Biosolids Forest Fertilization

A Complementary Mid-Term Timber Booster?

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Let's Fertilize Our Minds…

- An introduction to biosolids
- Biosolids management in BC
- Regulatory framework
- Why fertilize with biosolids
- Logistics: how we do it now
- Case studies
- Moving towards a biosolids fertilization program

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What is Biosolids?

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What is Biosolids?

The ***treated, stabilized*** semi-solid product of a wastewater treatment process:

- Municipal wastewater
- Pulp and paper wastewater
- Contain:

  Organic matter (>50%)

  Nutrients (0.1%-10%)

  Trace element content

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Trace Element Limits

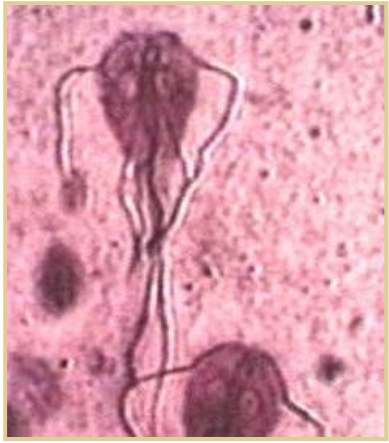
Trace Element	Chemical Fertilizers	Biosolids
Arsenic	75	75
Cadmium	20	20
Chromium	No limit	1,060
Cobalt	150	150
Copper	No limit	2,200
Lead	500	500
Mercury	5	15
Molybdenum	20	20
Nickel	180	180
Selenium	14	14
Zinc	1,850	1,850

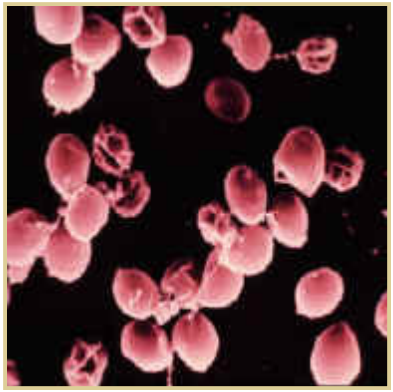
Biology of a Living Fertilizer

Treatment:

- Raw sludge is treated and stabilized to attenuate pathogens (giardia, cryptosporidium, salmonella, helminthes)
- Reduces indicator organisms (fecal coliform) to >2,000,000 MPN g (drywt) = $2e^6$ MPN/g
- Often reduced to less than 100,000 MPN/g
- High degree of die-off in environment

- Manures often contain 10^8 MPN/g - 10^{12} MPN/g by comparison





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A Rose By Any Other Name - Odour

Stabilization:

- Reduces volatile solids by a minimum of 38% (significant cause of odour)
- Most biosolids have musty, peaty smell
- Odour is transient
- Generally contained to within 100 metres of the application site
- Dissipates rapidly after application

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Biosolids Management in BC

- Land reclamation
- Agricultural application
- Silvicultural application
- Forest Engineering

