Udvalget for Fødevarer, Landbrug og Fiskeri 2010-11
FLF alm. del Bilag 34
Offentligt

GM-crops: Unintended effects on Organisms

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Two Prefatory Remarks

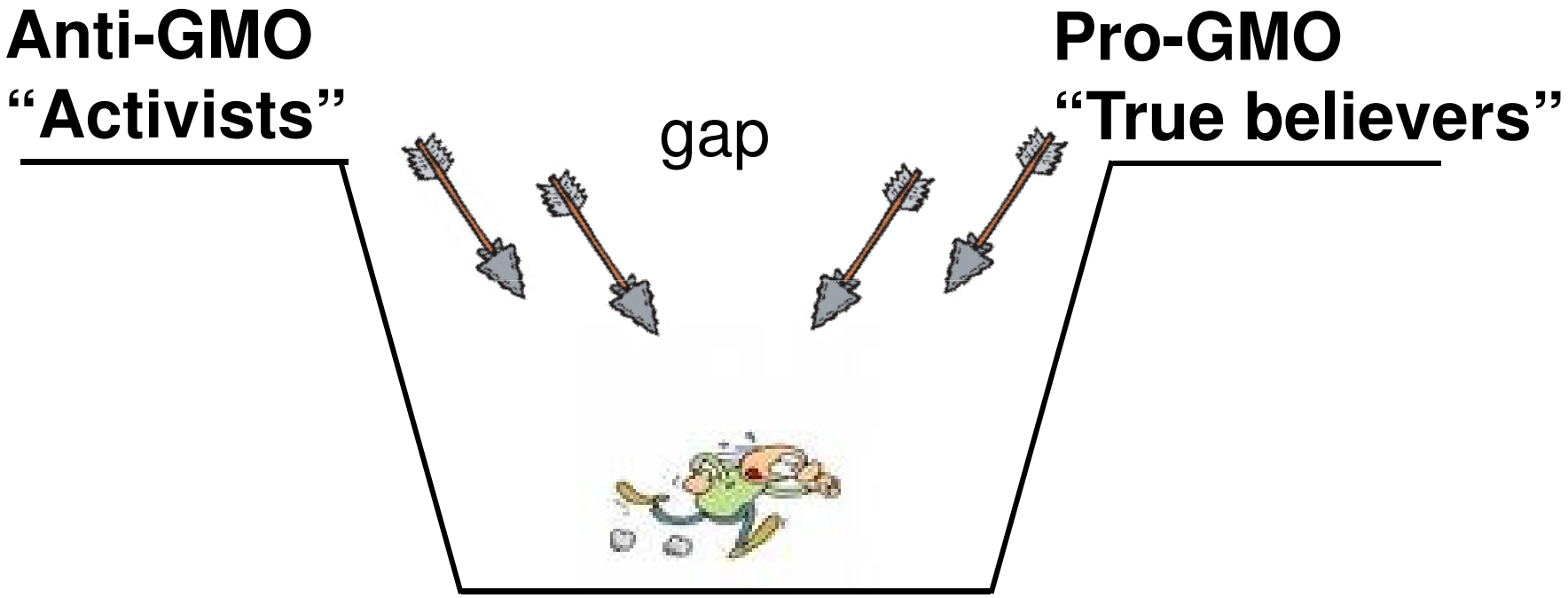
- **Some** GM crops are **better** for the environment than the conventional varieties they replaced.
  - Ex: Certain Bt cottons in Arizona, USA
- No GM crop can be declared safe for a new environment without first assessing the potential environmental risks
  - Risk assessment is essential

Main Conclusions

- **Methodology for assessing risks of GM-crops to organisms still needs improvements**

- **There are significant environmental risks of GM-crops to organisms that need to be evaluated**

Differing Perspectives



Treacherous middle ground

BATTLEFIELD

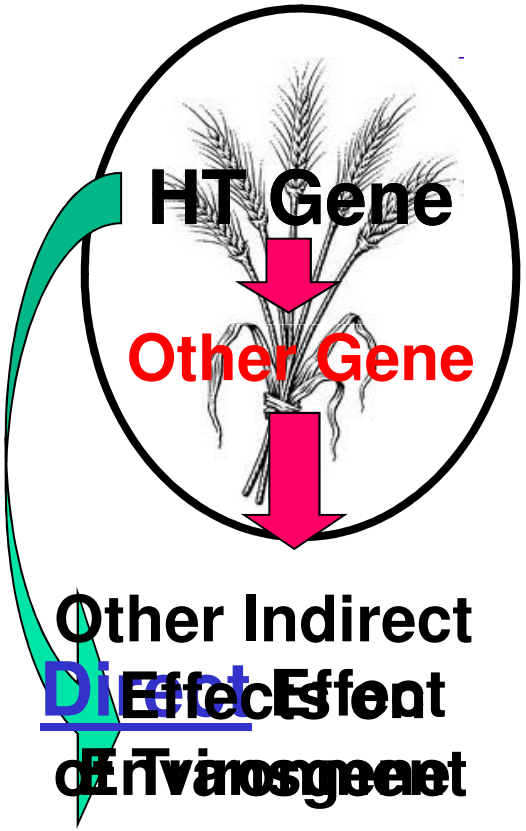
Papers suggesting that biotech crops might harm the environment attract a hail of abuse from other scientists. **Emily Waltz** asks if the critics fight fair.

