REVERSING REED CANARYGRASS INVASIONS WITH PROCESS-BASED APPROACHES

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RCG INVASIONS CAN BE REVERSED

- Reversing RCG invasions widely considered an unrealistic management goal
- The gap between experimental research and experiential management is partly responsible for this prevailing (and incorrect) view

→Reversals are possible but require 5 – 7 consecutive years of management; the average experimental suppression study is only 2 years

- Suppression research is plagued by hasty generalizations based on short-term, single-site experiments
- Majority of studies conclude: 1. Current approaches are ineffective, and 2. "more research is needed" [before RCG invasions can be confronted and reversed]

RCG INVASIONS CAN BE REVERSED

- We already have both a detailed bioecological profile of RCG and the tools/techniques necessary to reverse invasions:
- RCG literature review project (2002 – present)

→ 913 published studies from 311 peer-reviewed journals; > 9,400 pages of info *(project is ca. 75% complete)*

- New insights into RCG biology and community dynamics have increased our understanding of RCG invasions and provided alternative management strategies

→ ***RCG suppression not only possible, but increasingly a matter of routine management***


2008 (degraded sedge meadow, initial condition)


2014 (restored condition)

PROCESS-BASED RESTORATION

1. COMMUNITY STRUCTURE: A snapshot of ecological condition and species composition at a given point in time
   - ✓ *Emphasizes SINGLE-METHOD corrective measures*
   - ✓ *Leads practitioner to believe they can simply spray an invasive away (ideal formulation, rate, timing window)*
2. COMMUNITY DYNAMICS: How and why ecological condition and species composition change over time
   - ✓ *Emphasizes PROCESS MANIPULATION in invasive species management*

FEEDBACK PROCESSES structure communities and reinforce degradation and recovery pathways

State conditions (remnant or degraded) are INTERNALLY REINFORCED by feedback processes:

THRESHOLDS

RECOVERY ⟷ **DEGRADATION**

Positive feedbacks

Negative feedbacks

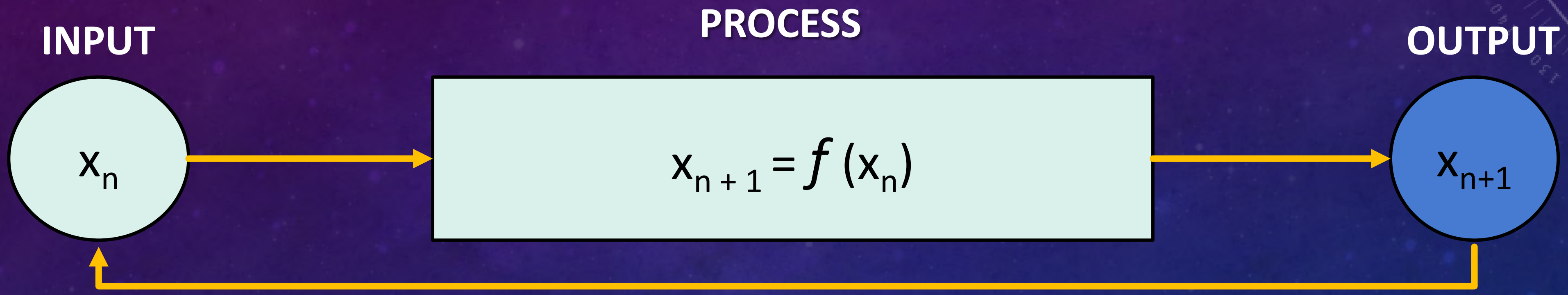
Remnant state

RCG-dominated state

→ Feedback cycles can be manipulated to augment and accelerate suppression treatments (herbicides, burning, planting, etc.)

FEEDBACK CYCLES DEFINED

The output of a process influences the future input of that same process



LITTER ACCUMULATION: One-step, single-variable feedback process

Perennial monocot invasions are litter-driven

(*Phalaris, Typha, Phragmites, Glyceria maxima*)

