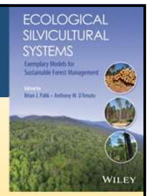
Ecological Silviculture of Acadian Forests (Ch. 11)



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UWSP Applied Ecological Silviculture Webinar Series - 2025
June 18, 2025

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Outline

- Geography and Cultural History
- Species Silvics and Soil-site Patterns
- Changes in Structure and Composition Since Presettlement
- Natural Disturbance Regimes and Stand Dynamics
- Multi-aged Silviculture - Irregular Shelterwood Variants
- Acadian Femelschlag (Irregular Group Shelterwood with Reserves)
- Status and Conclusions

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Geographic Extent

- 27.4 million ha
- Named after French settlers displaced from Nova Scotia ca. 1760
- Mixture of former agricultural lands with majority never settled or farmed
- White, Green Mtn National Forests

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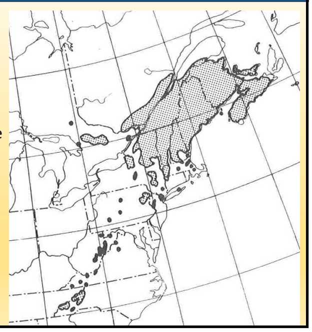
Range of Red Spruce (*Picea rubens*)

- Dominated presettlement forests
- Commercially important since the early 1800s
- Dominated harvests after white pine was exhausted



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Key Silvics

- Advance Regeneration
- Two-rotation(+) maturation
- “LIT” species (Long-lived, Intermediate or Tolerant) demand patience
- White, black spruces uncommon

Species	Shade Tolerance	Regeneration Mechanisms	Two-rotation?	LIT species?
Red spruce	Very	Advance	Essential	YES
Balsam fir	Very	Advance	NO	NO
Eastern hemlock	Very	Advance	Essential	YES
Northern white-cedar	Very	Advance, Seed Rain, Layering	Essential	YES
Eastern white pine	Intermediate	Advance, Seed Rain	Possible	YES
American beech	Tolerant	Vegetative, Advance	Possible	YES
Red maple	Tolerant	Advance, Vegetative	Possible	YES
Sugar maple	Tolerant	Advance	Essential	YES
Yellow birch	Intermediate	Advance, Seed Rain	Possible	YES
Paper birch	Intolerant	Seed Rain	NO	NO
Aspen spp.	Intolerant	Vegetative	NO	NO

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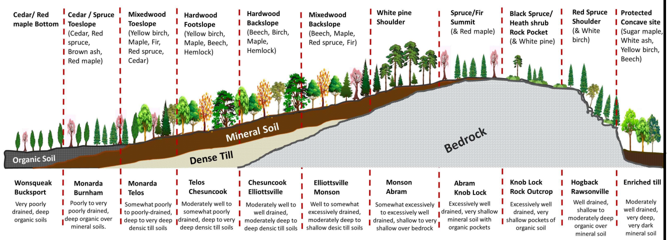
Species Composition Reflects Landscape Position – Archetype Catena on a Drumlin

Figure 1. Chesuncook Catena Overview—soils below and vegetation above



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Historical Exploitation – 6 Periods (Seymour 1992)

- Sawlog era (mid-late 1800s)
- Establishment of paper industry ca 1890s
- Spruce budworm aftermath (1925-1940)
- Maturation of second-growth forests (1950-1980)
- Harvest and regeneration of second-growth forests (1970-ongoing)
- Third-growth stands with no precedent – dominates the current age structure of SF forest type

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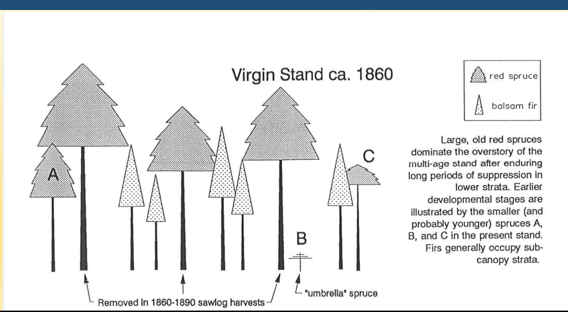
Chronosequence (from Seymour 1992)



