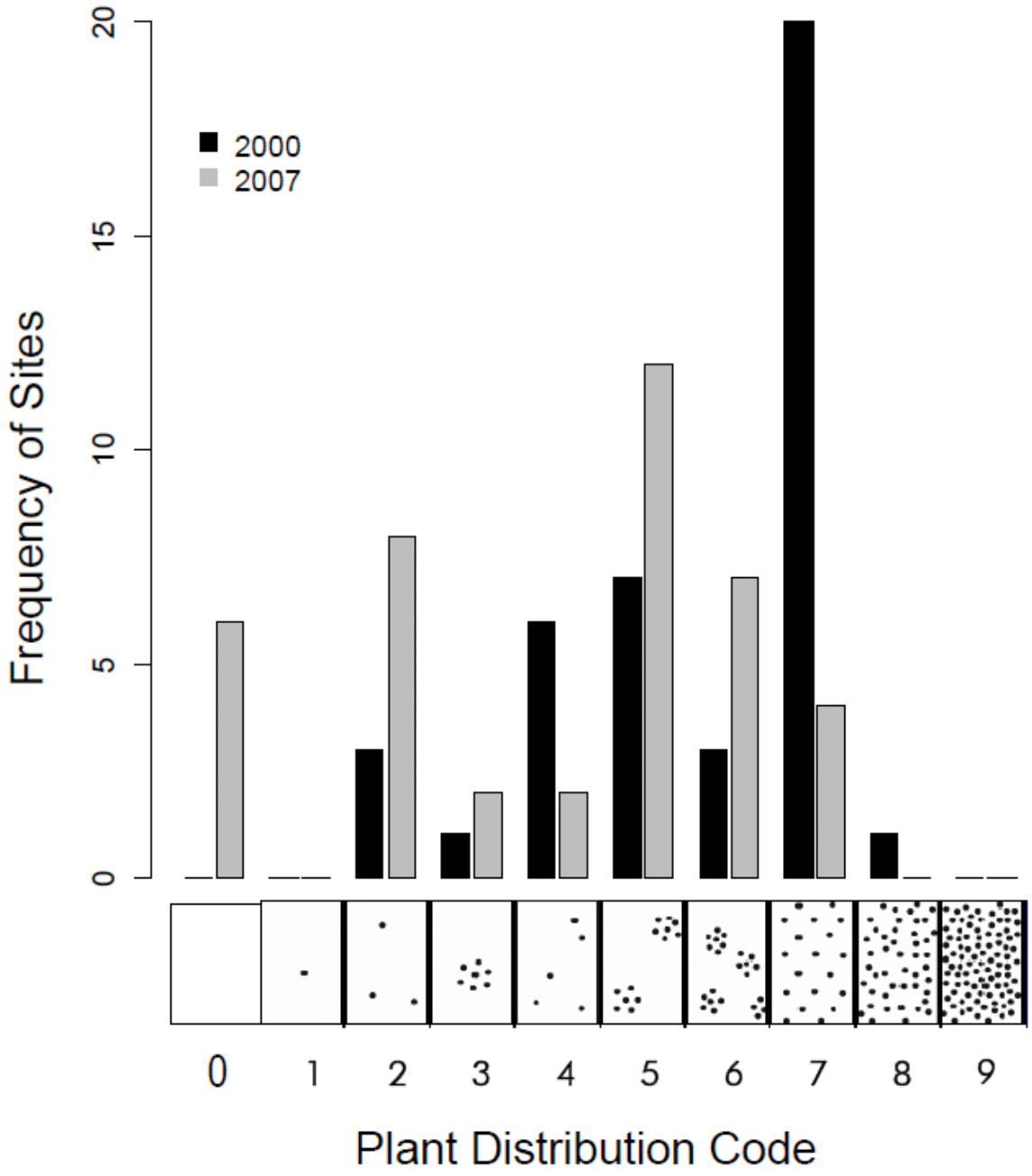
Data analysis:

- influence of MJ on size and density of DT plants:
  - chronosequence constructed of MJ establishment
    - 124 sites with MJ populations that were 3-10 years old in 2007
  - relationship between mean weevil density (weevils/cm of stem), average DT stem length, and approximated date of MJ establishment evaluated


Avg. Mecinus / cm of stalk
0.2
0.3
0.4
0.5
0.6
Avg. Stalk Length (cm)
30
40
50
60
70
3
4
5
6
7
8
9
10
Years Since Release

Data analysis:

- impact of MJ on regional DT spatial distribution:
  - 2000 and 2007 distribution codes from 63 sites compared
  - Wilcoxon rank sum test used to test for within site differences in DT density and spatial distribution


Frequency of Sites
0
5
10
15
20
2000
2007
0
1
2
3
4
5
6
7
8
9
Plant Distribution Code

Summary – regional impact

- MJ found on all sites where DT still present; weevil presence and density uninfluenced by site type (release, non-release, or reference) or distance from known release point
- MJ density increased to 0.64 weevils/stem by 8th year of establishment
- increase in MJ density correlated with decrease in DT stem length
- median distribution code for majority of sites decreased from 7 (continuous uniform) to 5 (few patches or clumps)