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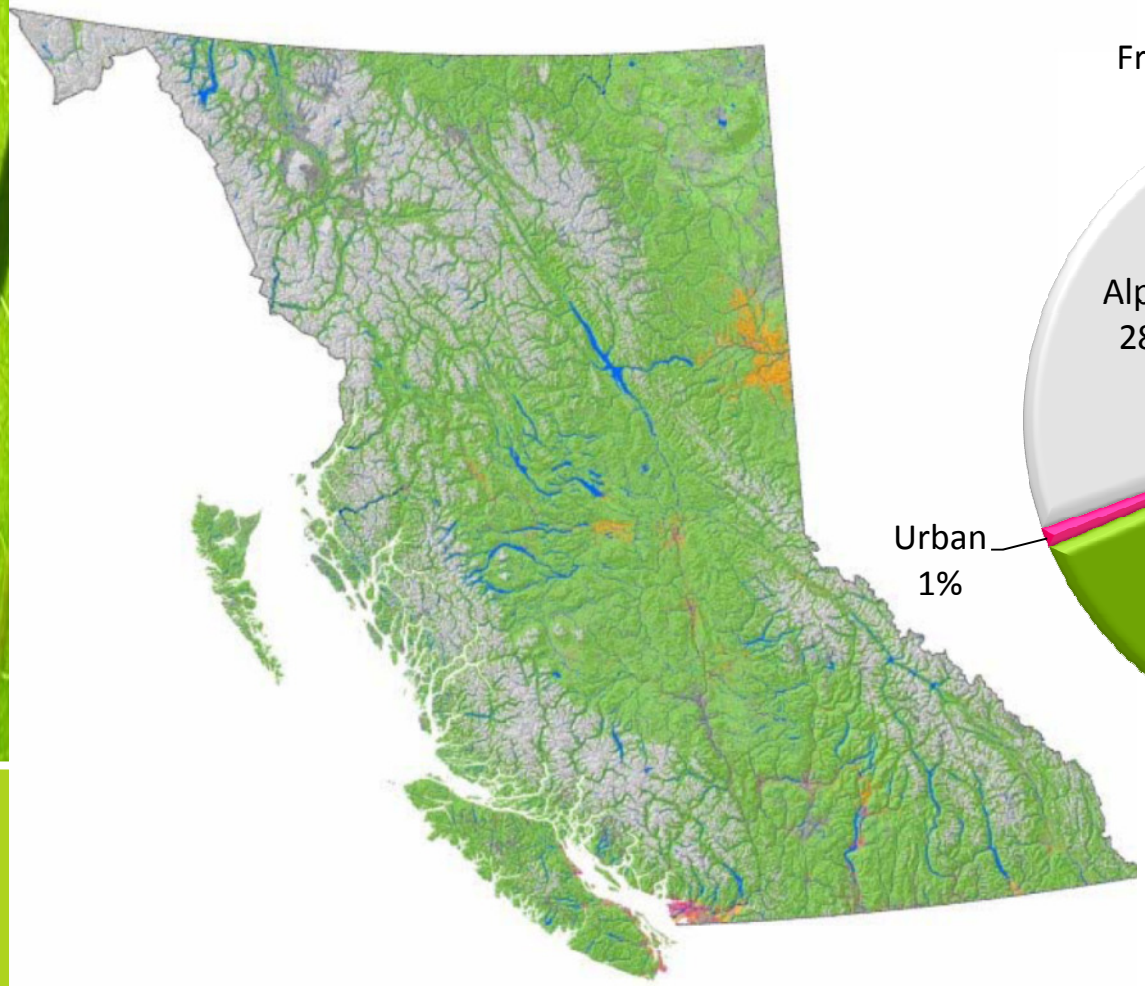
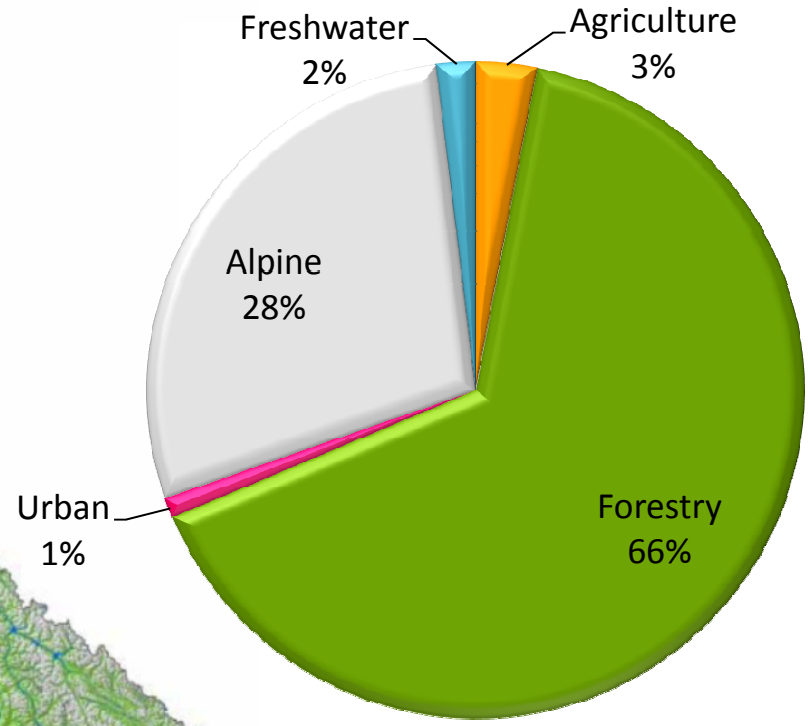
Land Use in BC





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Organic Matter Recycling Regulation

Regulates…

residuals • products

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Regulatory Framework in BC

Organic Matter Recycling Regulation

- Applies to:
  - production, distribution, storage, sale, use or land application of biosolids or compost
- Requires qualified professionals to author a LAP
- Biosolids process and quality criteria, post-application soil quality
- Same requirements apply for biosolids as for fertilizers in forest application (buffers, etc.)
- No additional approvals, no additional requirements to consult under OMRR (notification process)
- Biosolids is a component of the forest fertilization handook

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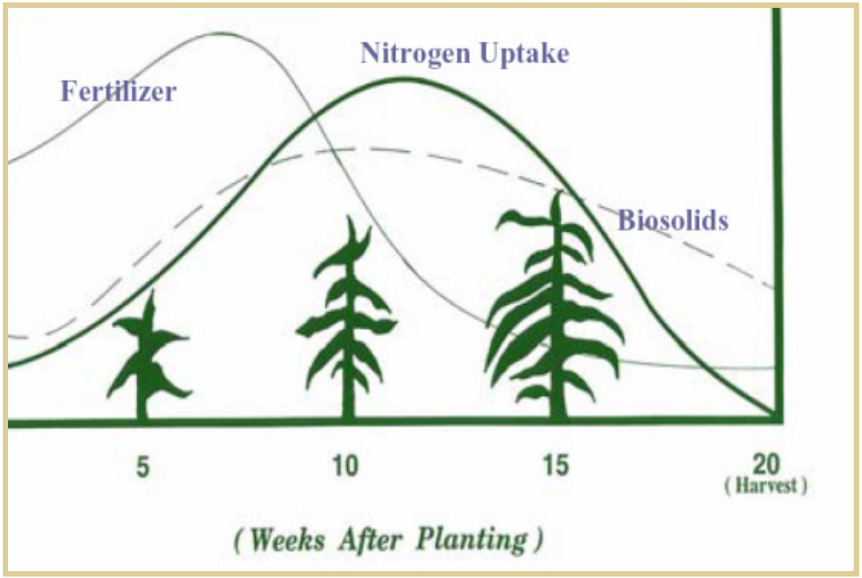
Why Forest Fertilization with Biosolids?

