Legal, administrative, financial and ecological challenges implementing invasive plant species management

(with a focus on biological weed control)

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Biological weed control on (or already off?) life support

- Problems are
  - Legal
  - Administrative
  - Financial
  - Recruitment of new generation
  - They are not ecological

- Can we retain BC as a viable control option in US? (thriving elsewhere)

Reason for control

Ecological:

- reduced biodiversity
- species endangerment

Economic:

- agricultural productivity
- forest, lake productivity, irrigation
- impact on recreation (fishing, boating)

Aesthetic:

- ornamental
- landscaping

Health

- poisonous or photo-dermatitis

Control options








Extreme Specificity – Ecological Benefits?

Classical Biological Weed Control

Definition:

The introduction of host specific natural enemies from the native range of the target non-indigenous plant.

Weed biocontrol State of the Art I

Identification of a problem

(move from perception to data)

- rate of spread of invasive species and distribution
- impact on native plant and animal communities
- attempt traditional control measures
- assess cost:benefit ratio of biocontrol
- survey for natural enemies in introduction area

Duration: many years, often decades

Weed biocontrol State of the Art II

Initiation of a control program

- Identification of natural enemies in native range
  - life history
  - distribution
  - impact
  - (specificity)
- Development of screening plant list

Duration: 2--3 years

Weed biocontrol State of the Art III

Detailed Investigations (pre-release)

- Life history, impact, host specificity
- Mass rearing techniques
- TAG review - APHIS proposal (AFONSI) (may need revision)
- Monitor species thought endangered by invader and target and nontarget plants/animals in future release areas (rarely done in past, increasing now – funding and procedures need development)
  - ideally using demography
- Shipment and release of control agents

Duration: 3-5 years (18 years for Phragmites and counting)

Weed biocontrol State of the Art IV

Detailed investigations (post-release)

- Mass production and redistribution
- Monitoring and evaluation (impact and spread)
  - insects
  - target plant
  - plant and animal species and communities
  - focus on demography

Duration: 10-20 years

Weed biocontrol State of the Art V

Evaluation

- Ecological and economic assessment of the entire project
  - Rarely conducted
  - Lack of procedures
  - Lack of funding
  - Lack of accountability in agencies and funding bodies

Historical Overview: host specificity

- Procedures changed with scientific advances and societal preferences
- Expert opinion (1880-1940)
- Crop testing procedure (1950 -1965)
- Centrifugal/phylogenetic procedure (1965 - present). Since 1988 relatedness was added as a factor
- Species in same habitat or taxonomically related species of concern due to rarity
  - why would specialized insects or pathogens select rare food sources?
  - Host plant abundance affects biocontrol agent populations (search effort)
  - No biocontrol agent has ever eradicated a host plant (would also be counter productive)

Testing procedures

- Increasing realism
  - Small cage/petri-dish, large cage, greenhouse, field cage, open field test
  - cut leaves, cut stems, whole potted plants, greenhouse grown plants, field grown plants
  - No-choice, single choice, multiple choice, plants in field community, long-term field evidence
- Adult feeding, oviposition, larval development, pupation, fecundity, population maintenance

Concern: host specificity

- Science of host specificity testing mature delivering predictable results
  - Focus on no-choice feeding, or small damage is irrelevant for goals to protect species or populations
  - No evidence (no data?) to suggest rare species at special risk (see Catton et al. 2015 for houndstongue)

- Unable to test likelihood of evolution of host specificity
  - re-testing over decades show stable relationships;
  - less probability than monarch (or other insects) shifting hosts

What should be of concern?

- Effects on non-target demography
  - Occasional feeding, even death of individuals can be tolerated if populations persist or grow!