Different Assumptions About What is Important

Only **Direct**, **Non-agricultural** effects mediated by **Non-humans**

Both **Direct and Indirect**, and **Agricultural and Non-Agricultural** effects, mediated by both **Humans and Non-humans**

Transgenic Agricultural Crop

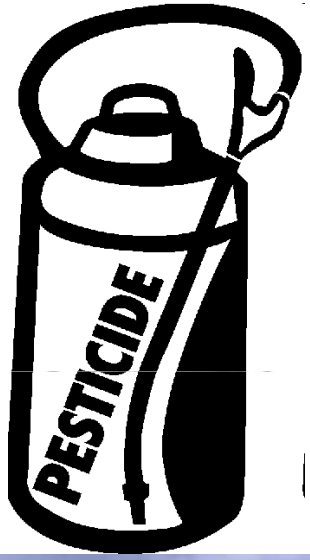


Direct Effect

Other Indirect Effects on Environment

Indirect Effect on Environment

Herbicide



GMO ERA Project

Kinds of Environmental Effects of GM Crops

1) Transgene flow and subsequent effects (both genetic and ecological)
2) Resistance evolution
3) Unintended effects on organisms and ecosystem processes.

Kinds of GM Crops

- Insecticidal Crops
  - Bt
  - Others
- Herbicide tolerant Crops
  - Glyphosate
  - Others
- Others
  - Virus-resistant (papaya, squash)
  - Third Generation Crops

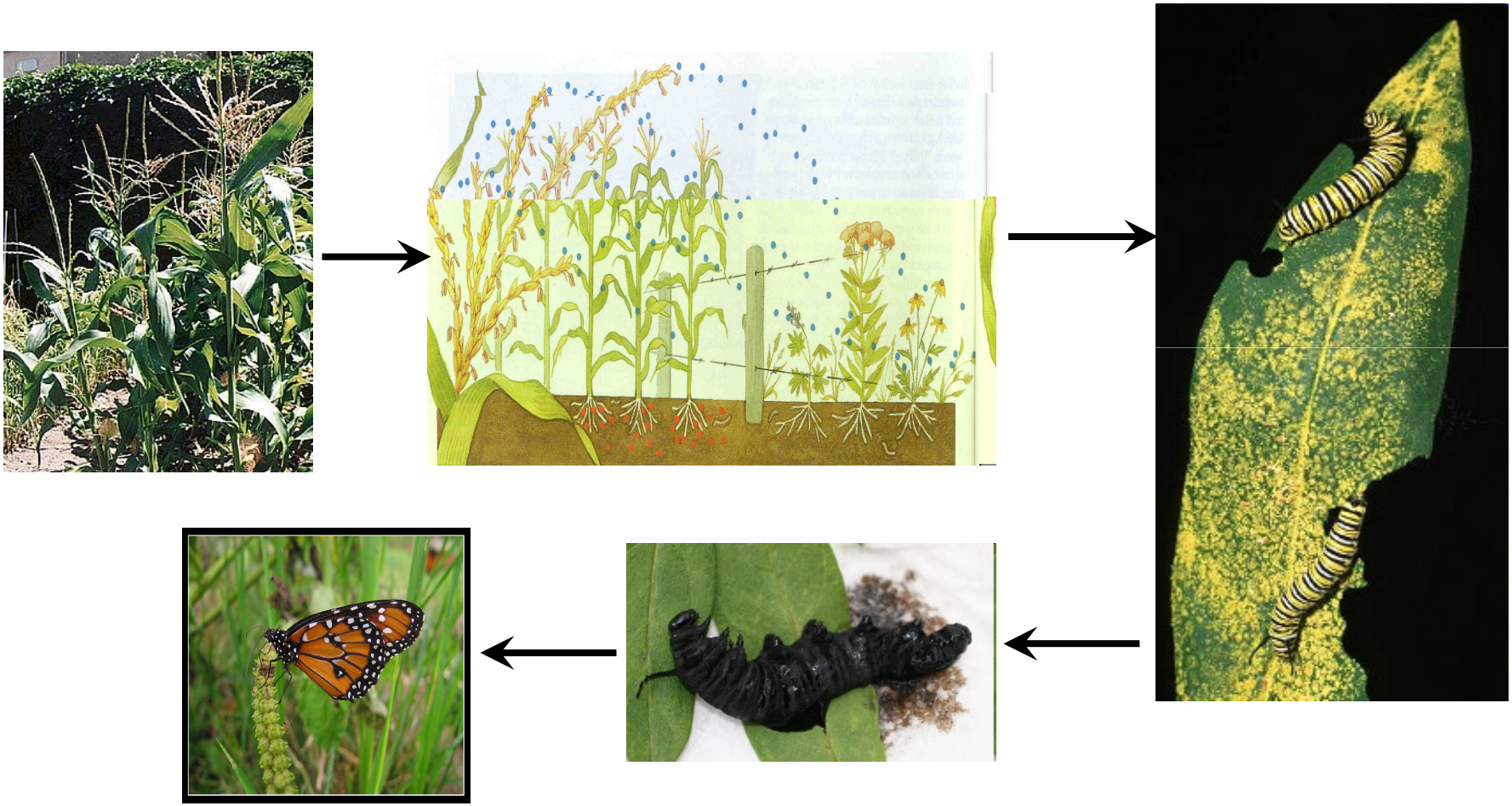
Kinds of adverse effects of Bt-GM plants on biological diversity