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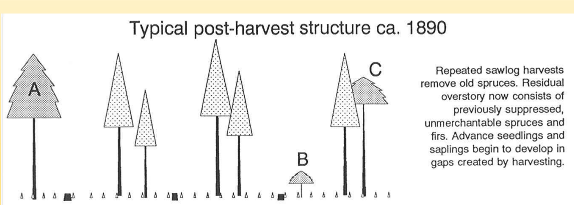
1890, after old-growth sawlog exploitation



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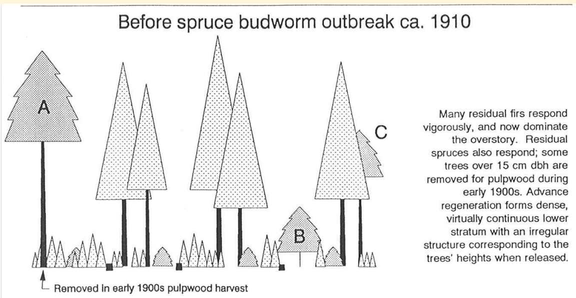
1910, just prior to severe budworm outbreak



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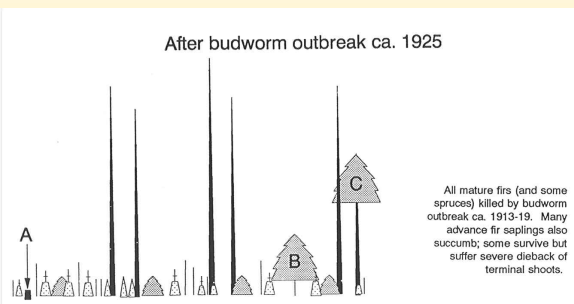
1925, after widespread mortality of fir, some spruce



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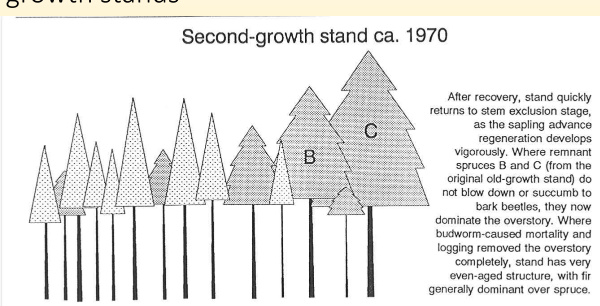
1970, widespread maturation of dense second-growth stands



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1860

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1910

- Very old balsam fir not exploited

+

- Residual old spruce not cut for sawlogs

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1925 – standing dead fir everywhere

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1970 (in stem exclusion, highly unstable ht-dbh ratios)

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Most industrial landowners abandoned partial cutting owing to windthrow risk

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1980 – complete overstory removal over large areas (unregulated until 1991)

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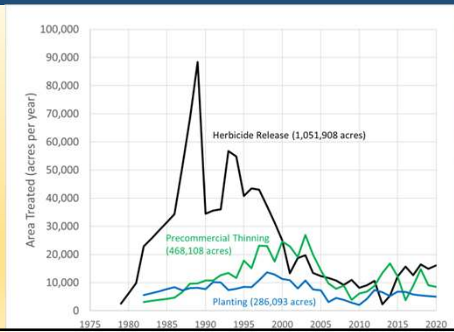
Onset of Silviculture Investments by Industry (Maine)



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1990 (PCT managed natural regeneration, high fir)

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2010 (90% fir, ready for commercial thinning and the next SBW outbreak)

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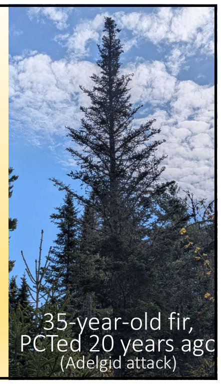
What's wrong with fir?