Historic Overview –BC programs

- Weed biocontrol practiced for > 100 years
- Worldwide, >550 herbivores (largely insects) have been introduced targeting 224 different plant species (>2000 programs). (Winston et al. 2014)
- Most active programs in North America, Australia, New Zealand, South Africa
- Non target effects (from 1998 catalogue):
  - Feeding: 24 (6.8%) (often spillover)
  - Establish populations on non-target: 4 (1.7%)
  - Demographic effect: 1 or 2 (*Rhinocyllus, Cactoblastis**)
  - Effects anticipated at time of introduction (not species specific; societal values differed)

- Food web effects unknown (detectable magnitude other than initial pulse?)
  - Cannot be predicted

Impact/Success Overview

- 30%-60% of programs claim success
  - Problems with definitions (pesticide reduction, full or partial suppression, ecological effects)
  - Problems in follow-up investigations ($$)
  - Differences among habitats, regions, countries
  - Good overviews in South Africa, New Zealand
  - Problematic elsewhere

Financial

- No clear path to obtain funding
  - Projects “stitched” together over many years
  - Major impediments to create follow-up assessments after initial releases
  - Increasing requirements (mandates) without enabling funding
  - Disconnect between treatment and assessment (which should be an essential part of every project and is not research!)
  - Example:
    - 18 years of BC efforts targeting Phragmites = ~ $1.5 million
    - 18 years of unsuccessful herbicide treatments = > $ 65 million

Legal

- Problem of single action review (USDA/APHIS)
  - Review is of one, but often continental action with focus on potential threat to agriculture
  - Review needs to evaluate all alternatives
    - Doing nothing
    - Continuing other treatments
    - Be timely and focus on demography
  - Review (and reviewers) need to be guided by state-of-the art science, not no-choice test

Frustration, no accountability, lack of future experts

Administrative

- Review housed in USDA/APHIS with charge to agriculture
  - Increasingly invasive species with conservation concerns are targets
  - Impediments during review appear rare or listed species or minor crops (no evidence to suggest that these should be the focus of review)
  - Consultation with USFWS Section 7 is major problem
    - Focus on AFONSI in USDA creates problems at USFWS
    - USFWS places undue burden (ecological and evolutionary forecasting) on BC researchers outlining requirements in BA
    - Enormous time delays, sometimes many years. Financial hardship to sponsors and ongoing invasions. No approval since 2009?

Questions from USFWS for one release petition

How quickly will the target vegetation be impacted (defoliated, whither, die-off)?

What species are likely to recolonize the treated area?

Could a more problematic invasive exotic take its place?

Does the bc agent have the same nutritional value as a native organism a species would normally consume?

Are there any trophic level impacts?

Will the organism adapt? If so, in what manner? Could it affect proposed and listed species?

Concern: food web effects

- Release of biocontrol agents will affect resource flows
  - Magnitude?
  - Desirable? (increased connectivity, stability or non-target effect?)
  - Chemical ecology (toxic species are everywhere, learning is ubiquitous)

BA and Endangered Species Act Consultation for Biocontrol Projects, April 8, 2015

- Likely outcomes

Informal Consultation

- No Effect
- May affect, is not likely to adversely affect

Formal Consultation

- May affect, is likely to adversely affect

- Biocontrol scientists have no experience
  - What is appropriate?
  - Who is charged with funding?

No Effect

- Guidance: Listed species or critical/suitable habitat does not occur in action area

- Problem:
  - Climate change reshuffles species' distributions
  - No ability to forecast future distributions
  - Responsible biocontrol scientists will often define action area as continental North America
  - Review will be of **all** listed/proposed species

May affect, is not likely to adversely affect

- Guidance:
  - Beneficial effects: No adverse effects to species, wholly beneficial
  - Insignificant effects: Should never result in take.
  - Discountable effects: extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects, or (2) expect discountable effects to occur.
- Problem:
  - Indirect food web effects will occur. Pulse? Magnitude, duration etc. wholly unpredictable

May affect, is likely to adversely affect

- Guidance:
  - Appropriate conclusion if adverse effects to listed species may occur as a direct or indirect result of the proposed action.
  - If the overall long-term effect is expected to be beneficial to listed species, but also is likely to cause some adverse effects in the short term.
- Problem:
  - How to determine absence of “is likely to cause”?
  - Phragmites example

Phragmites biocontrol: food web effects

- If all species are approved we will add 2-4 noctuid moths to a complex foodweb (only considering *Phragmites*)
- Not adding BC agents will
  - continue to eliminate native Phragmites and associated rare insect species (no data)
  - Allow introduced species (aphids and their natural enemies) to continue to thrive
- Lot's of uncertainty about effect sizes, use of invaded habitats by species, and metrics for assessment
- Who is charged with funding such investigations (if deemed necessary)?

