NDF WORKSHOP CASE STUDIES
WG-1, Case Study 6

Genus-level Approach to *Taxus* Species

Ken Farr,
CITES Scientific Authority, Natural Resources Canada,
Canadian Forest Service

Case Study Intent

- Purpose of is not to describe a specific non-detrimental finding procedure applicable to all *Taxus* spp.
- Case study presents an approach to sustainable harvest of the species *Taxus canadensis*
- Intent is to inform a discussion around making of non-detrimental findings for other *Taxus* species

Case Study: Placement?

- Initial question: Does this NDF case study belong in Trees Working Group? “Yes”, because …
- Involves a long-lived understorey woody species
- An example of a challenge facing forest managers: reconcile timber and non-timber resource demands
- sustainable approach requires knowing “For what do you wish to manage?”

Taxus: Classification

- Classification of species in the genus *Taxus* “notoriously difficult”
- “One species with numerous varieties” (Pilger, 1903)
- “Twenty-four species, 55 varieties” (Spjut, R.W. 1999).
- CITES (Farjon, 2001): 10 species, 3 infraspecific taxa within the genus
- 5 CITES Appendix II listed spp. (Asia)
- 5 non-listed (Europe and North America)

Classification

CITES Appendix II-Listed Species

	IUCN Status
• *Taxus chinensis*	(LR/lc)
• *Taxus cuspidata*	LR/lc
• *Taxus fuana*	Vulnerable (VU D2)
• *Taxus sumatrana*	LR/lc
• *Taxus wallichiana*	Data Deficient (DD)

Classification

CITES Non-Listed Species

IUCN Status

- *Taxus baccata* L. LR/lc
- *Taxus brevifolia* Lower Risk Near Threatened
- *Taxus canadensis* LR/lc
- *Taxus floridana* Critically Endangered CR B1+2c
- *Taxus globosa* LR/nt

Distribution

Global Distribution, Genus *Taxus* (Earle, 2008).

Global Population

- North American spp.: “isolated individuals in discontinuous populations”
- Asian spp. “scattered individuals under the canopy of other trees rather than as dominant species”
- Main threats to populations: habitat loss/degradation (human induced) & harvesting

Morphology

T. baccata

T. canadensis

T. baccata x T. cuspidata = T. x media

Biological Characteristics

- Non-resinous, evergreen gymnosperms (Pinophyta)
- Slow-growing, shade-tolerant understorey plants
- Many species reported as extremely slow-growing, long lived, taking 100 years or more to attain appreciable size
- Lateral branches well developed, similar to leading shoots (of interest in biomass collection)

Biological Characteristics

- *T. wallichiana* (Himalayan yew) reported to reach 20 (30) m with dbh to 1 (1.5) m
- *T. canadensis* (Canada yew) a sprawling multi-stemmed shrub rarely exceeding 2 m
- Numerous yew cultivars exist; exhibit distinct morphological variance in growth form, habit and needle form and colour

Biological Characteristics

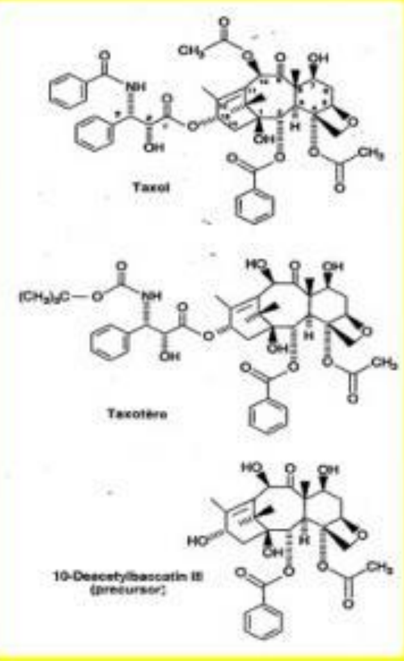
T. x media ‘Hicksii’

UTILIZATION AND TRADE

- Biomass (leaves, twig, bark, roots) of all *Taxus* species contains a unique class of diterpenoid alkaloids (taxanes)

- Since the 1990s, phenomenal pharmaceutical demand for paclitaxel and other taxane compounds

- paclitaxel (trade name Taxol), used to treat a range of human cancers



UTILIZATION AND TRADE

- Approximately 30,000 kg of *Taxus* biomass required to produce 1kg of refined paclitaxel
- Estimated 400 kg per year of paclitaxel products marketed annually in North America and Europe, global market estimated at 800 -1000 kg (2001)
- World sales of Paclitaxel in 2003 estimated at $4.2 billion US, were expected to grow to $13 billion US by 2008

UTILIZATION AND TRADE

- Demand for Taxol in North America and Europe in 2002 estimated to require 12,000,000 kg of *Taxus* biomass
- Large paclitaxel production facilities exist worldwide, including facilities in India, China, North America and Europe
- Import and export of biomass of one or another *Taxus* spp. is largely a function of supply and cost