Ecosystem benefits (interior)

- Improves soil
  - Increases water-holding capacity
  - Improves soil structure
  - Adds nutrients
  - Slow-release
- Understory vegetation
  - Increased growth
  - Animal habitat
  - Economic potential



(from Bowen, 2007)

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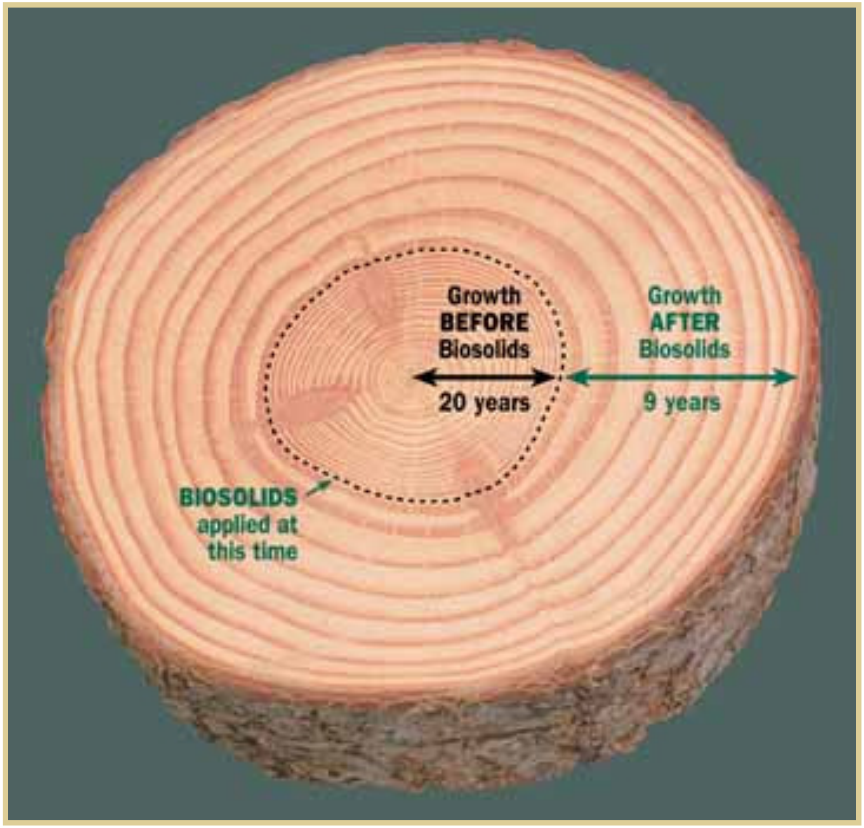
Why Forest Fertilization with Biosolids?

Industry benefits

- Lowest cost fertilizer option
- Full suite fertilization
- Increased timber production
- Carbon sequestration
- Site improvement
- Industry perception
- Relationships



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Comparing Fertilizer and Biosolids

Chemical fertilizer

- Advantages
  - Traditional
  - Easy to apply
- Disadvantages
  - Expensive
  - Non-renewable
  - Efficacy
  - Timing

Biosolids

- Advantages
  - Low cost
  - Recycled, C sequestering
  - High in organic matter
  - Improves moisture retention
  - Macro and micronutrients
- Disadvantages
  - Bulky, land-based application
  - Perception

Biosolids fertilization is a low-cost complement to a chemical fertilization program

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Comparing Fertilizer With Biosolids – NPK+

Material	Percentage by Weight					
	N	P	K	Ca	Mg	S
Ammonium nitrate	30	-	-	-	-	-
Interior Urea/S	35	-	-	-	-	10
Potassium nitrate	13	-	44	0.6	0.4	0.2
Potassium magnesium sulfate	-	-	22	-	11	23
Fish waste (acidulated)	5.7	3	-	6.1	0.3	0.2
Biosolids	5	2.11	0.09	2.34	0.24	0.54

Typical biosolids application: 500 kg N, 200 kg P, 9 kg K, 54 kg S

(adapted from Fox *et al.*, 2006, and http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-18/)

Regional Research

University of British Columbia

- Nutrient dynamics
- Ecosystem nutrient cycling
- Animal habitat
- Optimization of use
- Public and stakeholder education

Regional Research

TREATMENT	Control	Inorganic Fertilizer		Biosolids
Response	N/A	LOW	HIGH	YES
Rotation length - Years	11	11	11	11
MAI m^3/ha/yr	36.4	38.8	43.8	48.1
Net Present Value per Ha - NPV	$ 133	$ 39	$ 665	$ 1,596