1) Adverse effects on crop production
2) Reduced soil health or quality
3) Reduced value of non-crop economic activities
4) Reduced cultural value
5) Increased conservation concern
6) Reduced environmental quality
7) Increased human disease
(via environmental change)

First Story

The Value of Culture

Monarch butterfly and Bt maize in the US



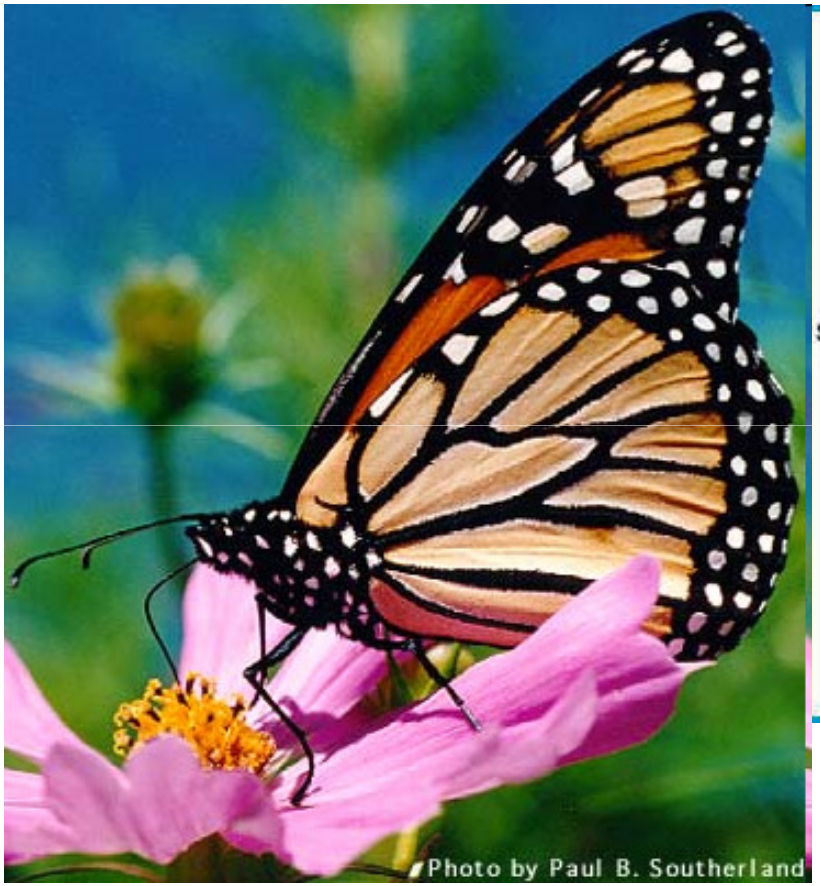
Main Result: No serious risk

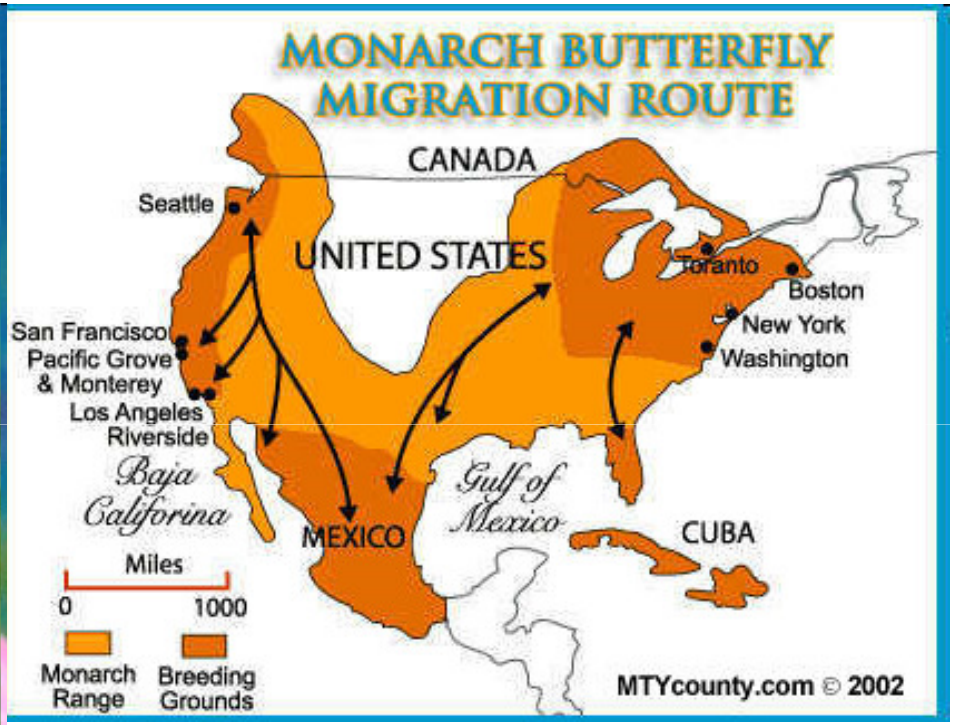
Overlooked

Monarchs were

overlooked by
both the USA and Canada