UTILIZATION AND TRADE

- Demand for Taxol in North America and Europe in 2002 estimated to require 12,000,000 kg of *Taxus* biomass
- Large paclitaxel production facilities exist worldwide, including facilities in India, China, North America and Europe
- Import and export of biomass of one or another *Taxus* spp. is largely a function of supply and cost

COMMODITY IN TRADE

- *Taxus* biomass sometimes exported as dried needles and twigs
- More often as crude liquid or powdered extracts of varying concentrations
- Chemical extracts in trade vary from "brown liquor" shipped in drums to whitish powder
- Pure paclitaxel is a whitish or yellowish, crystalline material

HARVEST METHODS

Harvest of Bark

- Bark from *T. brevifolia* (Pacific yew) was the first identified source of paclitaxel
- 10,000 kg of Pacific yew bark required to make 1kg of Taxol
- Bark from 52 000 to 78 000 yew trees harvested annually during the early 1990's
- By definition destructive, approach discontinued in 1993 by producer (Bristol Myers Squib)

HARVEST METHODS

Harvest of Leaf and Twig Biomass

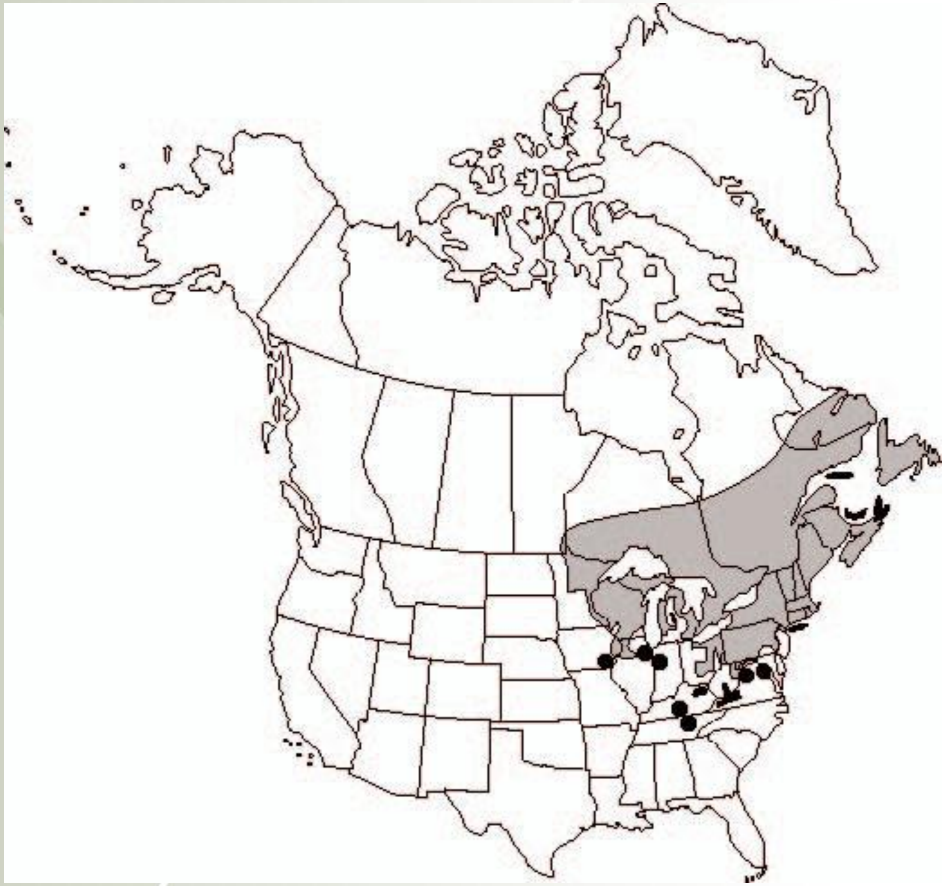
- Taxanes found to occur in the stem bark, roots and needles of other yew species e.g. *T. wallichiana* (Himalayan yew)

- Emerged as an alternate harvesting approach that had potential to support repeatable and sustainable harvesting

Example, *T. canadensis*

- Management approach here presented is specific to one non-CITES listed sp. (*T. canadensis*)
- Historically, species was not seen as commercially important, largely missed in forest resource inventories *
- * Will be captured in “next generation” forest inventories

Example, *T. canadensis*



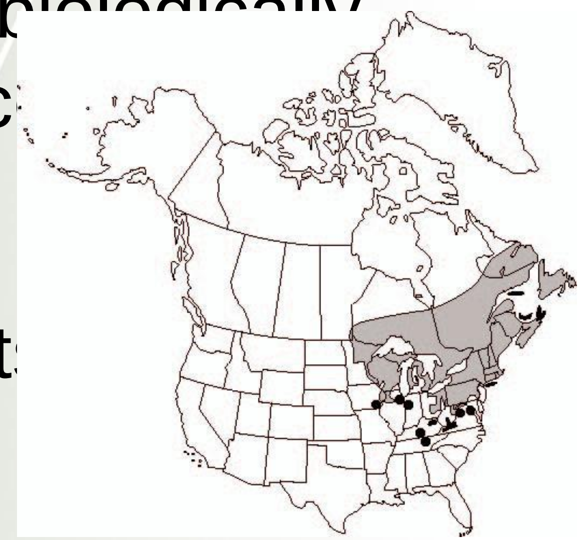
Distribution, *Taxus canadensis*

Management History

- Early 1990’s, sudden interest in *T. canadensis* as an alternative source of income for rural communities