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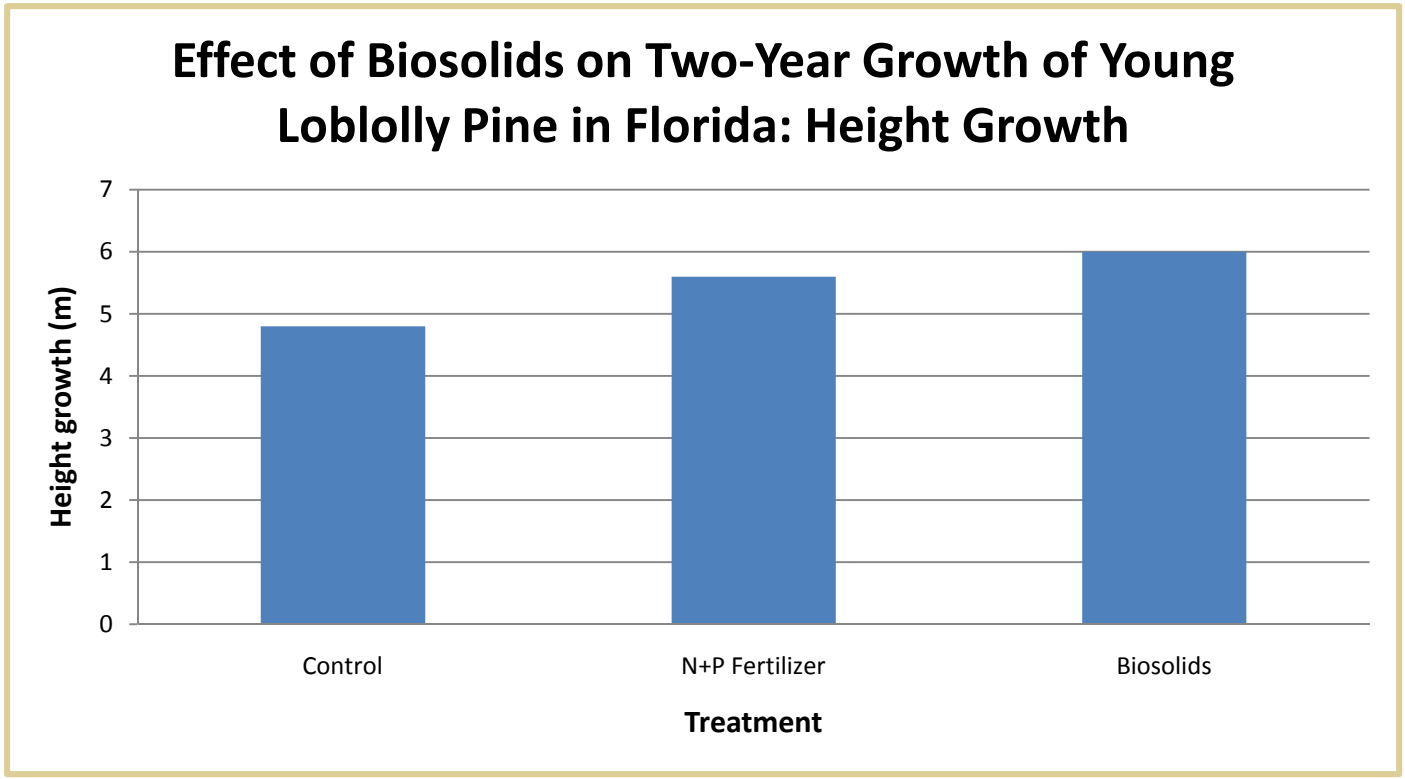
Continental Research

Florida - Loblolly Pine



(from Fox, 2006)

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Continental Research

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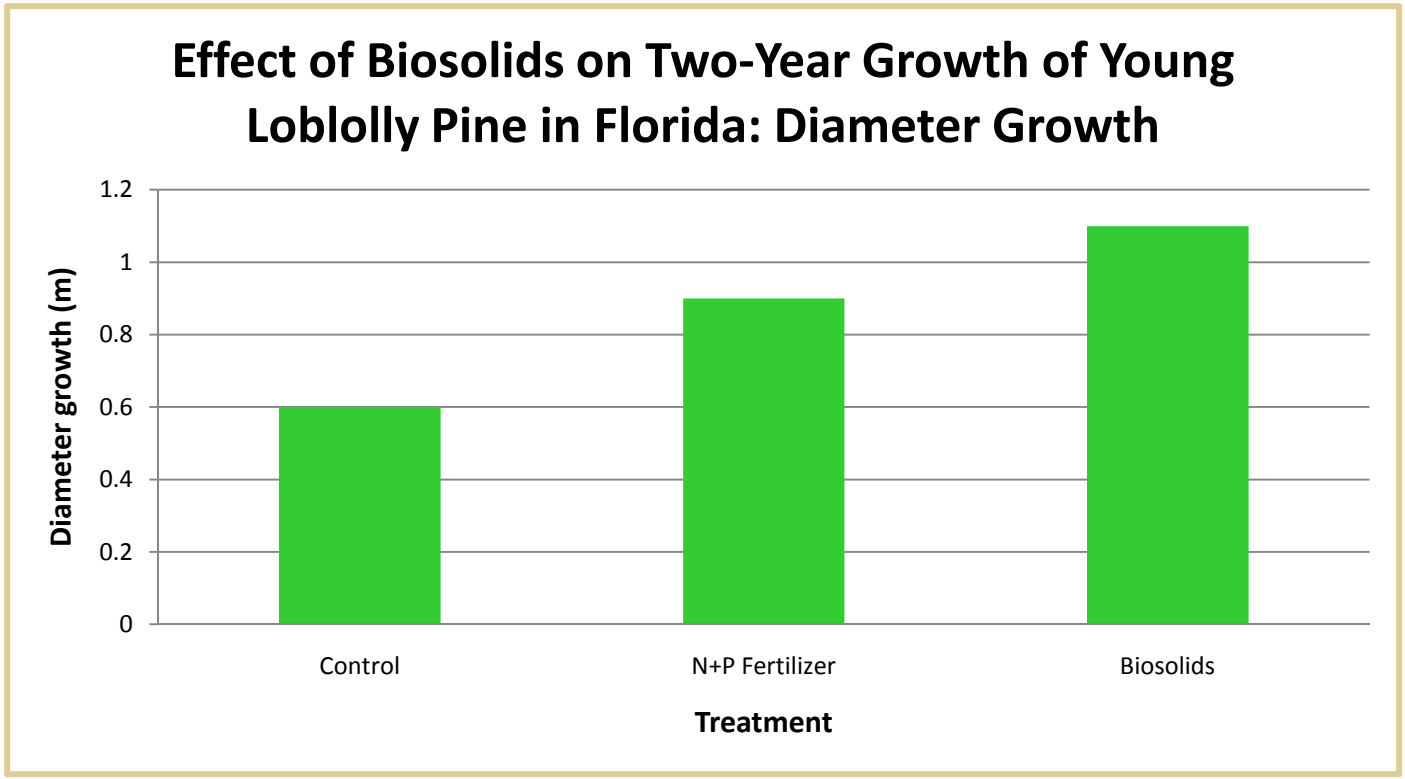