- Well-known issues with early-onset stem and root decay, spruce budworm
- More serious is the heightening severity of *balsam woolly adelgid* attack owing to the warming climate
- Formerly limited to coastal Maine, now widespread



35-year-old fir, PCTed 20 years ago
(Adelgid attack)

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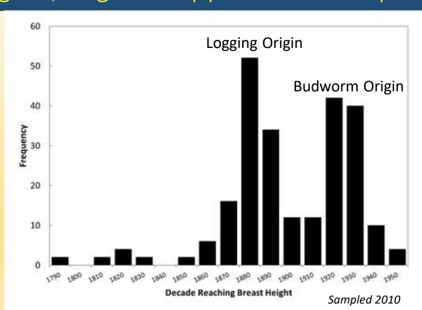
Stands that escaped pulpwood clearcuts were somewhat more irregular, single-canopy but not strictly even-aged



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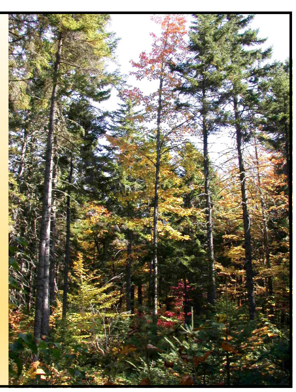
Some landowners used uniform shelterwoods, targeting just fir and leaving spruce



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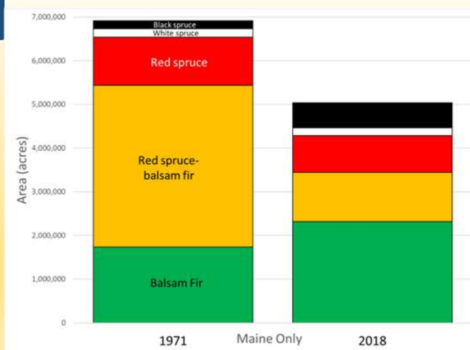
Type Conversion Legacy

- Nearly 2 million acres (28%) lost over 50 years
- Areas now in northern hardwood or aspen-birch types
- Major restoration challenge via planting



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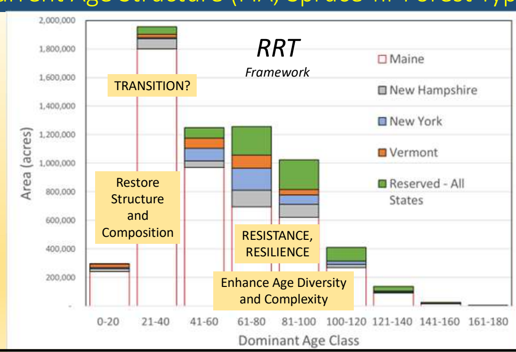
Current Age Structure (FIA, Spruce-fir Forest Type)



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Disturbance Ecology of Acadian Forests: *Gap Dynamics*

- Disturbance regimes dominated by partial disturbances (some minor exceptions), long-lived shade-tolerant species
- Stand-replacing disturbances and thus, even-aged stands, were very rare

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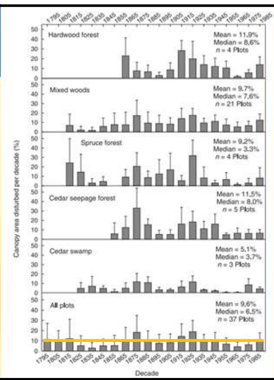
Disturbance History (Big Reed Preserve, Fraver et al 2009)

- ~10% per decade for 180 years, or 1% per year
- Some types (spruce) more "pulsed" than others
- 1,150 return interval for 50% canopy loss at 0.15-ha scale
- Fire, stand-replacing disturbances absent



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What silvicultural systems do these dynamics imply under Ecological Forestry? Resistance and Resilience

- Multi-aged stand structures, with a significant component of "old" trees
- Regeneration in small gaps or patches within irregular stands, averaging 1% per year
- Maintain some unharvested matrix conditions for several cutting cycles
- Permanent retention of legacy reserves

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Natural Disturbance Analogues in Silvicultural Prescriptions (Seymour and Hunter 1999)

- Disturbance rate: Cutting cycle, percent of stand regenerated per entry
- Patch size: Gap or group sizes; their orientation and proximity to each other
- Biological Legacies: Designation of permanent reserve trees ***in gaps***

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Acadian Forest Ecosystem Research Program, est. 1994 (two treatments)