- Lead, initially, to excessive and b
unsustainable harvesting practic

- Experience suggested unlimited
harvesting in the accessible parts
of sp. range could result in
localized commercial extinction



Harvest Guidelines, Principles

- Response: formation of an *ad hoc* Working Group (Canadian Ground Hemlock Working Group)
- Comprised of Canadian Federal and Provincial forestry officials, private sector growers, harvesters and paclitaxel producers
- Worked together to establish voluntary harvesting guidelines, principles, corresponding criteria and indicators

Harvest Guidelines, Principles

Guidelines and principles were intended to address:

- adherence to applicable provincial and federal legislation and international treaties
- conservation of biodiversity, soil and water on harvest sites
- monitoring and tracking to ensure harvesting met sustainability

Harvest Guidelines, Principles

- Guidelines focused on the level of harvest intensity that can reasonably be employed if full regeneration of the harvested population is expected

- Initial guidelines suggested removal of 4 or 5 years of growth was ‘biologically’ acceptable

- View was based on provision plants would not be re-harvested for period of time equal to, or longer than, the number of years of growth extensions removed

Harvest Guidelines, Principles

- Guidelines focused on the level of harvest intensity that can reasonably be employed if full regeneration of the harvested population is expected

- Initial guidelines suggested removal of 4 or 5 years of growth was 'biologically' acceptable

- View was based on provision plants would not be re-harvested for period of time equal to, or longer than, the number of years of growth extensions removed

Harvest Guidelines, Principles

- Subsequent research and harvest trials suggested plants require a period of time significantly longer than 5-6 years to recover
- Physiological research, field testing determined optimum sustainable harvest level is removal of not more than 3 years of growth (i.e. 3 most current seasonal growth extensions) from any stem
- Revised guidelines reflected discussions among harvesters and harvest contractors

Harvest Guidelines, Principles

Significant point:

- Biomass harvest limits are applied directly to individual stems, rather than indirectly to (e.g.) volume of biomass per unit of harvested land area

- Guidelines are applied on Crown (publicly owned) lands in two Canadian provinces, part of legal framework in one province

Harvest Guidelines, Principles

Guidelines Also Consider:

- Timing of harvest
- Selection of plants for harvest (minimum plant size)
- Stem retention (one in five)
- Harvesting methods (tools, procedures)
- Optimum time between harvests (4 years)

Harvest Guidelines, Principles

Principles establish best practices and 'code of conduct' i.e. :

- Adhere to legal frameworks
- Maintain viability of natural populations
- Conserve the quality and quantity of biomass
- Ensuring conservation of biodiversity, soil, water and other ecosystem attributes

Legal Framework

- In Canada, conservation of wild species is multi-jurisdictional, under authority of various provincial, territorial, and federal acts related to wildlife management

- Specific regulation of *T. canadensis* harvest varies by jurisdiction

NDF Considerations

- Linkage of harvest intensity to a physiologically-based rate of annual stem growth is a transferable method for informing non-detriment determination

- Stem-specific control approach is an “allowable cut” estimation that, if verifiable, <u>ensures</u> non-detrimental harvest

NDF Considerations

Additional monitoring and control methods employed:

- requirements for harvest site mapping and reporting
- mandatory training and licensing of biomass harvesters and sellers
- chain-of-custody and transport controls
- limit of legal biomass export and import to licensed buyers