Monarchs are Amazing





>3000 km

Monarchs are Amazing

Aggregate in winter
>100 million
in Mexico

Cultural Significance in N. America

Monarchs in the Classroom

Kinds of adverse effects of Bt-GM plants on biological diversity

1) Adverse effects on crop production
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3) Reduced value of non-crop economic activities
4) **Reduced cultural value**
5) Increased conservation concern
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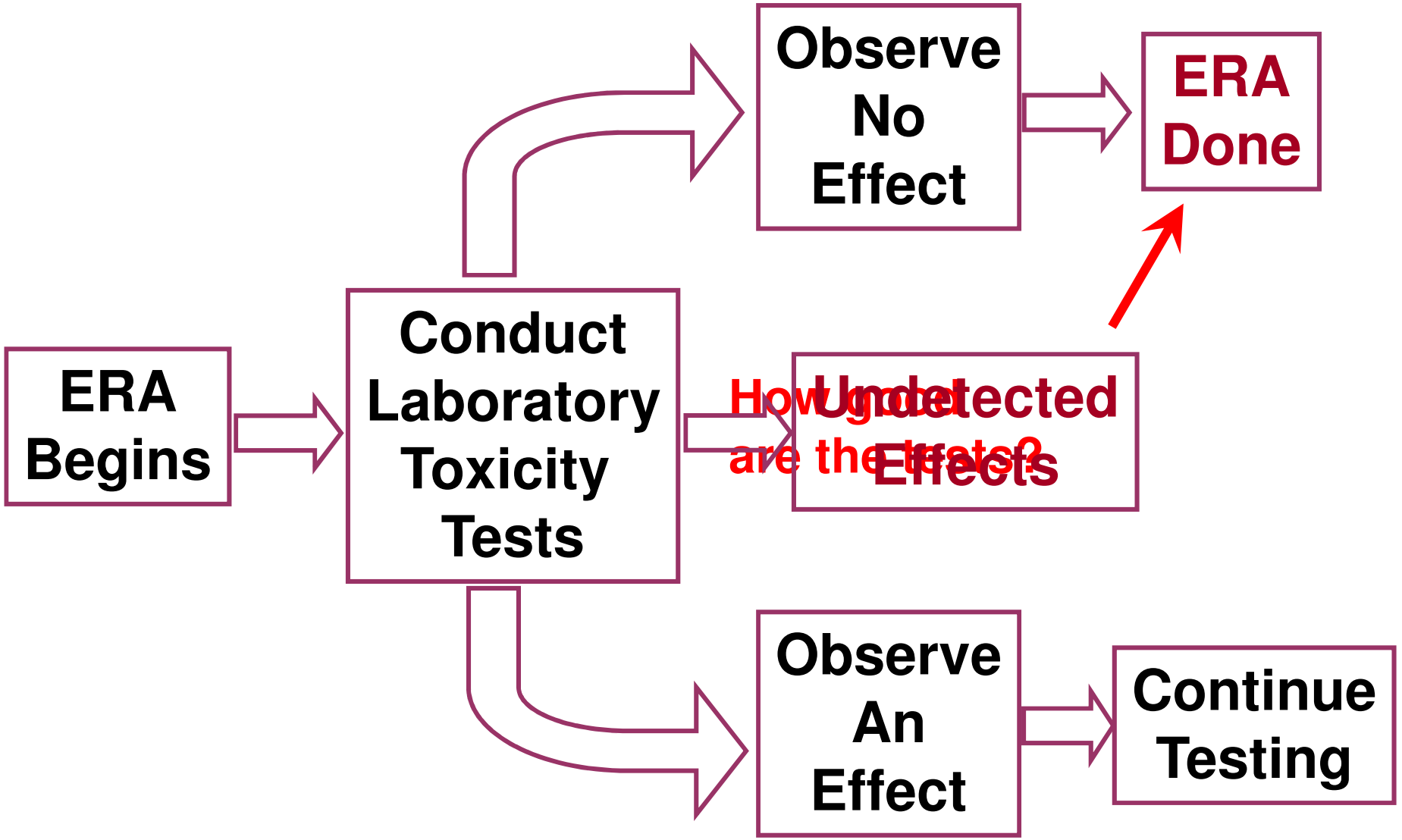
Second Story