(from Fox, 2006)

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International Research

New Zealand - Radiata Pine

- Examined economic benefits
- Standard application rate
  - 300 kg N ha^{-1}
  - \$217 ha^{-1} (NZD) increase in value
- High application rate
  - 600 kg N ha^{-1}
  - \$411 ha^{-1} (NZD) increase in value

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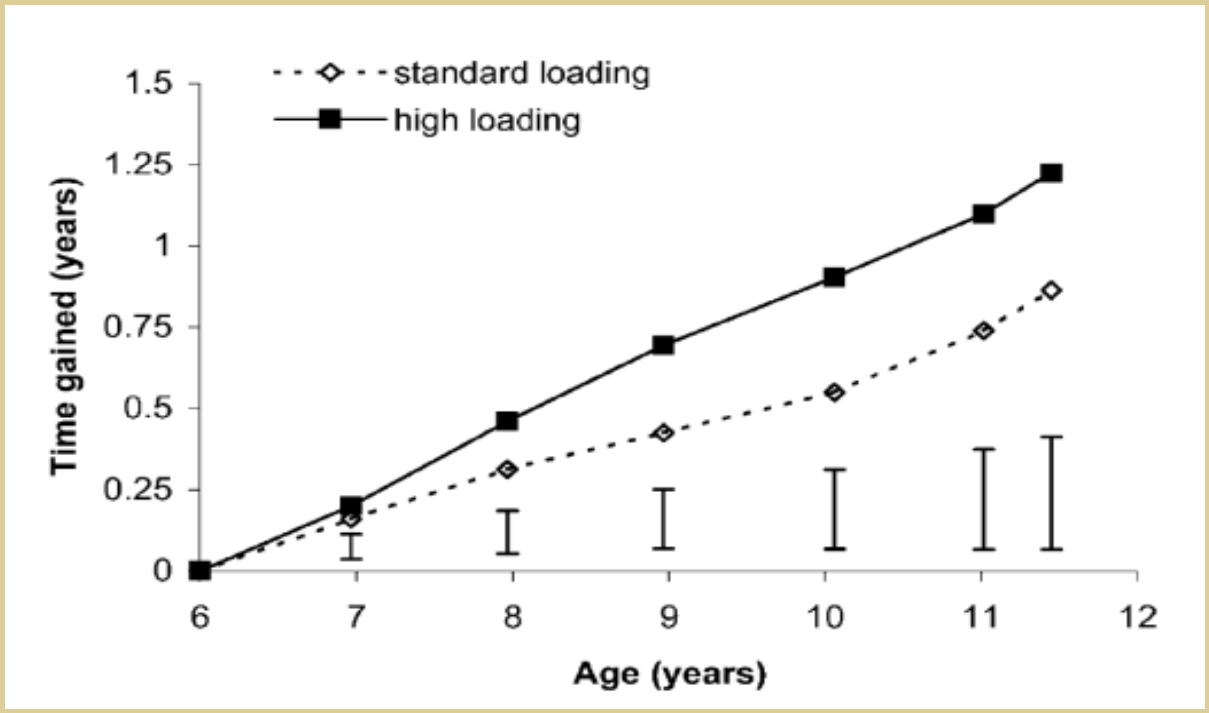
International Research

New Zealand - Radiata Pine



(from Kimberleya *et al.*, 2004)

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Logistics – How we do it now

Dewatered biosolids – forestry equipment

- Improved coverage
- Improved aesthetics
- Flexibility in use
- Longer growth response

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Logistics – Division of Responsibilities

Land Manager:

- Site selection / Access

Integrated Biosolids Contractor:

- Agronomic assessment
- Professional OMRR requirement
- Stockpiling
- Application
- Public Relations
- Post application assessment
- Producer pays