NDF Considerations

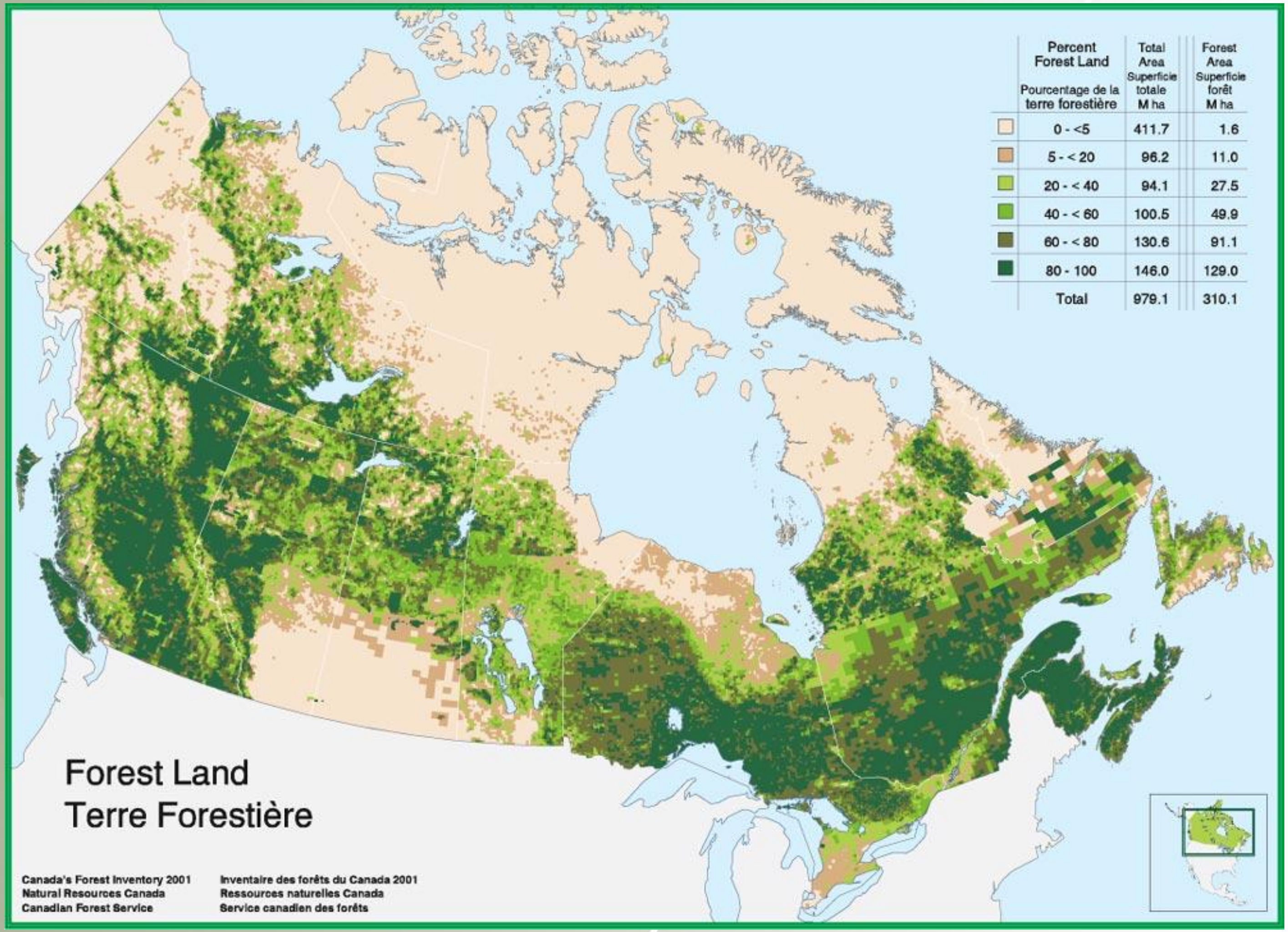
- Linkage of harvest intensity to a physiologically-based rate of annual stem growth should be a transferable method for informing non-detriment determination

- Use of stem-specific measurements in harvest guidelines can serve to reduce regulatory burdens (i.e.) regulation by area, volume