Assessing Sustainability

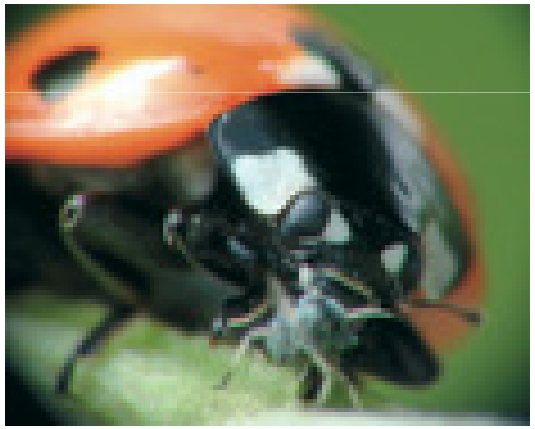
Risk Assessment for Chemical Toxins

- Promoted by biotechnology industry for GM-crops
- European Food Safety Agency. *EFSA Journal* **99**, 1-94 (2004)


ERA Begins
Conduct Laboratory Toxicity Tests
Observe No Effect
ERA Done
How good are the tests?
Undetected Effects
Observe An Effect
Continue Testing

Natural and Biological Control

- Value high (worldwide US$417 x 10^9)
- Ecologically sustainable pest control

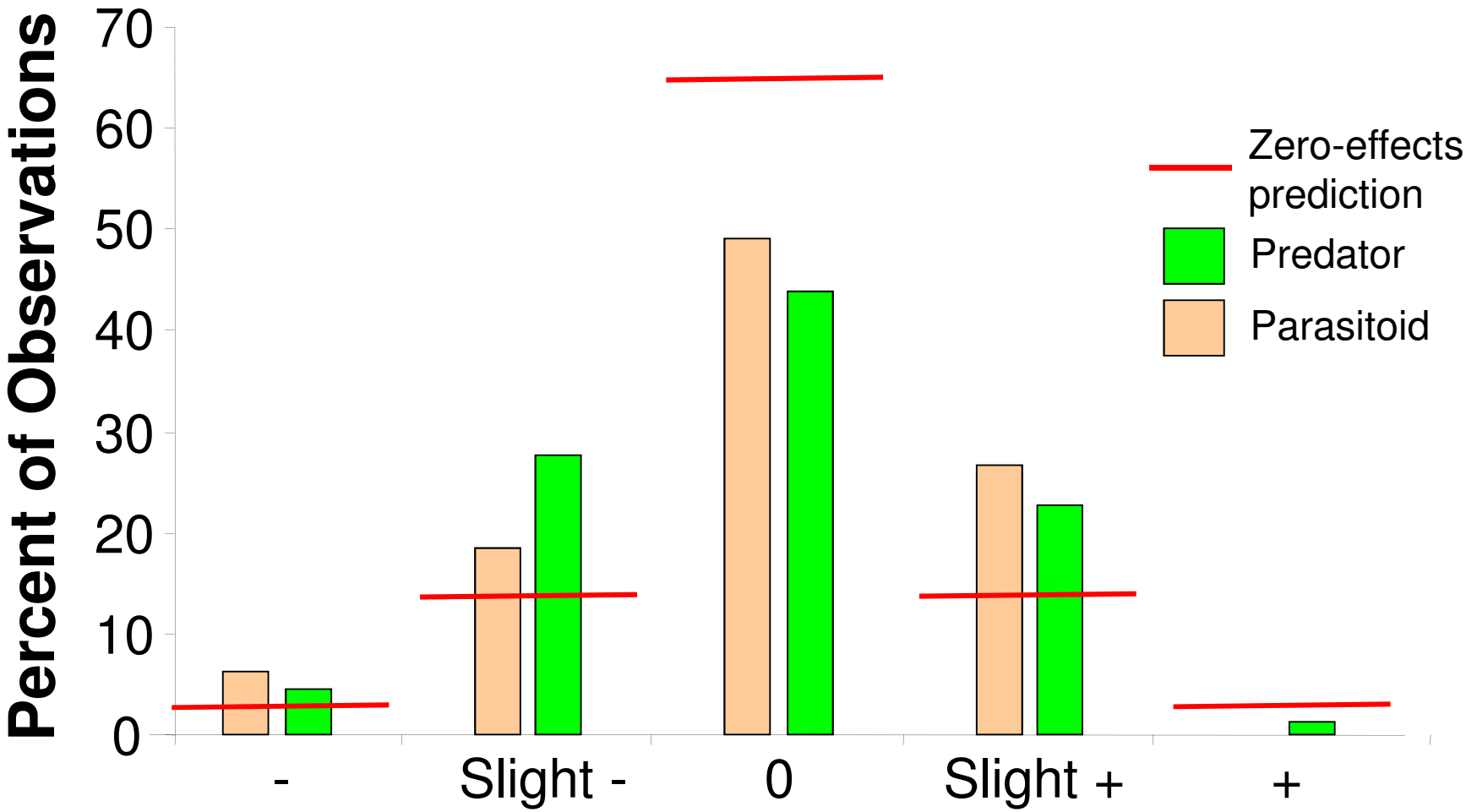



GM-Bt-crops

- Laboratory data
- Natural enemies
- Direct effect of Bt-toxin

- 55 studies
- 273 responses measured