Guidance on quality BA - 1

- Has the full range of potential adverse effects for each listed species/proposed species/critical habitat in the action area been adequately evaluated?
  - The analysis must be based on the best available scientific and commercial data including all field or trial research that pertains to the proposed release

- Problem:
  - Laws and regulations and ethics explicitly prevent any or all field or trial research until after permit for field release is granted

Guidance on quality BA - 2

- How quickly will the target vegetation be impacted (defoliated, whither, die-off)?
- What species are likely to recolonize the treated area?
- Will any listed/proposed species or prey of listed species utilize the release organism as prey?
  - Unknown, habitat, region and species specific

Control options vs success



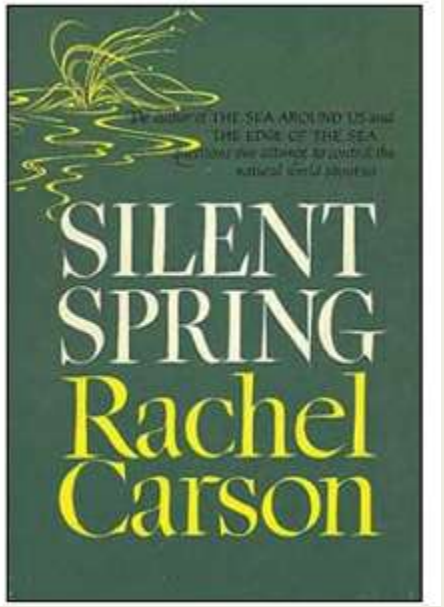






How did we get to this point?

Invasive plant control: nature.nps.org



Conservationists as major users of herbicides!
No long-term assessment of effects
$4million annually for *Phragmites* control alone
Conservation benefits?

Beneficial effects of treatments?

- No idea about local or regional (collective) impacts of plant invaders or their management
- No long-term reduction of negative impacts, species need to be managed in perpetuity
- Major food web disruptions (largely unknown)
- Local herbicide use, collectively, creates global problems
- Long-term effect of herbicides (where we know) favor invaders and suppress native species, do nothing is better alternative
- Not always are plants drivers of ecological change (earthworms, deer, elk, livestock are transformative!)

Definitions of success

biological as well as all other management options

- Biological (defined through demography and populations)
  - Suppression of target abundance and spread
- Ecological (defined through demography and populations)
  - Increase in native species of concern
  - Absence of non-target effects
- Social
- Economic

Please note:

- BC agents can only influence biological success
- Ecological success does not automatically result in ecological success
- Lack of funding prevents rigorous assessments

Tamarix and the SW willow flycatcher

(This may change for final presentation)

- High profile case, no need to repeat details
- Current status (as far as I know the evidence)
  - Nests in salt cedar have lower hatching success
  - BC agents move fast but not like wildfire
  - Birds switch nesting substrate
  - Birds eat bc agents
  - In areas with BC bird populations increase
  - BC not a threat but benefit to protection
  - At least we have some data
  - Nobody wonders about grazing

Invasive species control vs conservation

- The plant and its origin is not the problem
- Problems are:
  - Extent of near mono-specific area occupied
  - Traits and trait variation (low in monoculture)
  - Lack of trophic linkages
  - Lack of habitat use (specialists)
- Specification of desirable final outcomes
  - “healthy”, “diverse” habitats providing livable environments where native species can thrive
  - vs. reduction in invasive species x or y

Systematic Review on evidence for IS impacts on listed species (Roberts et al)

- Systematic review commissioned by USDA Invasives Causing Extinction (ICE) program
  - 6.5% of species were assessed
  - assertions not based on primary or even secondary evidence

Lessons for the future

- Make invasive species management accountable to assess
    - impacts of invaders
    - impacts of control treatments (biological, chemical, physical, mechanical)
    - use demography for species of concern
    - acres treated or # of individuals killed NOT appropriate

- Enable staff by providing funding and education

- Change institutional reward and accountability structures
    - funding control and assessment simultaneously
    - accept responsibility for data collection
    - accept responsibility for public trust management