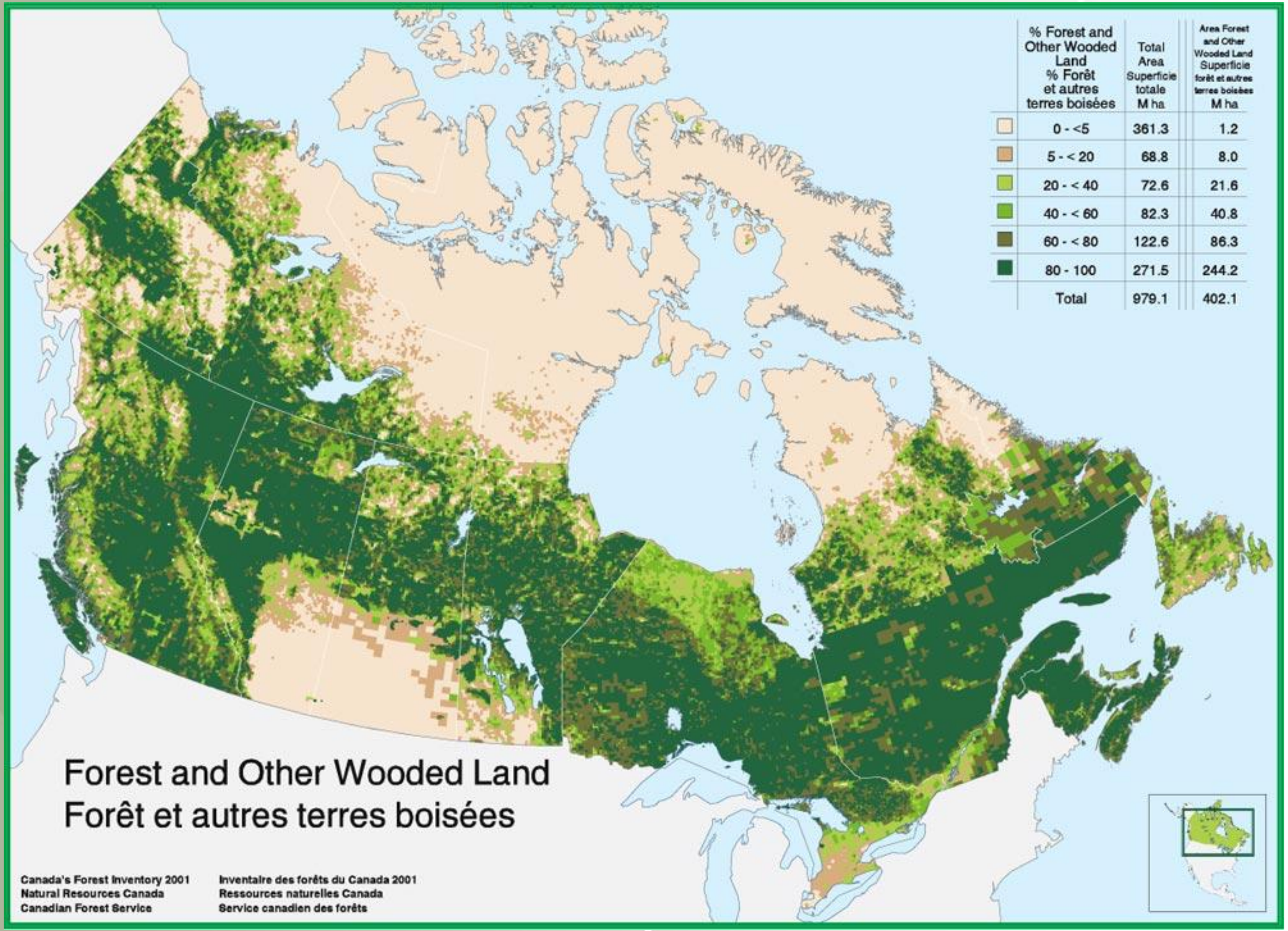
NDF Considerations

- Process here described a response to sudden, unexpected, uncontrolled and unsustainable demand pressure on an understorey species outside mainstream forest management
- In such situations, botanical and ecological data, forest classification data, modeling, may be required as short-term replacement for detailed forest resource inventories