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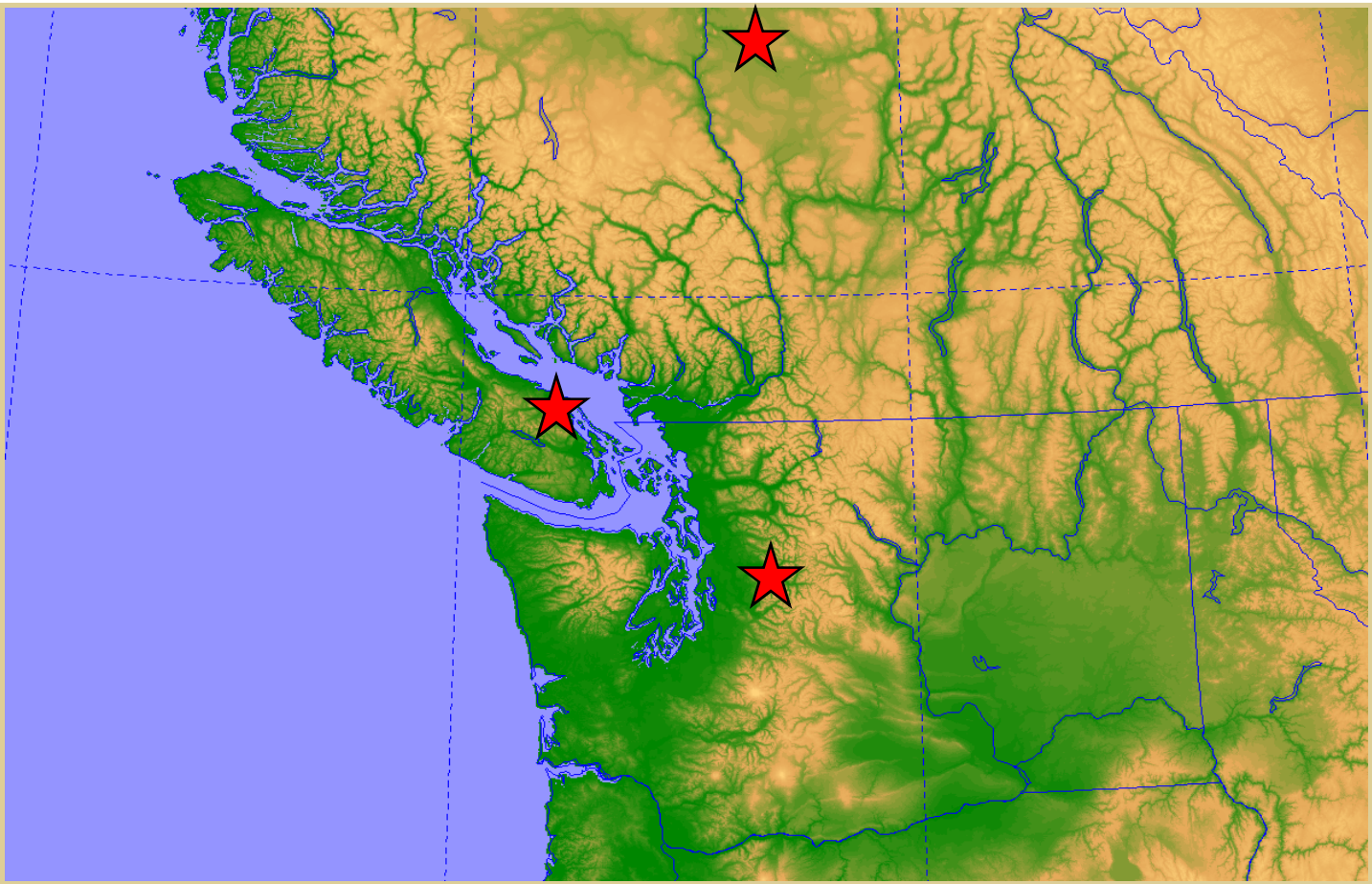
Case Studies



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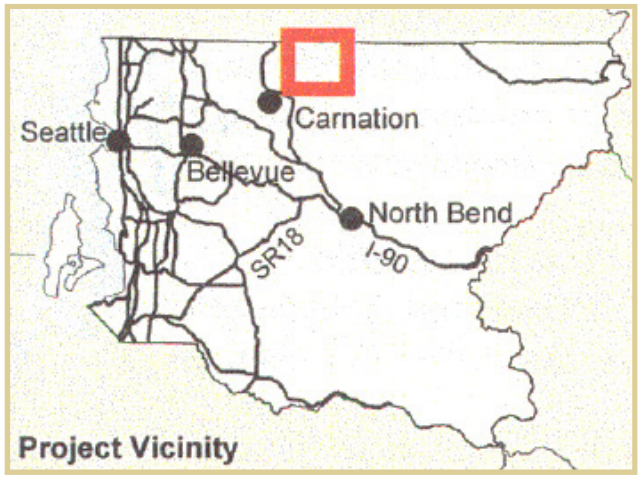
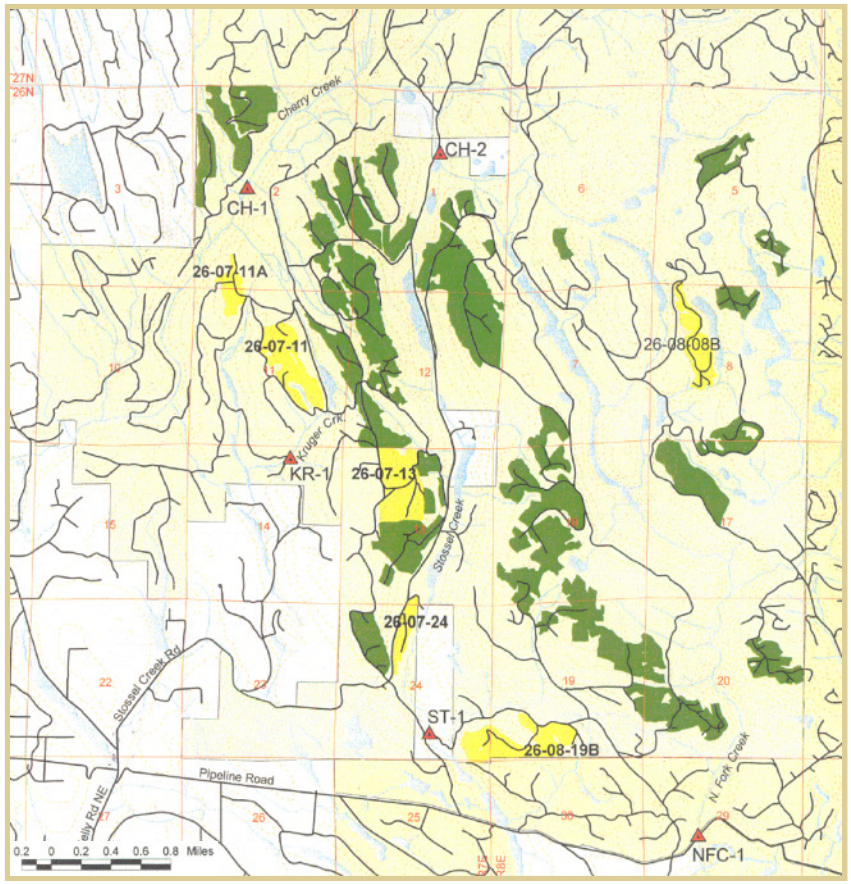
Case Study - King County, WA