LITTER FEEDBACKS REINFORCE RCG INVASIONS

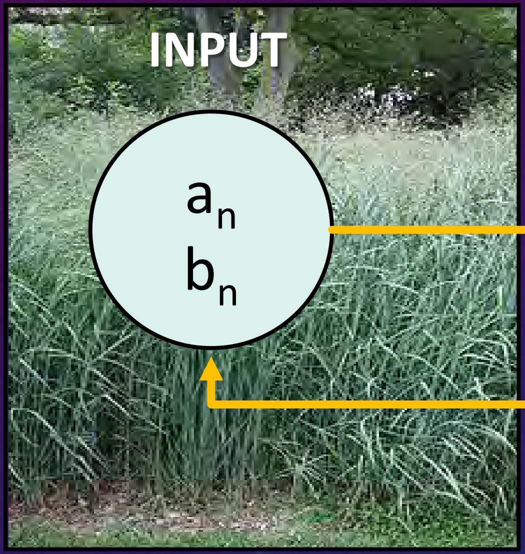
Aboveground biomass production

Litter accumulation

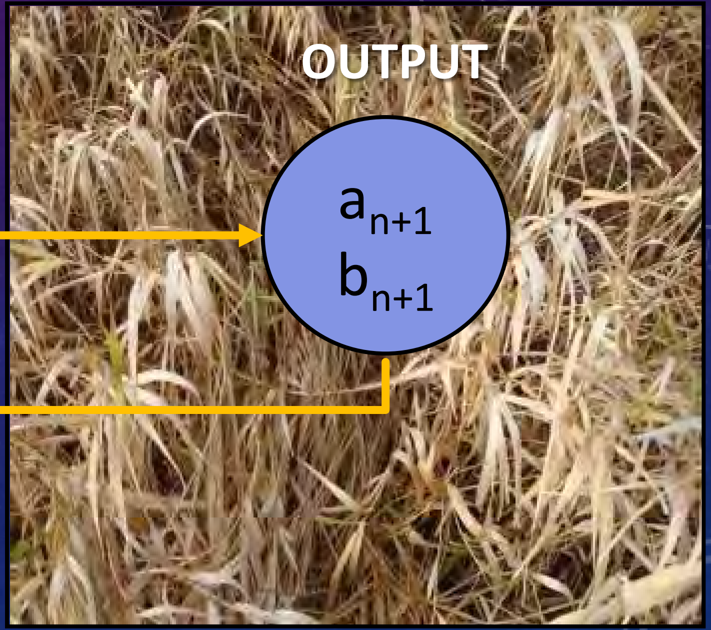
Litter mulches competing species, leading to RCG expansion;
Each iteration of the feedback cycle increases litter accumulation

ONE-STEP, TWO-VARIABLE FEEDBACK CYCLES

Nutrient inputs amplify the litter-dominance feedback



$$a_{n+1} = f\,(a_n, b_n)$$
$$b_{n+1} = a_n$$



a = aboveground biomass/litter accumulation
b = nutrient inputs

Litter-nutrient feedbacks can be uncoupled with fire management; Herbicide applications are less effective without litter removal

DYNAMICS OF SYSTEM COLLAPSE

Remnant Sedge Meadow

Fire suppression + / - hydrological disturbance

Degraded condition is internally reinforced by negative feedbacks

Mixed shrub-carr + SM

RCG expansion

High ET rates (2º hydro dist.)

Species Loss

RCG Monoculture

Amplified Hydrological Disturbance

Amplified Litter Accumulation & Competition

RCG invasion

NH_4 NO_3 PO_4

Litter Accumulation; Competition

POSITIVE FEEDBACKS – COMPETITION VARIANCE

- RCG is a competition-variant species (establishment is low where it has to compete with other species)
  - Not always detected by experiments in artificial environments (native species not given sufficient time to completely establish, conditions for RCG are ideal, etc.)
- Presence and abundance of competing species augments suppression efforts *when selective herbicide formulations are used for suppression*

→ *Timing is important; suppress RCG early in growing season in mixed stands*

- Positive feedback set in motion by the combination of litter removal and selective control of RCG involves native species recruitment; this feedback promotes and reinforces the remnant condition

DYNAMICS OF SYSTEM RECOVERY

RCG Monoculture

Primary Hydro Dist.
Tile removal
Ditch fill

Secondary Hydro Dist.
Tree/shrub removal

Rx burns

Hydrology repaired

Litter removal

N and P mining

Species recruitment

Seeding and plugging natives

Selective Herbicide Applications

RCG abundance decreases

SM expansion

Remnant Sedge Meadow

Historical feedbacks are restored by multiple-treatment management

→ *Feedbacks now reinforce the remnant state*

2006 ditch fill and scrape pond construction; bareground seeded and plugged (77 species at 10 lbs/acre in log-series abundance pattern)


2007 predictable initial response: RCG invasion


2011 mid-successional vegetation establishment


2013 desired endpoint community

TIPS FOR EFFECTIVE RCG SUPPRESSION

1. Burn the site often to remove excess litter and nutrients
2. When native species begin to appear (or when confronting invasions in mixed vegetation stands) use grass-selective herbicides to promote competition
3. Time selective applications to match peak growth of RCG and native species (apply early in the growing season when RCG exhibits maximum growth)
4. Understand herbicide-additive chemistry and use herbicide additives properly to promote enhanced herbicide performance
   - ✓ Clean and neutralize spray tanks BEFORE using selective herbicides!
   - ✓ Use MSOs to dissolve leaf epidermis and promote greater herbicide uptake, sticking agents near sensitive species

WHY ARE MULTIPLE-YEAR TREATMENTS NECESSARY?

- Rhizome apical dominance results in non-uniform herbicide distribution within rhizomes
- Herbicides only kill a portion of rhizome
- Plant resprouts from dormant lateral buds
- Necessitates multiple-year applications

SUMMARIES CAN BE DOWNLOADED FROM

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