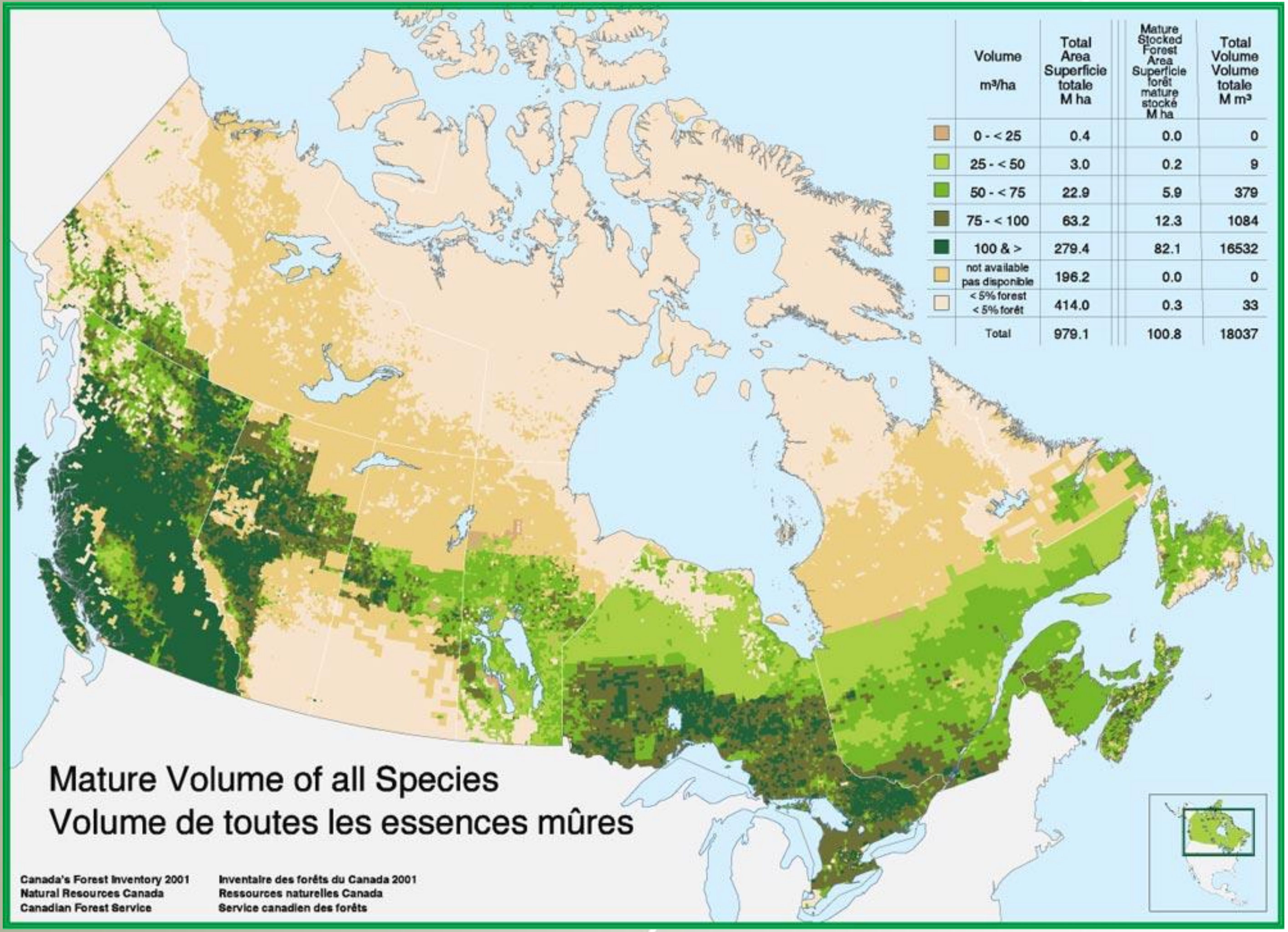
NDF Considerations



NDF Considerations



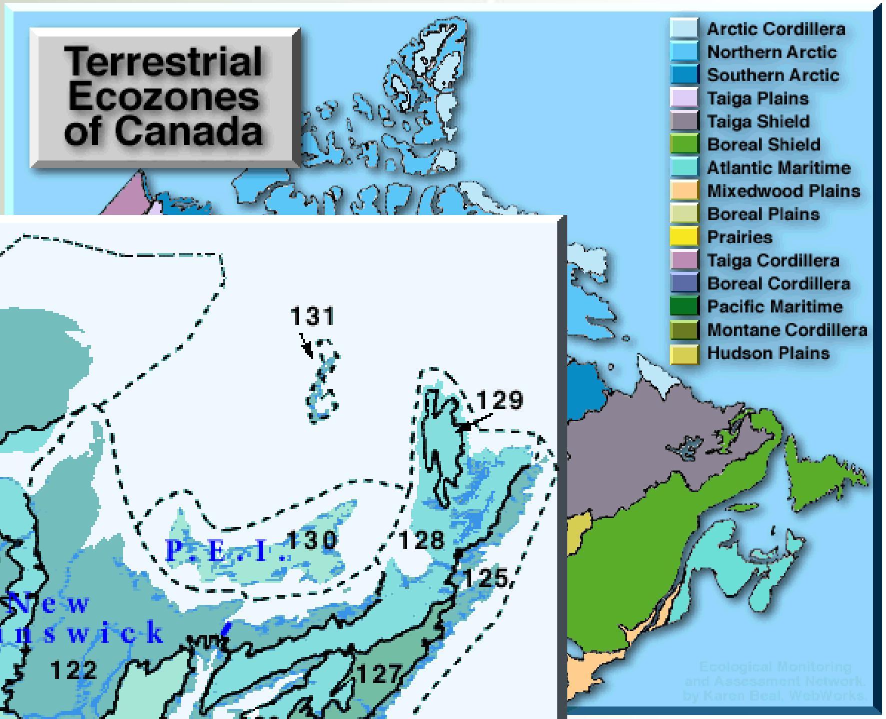
NDF Considerations

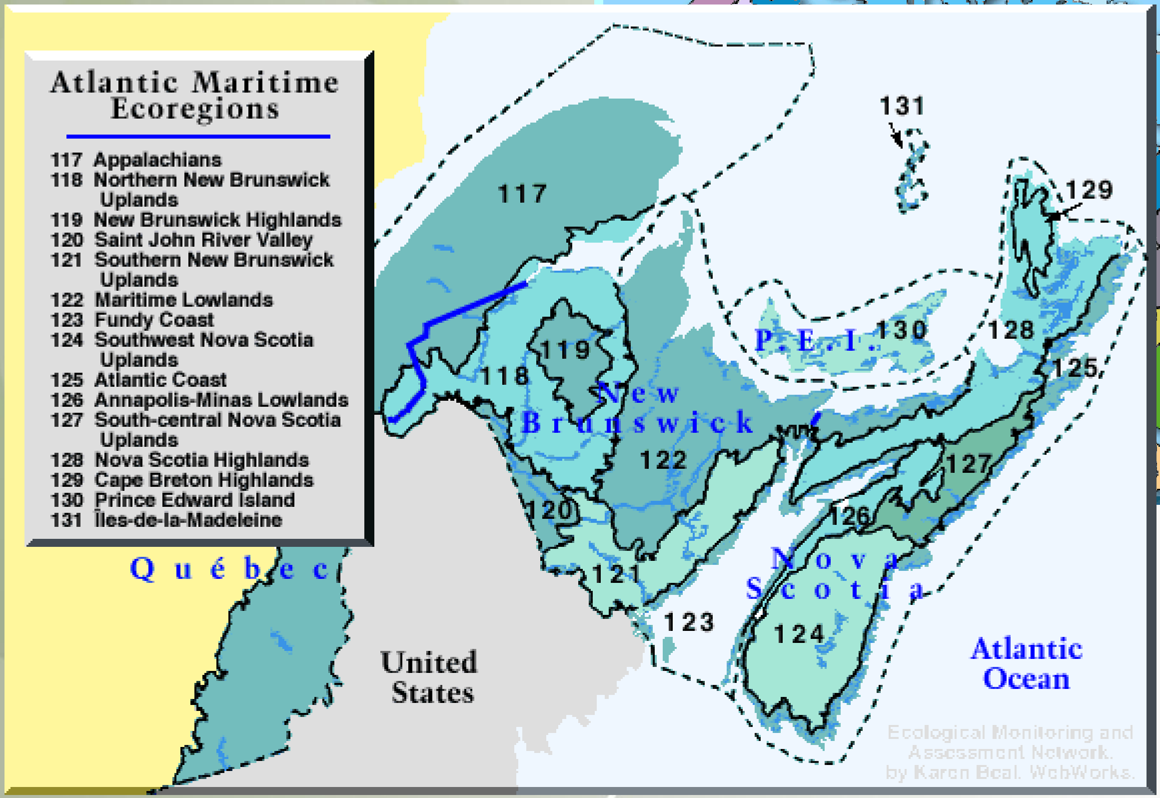


Volume m³/ha	Total Area Superficie totale M ha	Mature Stocked Forest Area Superficie forêt mature stocké M ha	Total Volume Volume totale M m³
0 - < 25	0.4	0.0	0
25 - < 50	3.0	0.2	9
50 - < 75	22.9	5.9	379
75 - < 100	63.2	12.3	1084
100 & >	279.4	82.1	16532
not available pas disponible	196.2	0.0	0
< 5% forest < 5% forêt	414.0	0.3	33
Total	979.1	100.8	18037