Bt-toxins : non-zero direct effects



Andow, Lovei and Arpaia, Environ. Entomol. 38:1528-32.

Reported Results

- All of the original papers found **no direct** effects
- All of the review papers found **no direct** effects
  - "Laboratory studies have revealed ... no indication of direct toxic effects [of Bt-toxins]."
- Conclusion: **There are many undetected effects!**
- **Assessment method must be improved to assess sustainability accurately**

Third Story

The Last Animal Alive Will be a Cockroach

Kinds of adverse effects of Bt-GM plants on biological diversity

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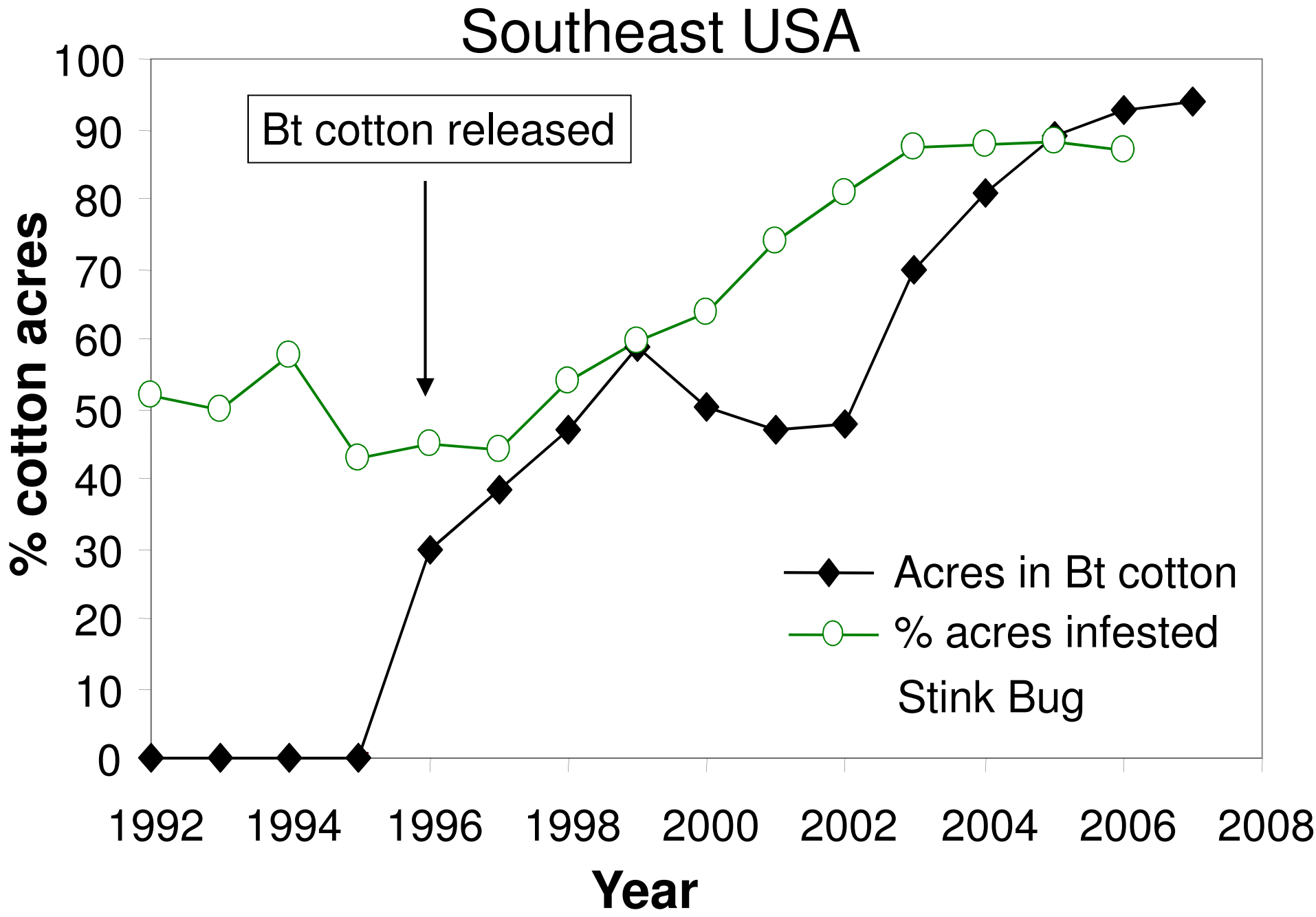