Legend
- Water Quality Monitoring Stations
- 2006 Biosolids Application Units
- Other Biosolids Application Units
- Township, Range & Section Lines
- 100-foot Contours
- Roads
- Rivers, Streams & Lakes
- State DNR Marckworth Forest
- Hancock Snoqualmie Forest



Biosolids Forest Fertilization

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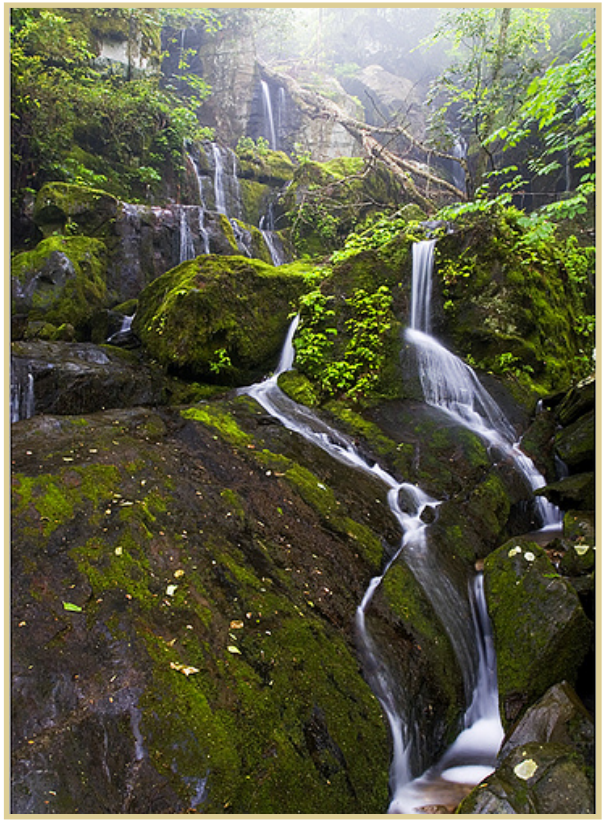
Case Study - King County

Summary

- Biosolids fertilization of public timber stands since 1985
- Applications to a private holding of a major forestry company initiated
- Monitoring parameters
  - Ammonium-N
  - Nitrate-nitrite-N
  - Fecal coliform
  - *Enterococcus spp.*
- No effect on surface water quality