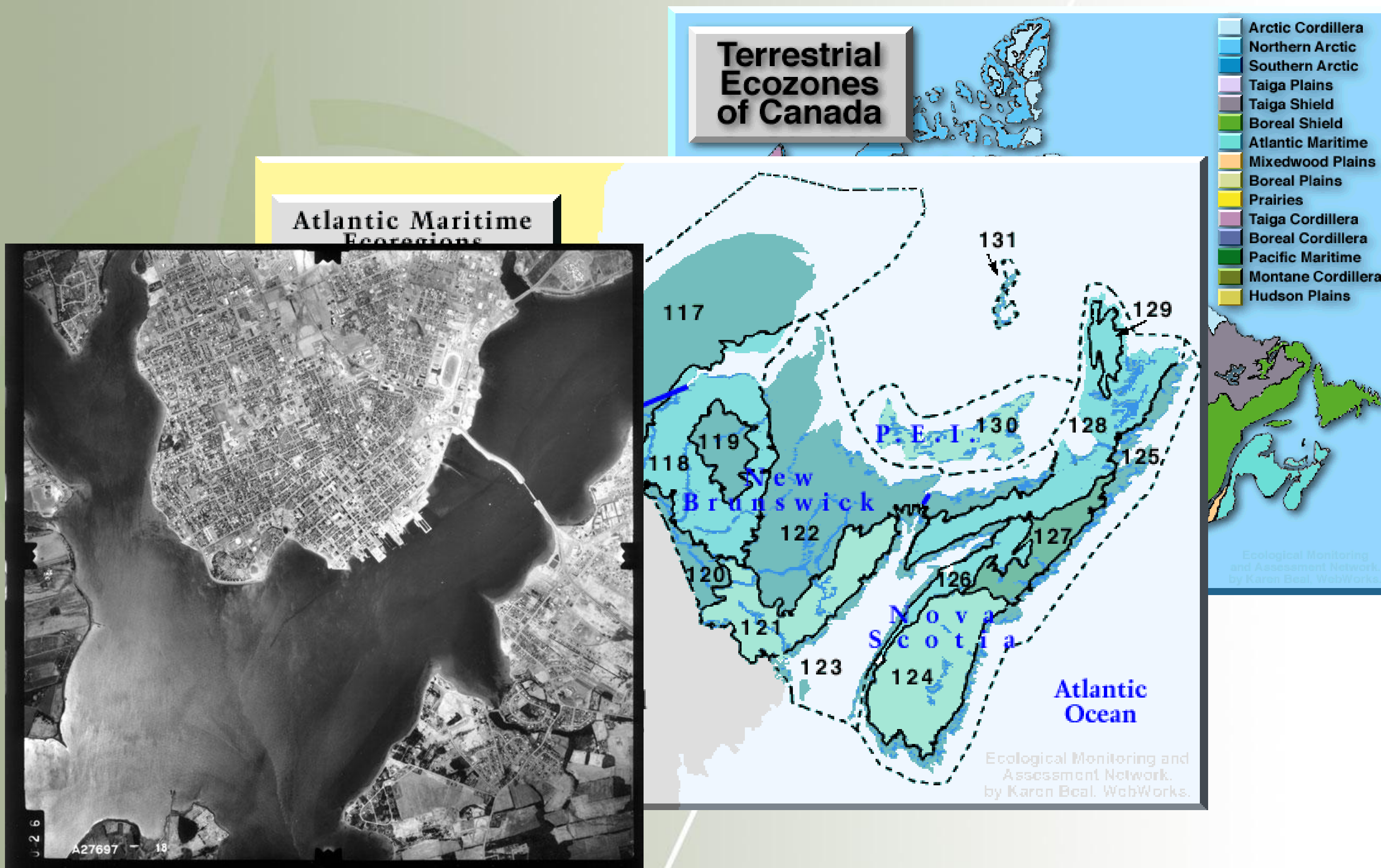
Considerations for NDFs

Considerations for NDFs



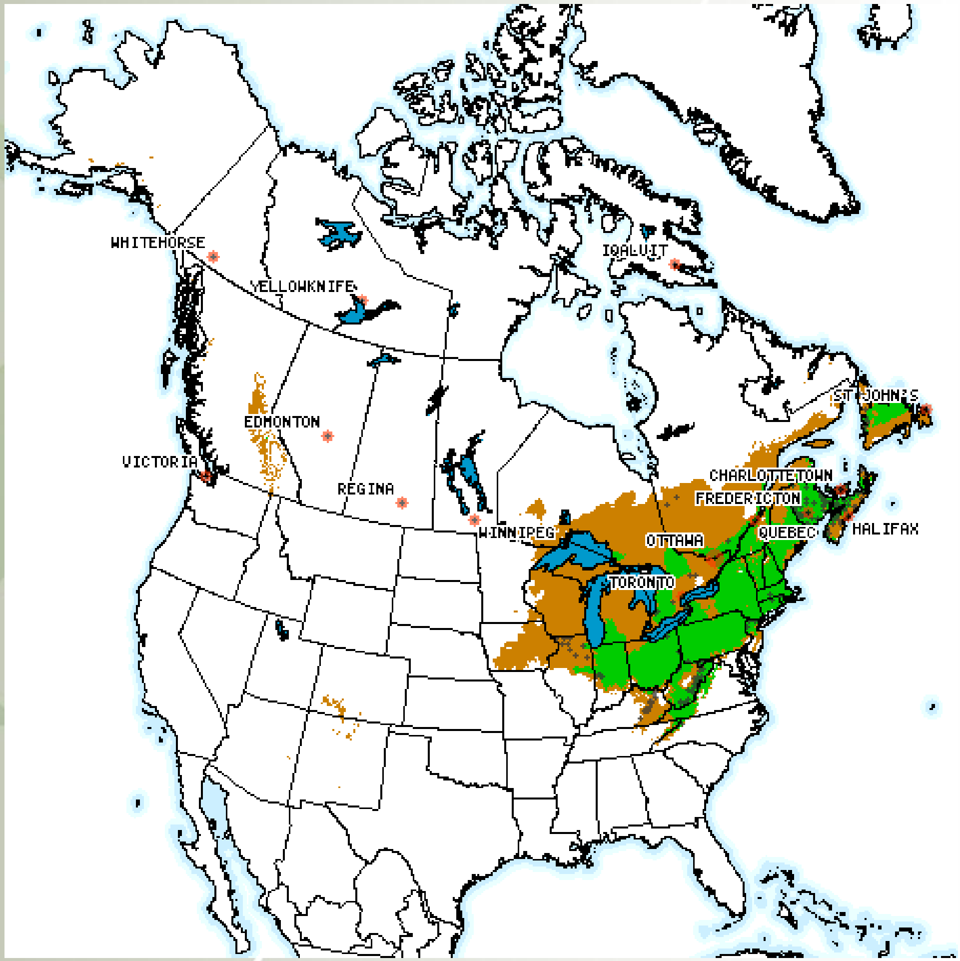


Considerations for NDFs



Considerations for NDFs

- *T. canadensis* bio-map (climate and digital elevation modeling using ANUCLIM)



Economic Considerations

- Stem-specific harvest limits contained in the guidelines can produce measurable economic advantages for harvesters

- Positive economic outcomes are linked to quality and quantity of product (taxanes) in biomass harvested, and to reduced travel, transport and operating costs

Considerations for NDFs

- Process here described arose from a “wild west” situation … sudden, uncontrolled and unsustainable pressure on species
- In such cases, what is minimum information required for making an NDF?
- Full adherence to guidelines that evolved for *T. canadensis* (a sustainable stem-specific harvest) would equate (functionally) to a NDF

Considerations for NDFs

- Case study is about management (therefore not an NDF) but was based on an NDF 'finding' − a harvest limit based on a species specific morphology, physiology

- Inclusive approach (regulators, harvesters, buyers, commodity producers) was a component of success

Considerations for NDFs

- Global NTFP market (pharmaceuticals) evolves, relocates more rapidly than fibre market − ability to consider, produce NDF’s quickly required

- NTFP and traditional forest management approaches increasingly linked … (a challenge for managers and Scientific Authorities)

- Final point for consideration … sustainable harvest does not equate to sustainable forest management

NDF WORKSHOP CASE STUDIES
WG-1, Case Study 6

Genus-level Approach to Taxus Species

Ken Farr,
CITES Scientific Authority, Natural Resources Canada,
Canadian Forest Service