- ***Expanding*** gap systems based entirely on three ecological parameters (NOT from any cookbook):
  - ✓1% annual disturbance frequency, over 100 years
  - ✓Small, sub-stand regeneration patches (0.1 - 0.2 ha, expanded on 10 or 20-year cutting cycle)
  - ✓>10% (arbitrary) permanent structural retention, left in gaps as they are harvested
- *North American Translation:*
  - *Irregular group shelterwood with reserves (large gaps)*
  - *Group selection with reserves (small gaps)*

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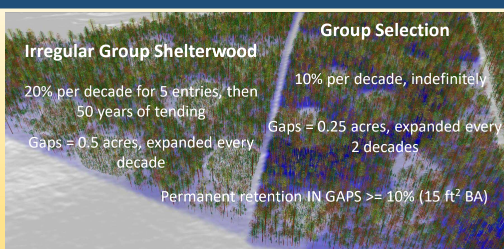
Small sub-stand patches (gaps) with retention



After second harvest (= first large-gap expansion)

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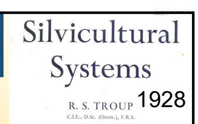
Irregular (group) Shelterwood = *Femelschlag* (Raymond et al 2009)



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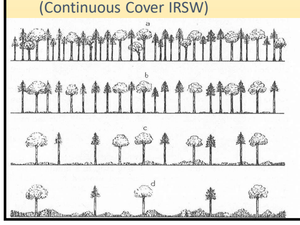
European system used to convert simple structures to more complex ones using a simple, area-based approach

Swiss Femelschlag (Continuous Cover IRSW)



Bavarian Femelschlag (Expanding Gap IRSW)

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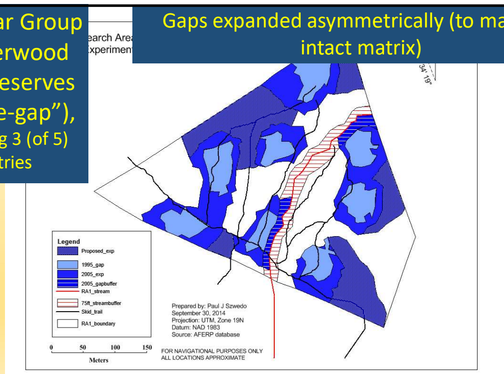
Irregular Group Shelterwood with Reserves ("Large-gap"), showing 3 (of 5) entries

Gaps expanded asymmetrically (to maintain intact matrix)



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Irregular group shelterwood – aka "Acadian Femelschlag"

3 Types of Retention:
- Permanent Reserves (legacy)
- Immature growing stock ("tall regeneration")
- Overwood if necessary for seed and shade

[Matrix fully stocked, lightly thinned, not shown]

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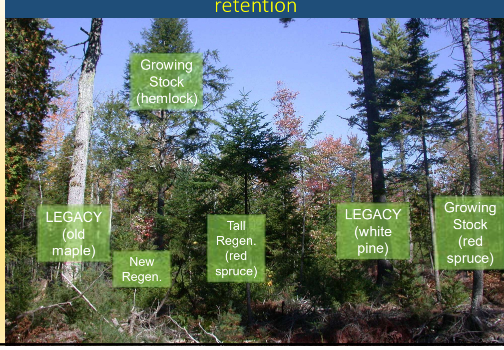
Large Gap after second entry: 3 components of retention



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Advantages of Group-based Shelterwood Systems -- Ecological

1. Manages regeneration deliberately, not by assumption (of future ingrowth) – area-based structure
   -- Gap size, overall regeneration rate
2. Ecological sustainability guaranteed (if cutting cycle is comparable to natural disturbance rates)
3. No need to assume a problematic linkage between age and size

All of these are demonstrated Achilles' Heels of multi-aged systems using a diameter structure (B-d-q)

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Advantages of Group-based Shelterwood Systems -- Operational

4. Prescription elements are concentrated on 10-30% of the stand: Pre-harvest layout, designation of reserve trees, logging, enrichment planting, early tending
   -- No need to work throughout entire stand (after first entry)
5. No need for pre-harvest dbh distribution information, or overall marking tally
6. Light harvests (<25%) are feasible (volumes are concentrated, not dispersed)
7. Modern GIS makes the field work efficient and rigorous

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Slide 38

B1 Bob, 6/12/2025

Long-reach CTL systems are ideal for these gap expansion harvests – Ponsse Ergo, Scorpion