Southeast USA
Bt cotton released
% cotton acres
100
90
80
70
60
50
40
30
20
10
0
1992
1994
1996
1998
2000
2002
2004
2006
2008
Year
Acres in Bt cotton
% acres infested
Stink Bug

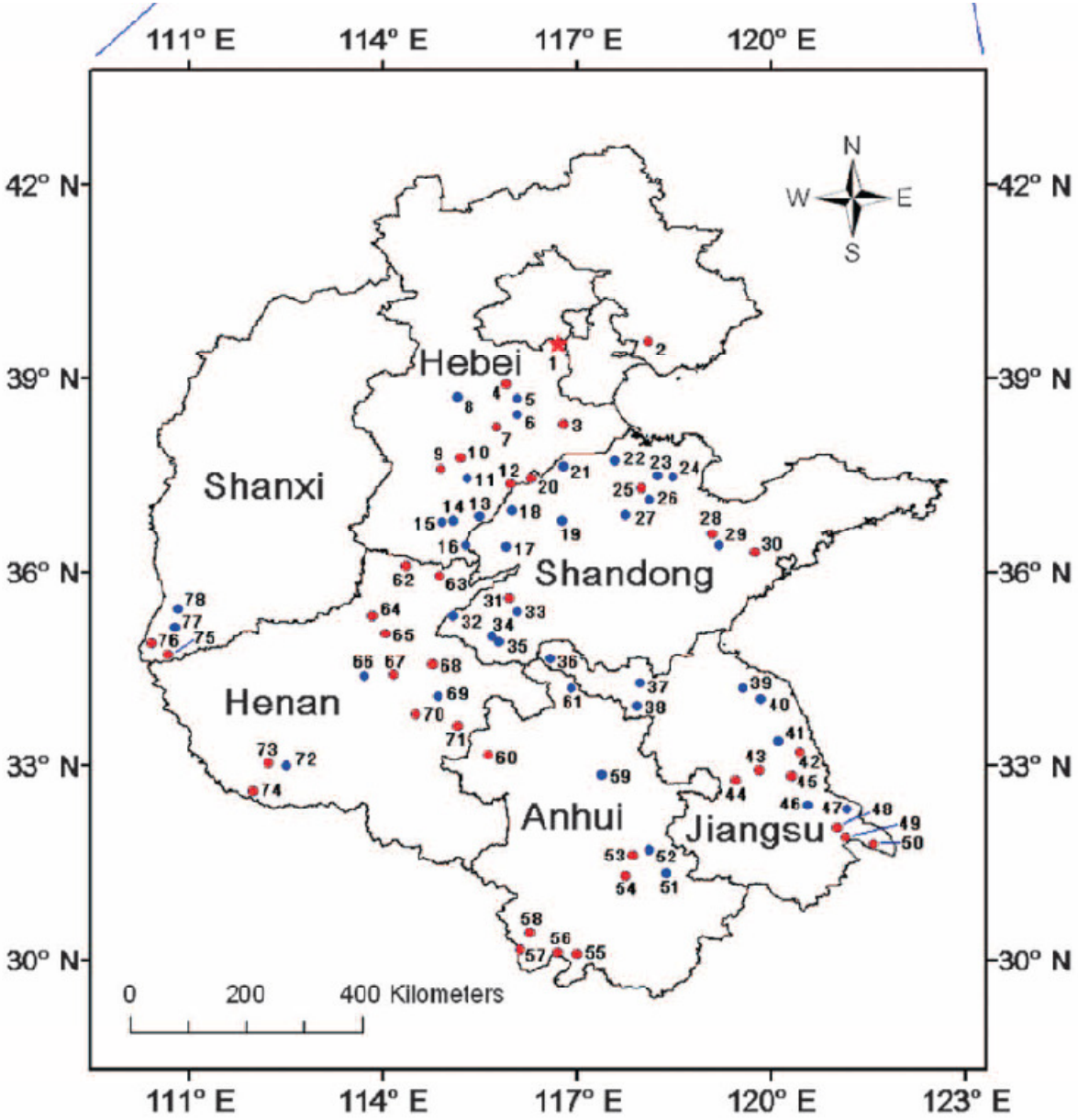

Nezara viridula


Euschistus servus

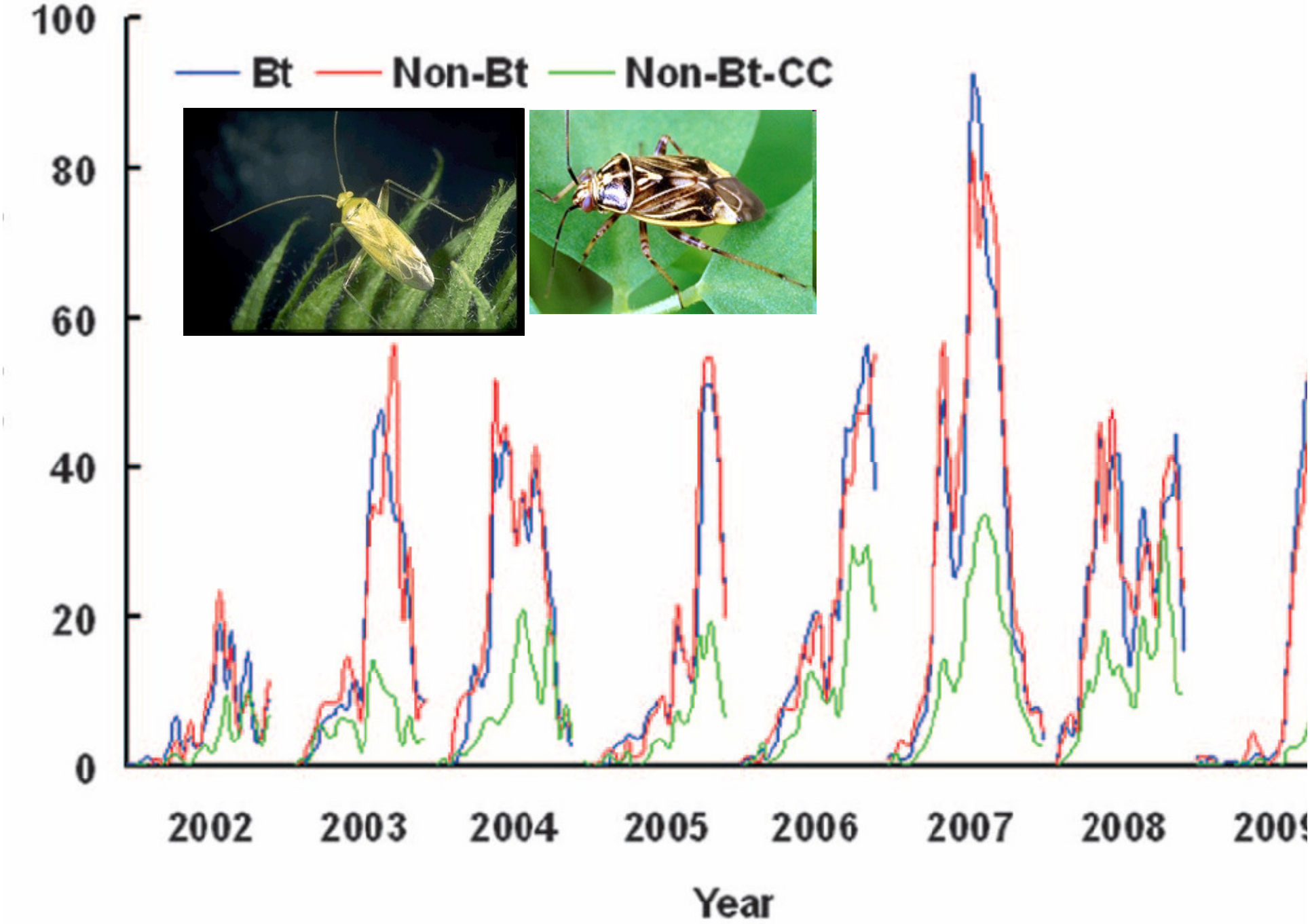
Consequences in the US

- Crop losses
- Insecticide applications
- Excellent extension system

= Financial benefits and some environmental benefits of Bt cotton have been sustained


111° E
114° E
117° E
120° E
123° E
42° N
39° N
36° N
33° N
30° N
N
W
E
S
Hebei
Shanxi
Shandong
Henan
Anhui
Jiangsu
0
200
400 Kilometers


Hebei
Shanxi
Shangdong
Henan
Jiangsu
Anhui


100
80
60
40
20
0
Bt
Non-Bt
Non-Bt-CC
2002
2003
2004
2005
2006
2007
2008
Year

Consequences in China

- Crop losses
- Increased insecticide applications
- Poor extension system

= Financial and environmental benefits of Bt cotton have been lost

Humankind
should not
expect to win the
war against crop
pests

Main Conclusions

- **Methodology for assessing risks of GM-crops to organisms still needs improvements**

- **There are significant environmental risks of GM-crops to organisms that need to be evaluated**