Scots pine decline in the Rhone valley - system analysis and management options


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1. Scots pine decline - System analysis
Pines with varying crown transparencies
Scots pine decline in the Swiss Rhone valley

20. century - increased since 1990ties
Why do the pines die?

Forest ecosystems are complex and dynamic: consist of a high variety of biotic and abiotic components, with a high variability of combinations in space and time.

Forest decline processes are mostly multi-causal (only at very extremes (e.g. mountain pine beetle, pollution, fire, storm) single factors might become dominant):

- Site factors are heterogenous in space and time
- Tree species (mixture, structure, age, growth strategy, sensitivity, ...)
- Multiple, often species-specific stressors (e.g. climate, pests, competition, ...)
- Systems with individual histories (forest management, succession)
Mortality and summer drought

- Pine mortality increased in the year following hot-dry summers
- Multiple drought years significantly increase the probability of pine death

(Bigler, Braeke, Bugmann, Dobbertin, Rigling 2006: Ecosystems)

(Rigling et al. 2006: FORUM F. WISSEN)
Irrigation experiment Pfynwald: trees

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<td>8 plots (each 40x25 m) in 4 blocks each 1x watered and control (60-100 trees) Irrigation Apr-Oct, during the night June 2003 - October 2009</td>
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<td>Transparency change 2003-07 Control: + 9.8 % Irrigated: - 6.1 %</td>
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<td>Mortality (March 03 - March 07) Control: 18 trees 6.08 % Irrigated: 7 trees 2.45 %</td>
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<td>Irrigation has a positive effect on foliage mass and reduces tree mortality</td>
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(Dobbertin, Landolt, Pannatier, Rigling: data unpublished)
Irrigation experiment Pfynwald: mushrooms

Saprotrophic irrigated vs control

Mycorrhizal irrigated vs control

Lignicolous irrigated vs control

Mycorrhizal fungi seem to be much more affected by summer drought than saprophic fungi and wood inhabiting fungi.
2000-2005 in total 200 trees were cut, put into breeding chambers with insect-traps.

- Hot - dry summers boost the development- and infestation rate of damaging insects

(Wermelinger, Rigling, Dobbertin: in review; Ecol. Entomol.)
Pine decline and spreading of broadleaves
1 Forest grazing
- Goats and sheeps
- Selective browsing (neg. for broadleaves)
- Seed bed pos. for pine

2 Litter raking
- Negative impact on seed bank (oak) and nutrients
- Seed bed pos. for pine

The abandonment of forest grazing and litter raking caused a change in the competition balance between oak and pine

(Gimmi & Bürgi; Env. History, accepted)
• Pine decline as a result of the direct (drought) and indirect effects (pests) of climate change.

• Shift in tree species composition (from pine to oak) as a result of past forest use (grazing, litter racking, & locally selective cuttings, plantations).
2. Prognoses on future development
It is getting hotter

Number of days with mean temperature > 20°C in Visp

\[ y = 1.3413x - 2638 \]
\[ R^2 = 0.5049 \]

![Graph showing the number of days with mean temperature > 20°C in Visp from 1980 to 2005 with a linear regression line and data points.](image)
Future climate scenarios

South of the Alps

- Exceptional summers like in 2003 will occur every 2 to 3 years
- Winters will become warmer and more moist
- Summers will become hotter and drier

(OcCC 2007)
Summer hot spell 2003 had significant consequences on the forests:

- Water shortage
- Forest fires (e.g., Leuk 300 ha protection forests destroyed)
- Trees almost stopped their growth, increased mortality and early leaf-shedding was frequent, also for oak!
3. Management options
**Szenario 1: moderate warming**

**Target forest:**
Mixed broadleaved forest (dominated by oak and with pine mixed in)

**Phytosanitary measures:**
large area, different pests, difficult to access, difficult to control - not efficient

**Measures to increase tree vitality:**
Reduction of the competition for water by
- thinnings
- removal of the understorey (e.g. goats)
- removal of mistletoes

**Measures to reduces the risks of pests:**
- avoid monocultures
- promote tree species diversity
- increase horizontal, vertical and age structure

**Regeneration strategies:**
- increase species diversity
- avoid big openings (drought)
- regeneration under shelter
- timing of seeding and planting
- promote broadleaf seed trees
**Szenario 2: hot spell 2003 as future average?**

Too dry for native forest vegetation

Recruitment as bottleneck after e.g. forest fires

There is a need for experiments ...
- Experiments with alternative tree species
- Irrigation (vss control)
- Rain shelters (simulate drought)
- Altitudinal gradients and top-down transplantations (simulate warming)
- Warming experiments

... to adapt forest management concepts
Thank you for your attention

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