- Run trails on the matrix side of the expansion zone
- Reach in toward the previous gap
- No traffic through regeneration

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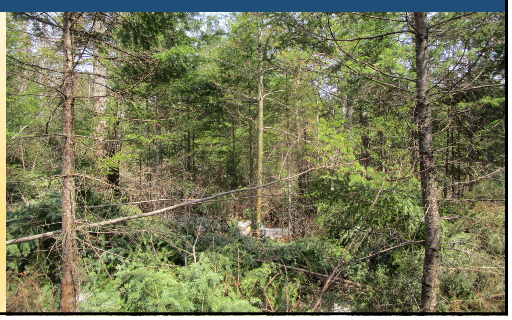
Elaborate cleaning/PCT prescription to improve composition and reduce density of sapling regeneration in gaps - 3 distinct vertical strata

- Emergents (birch, aspen, larch) on 50-100 ft spacing
- B-stratum (white pine, red oak, red maple) on 20-25 ft spacing
- C-stratum matrix (tolerant conifers) on 7-10 ft spacing
- Rare species are "invisible"



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Reserve (Legacy) Trees

Reserve trees that die are periodically replaced

Criteria for selection:

- Current or potential wildlife use
- Large, tall structural components
- Uncommon species

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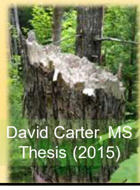
20-year fate of AFERP reserve trees MUCH better than studies in single-cohort stands!



David Carter, MS Thesis (2015)

Tree Species	Number	Survival
Abies balsamea	4	100
Fraxinus americana	22	100
Fraxinus nigra	1	100
Ostrya virginiana	2	100
Picea glauca	6	100
Populus grandidentata	12	100
Quercus rubra	20	100
Tsuga canadensis	150	97
Acer saccharum	32	97
Acer rubrum	120	97
Betula alleghaniensis	14	93
Pinus resinosa	14	93
Pinus strobus	127	91
Fagus grandifolia	17	88
Picea rubens	150	88
Betula papyrifera	25	84
Thuja occidentalis	85	82
Populus tremuloides	18	67
Total	820	92

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Current Status (2025)

- These gap-based systems are clearly viable and have been widely adopted by public lands managers and family forest owners.
- Nova Scotia Crown Lands – 1 million ha now largely under irregular shelterwood silviculture, a radical change from 10 years ago (Triad, SGEM)
- The longer I follow and manage these experiments, the more encouraged I become.
- Fourth gap expansion at AFERP due this winter

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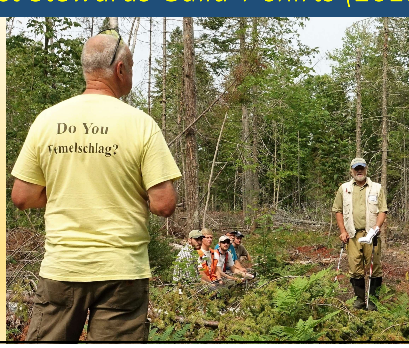
Forest Stewards Guild T-shirts (2018 Tour)



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Closer to natural patterns, but rare in practice

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Irregular shelterwood is not a panacea

- Not applicable in: Uniform even-aged stands dominated by shade-intolerant, early-successional, short-lived species (pure aspen, fir, exotic plantations) – LIT seed sources gone
- Resistance and Resilience not possible.
- *Transition*, via planting red spruce, Norway spruce (as hemlock replacement), white pine

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Key Steps (linked to D'Amato Principles, 2025):

- Leave permanent legacies to meet biodiversity objectives related to large, old trees. (***Continuity, Complexity***)
- Avoid regeneration patches with no retention - put them where they need to be and leave overwood in gaps to create diffuse light in the understory. *With such retention, group size becomes irrelevant.* ***(Complexity)***
- Conserve small-dbh midstory growing stock always (two-rotation species) ***(Complexity),*** but…
- Remove undesirable low shade of midstory competitors (fir, beech, hemlock) if needed to ensure diverse regeneration ***(Complexity)***
- Apply group shelterwood when the stand is spatially diverse ("patchy") – set the regeneration rate (% area in gaps, cutting cycle) based on natural disturbance dynamics (***Timing***)

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