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Case Study – King County

Growth Response

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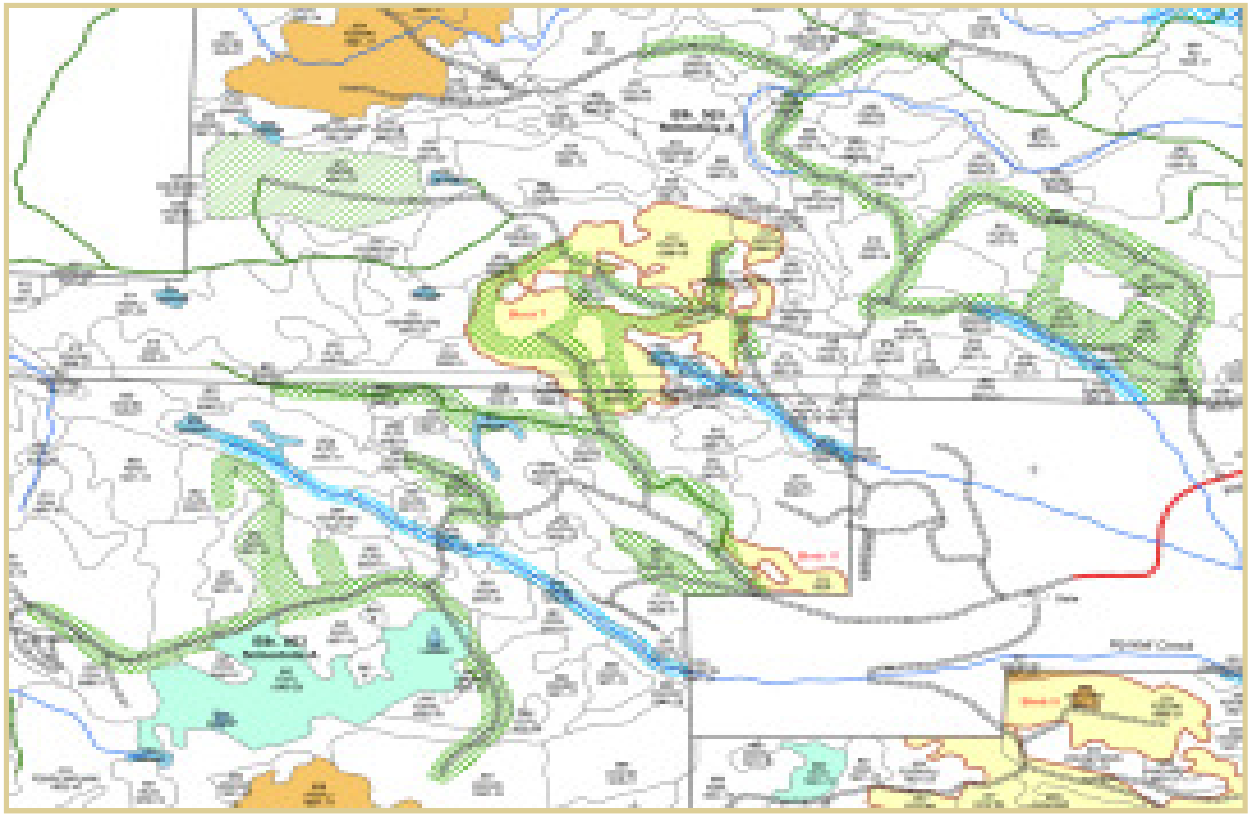
Case Study

Vancouver Island University Malaspina Woodlot, Nanaimo, BC



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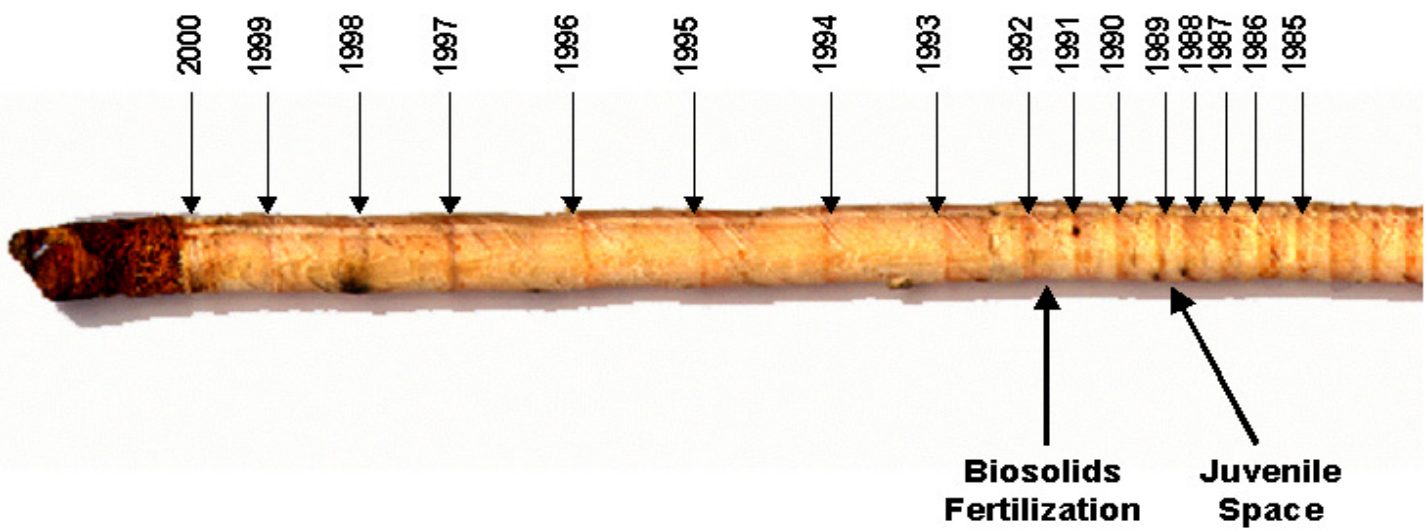
Case Study - Malaspina College

- Extensive soil and water monitoring - no adverse impact
- High recreation value
- Excellent growth response



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Case Study – Prince George

- Baldy Hughes rate trial
- Road and landing reclamation
- Demonstration on pine/fir/spruce
- Strong growth response observed

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Case Study – Prince George

Biosolids Forest Fertilization

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Let the biosolids hit the fan!

Site selection

- Proximate to population centres
- Large scale (200-2000 ha)
- N. Interior/ S. Interior
- Turn award winning reclamation programs into award winning forest fertilization programs
- Progressive and sustainable resource use
- Turn biosolids into a tool to mitigate mid-term timber shortage
- Add a new tool for C sequestration and climate change mitigation
- Biomass/Bioenergy program development

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Questions?

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Interior Forest Fertilization Meeting February 17, Prince George BC

Biosolids Forest Fertilization

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