

AN OPERATIONAL APPROACH TO FOREST DEGRADATION

Carlo Bernardini Instituto_Forestal_bateman@interid
 Mauro Murru Instituto_Forestal_murru@interid
 Simone Molteni Instituto_Forestal_molteni@interid
 Yvanna Rojas Instituto_Forestal_rojas@interid
 Gerardo Vergara Instituto_Forestal_vergara@interid
 Paola Araya Instituto_Forestal_araya@interid
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Why the interest on Forest degradation?

- Is defined as "changes within the forest which negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or services" FAO-FRA 2000.
- Or "forest degradation is a long-term reduction of tree crown cover towards but not exceeding the minimum accepted 'forest' threshold", IPCC.
- Notice the definition itself is an issue.
- Forest degradation:
- Is related to REDD+ in Climate Change.
- Is related to Deforestation, because is actually a precursor of Deforestation.
- We may be very effective in avoiding deforestation, but we may not realize the leakage our actions are producing, i.e., degradation.
- Degradation and deforestation are strongly related and should be treated together.
- Example of this in Chile we have no deforestation, but we have degradation (leakage effect?), which is the reference we are using to arrive to such a conclusion, ancient information may answer this 1944 vs 2000.)

How to face forest degradation measurement?

- One option: giving up
- Or, searching for good scientific solutions like:
 - Taking advantage of "system thinking" to organize the scope of analysis.
 - i.e., Considering the forest ecosystem from a hierarchical point of view (Hierarchical theory, Prigogine I, 1990) (Allen T. F. H. and T. Hoekstra, 1992. *Toward a unified ecology*).

- Given this approach, forest degradation may be observed at different levels from the:

- Landscape level** (genetic implications, fragmentation, reproductive capacity of forest, connectivity, among others)
 - to even,
- chemical reactions level** (organism cells, soil minerals)
 - Given our limitations we face with data and resources, we always use to have at most information related to the interval of *landscape level to stand development level*.

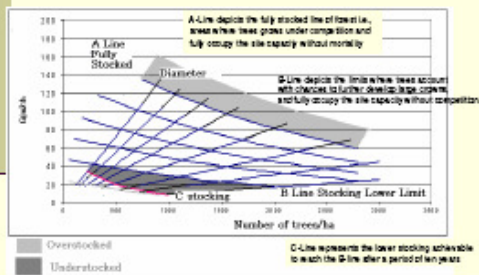
The Chile's study case

- Level of analysis:** Stand development
- Objective:** test an operational approach to identify areas of forest degradation based on stock definition.
- Measurement tool:** Density, approached by the stocking chart (Gingrich S.F., 1967)
- The forest:** one the most important forest type in southern forest in Chile: Roble-Rauil-Coihue forest types (MM ha 1,4.)
- The data:** 290 permanent sampling plots from National Forest Inventory (systematically located in a grid of 5 km by 7 km., since 2000)

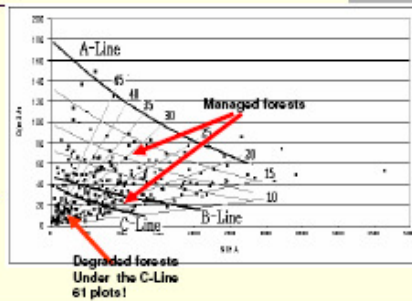
The Stocking chart

- Stock is defined as the "Volume of all living trees more than 'X' cm in diameter at breast height (or above buttress if these are higher) measured over bark from ground or stump height to a top stem diameter of 'Y' cm, excluding or including branches to a minimum diameter of 'Z' cm. Excludes: smaller branches, twigs, foliage, flowers, seeds, stump and roots" (FRA 2005).
- Forest stock is a common term used by forest managers for describing the optimal combination of tree size, growth, and numbers of trees in relation to a particular management objective.
- The stock is closely related to stand density which implies how the growing space is occupied by trees in the forests.
- Forest stocking varies according to company or owner management goals.
- However stocking is flexible enough to include even small trees, (national forest inventory in Chile include from 4 cm DBH trees)

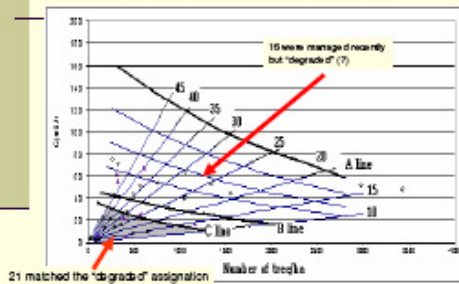
The stocking chart represents the state of the forest by relating, Numbers of trees/ha, Basal Area/ha and, Site space occupation (%)



How does this work for identifying degraded forest? The case of Roble-Rauli-Coihue forest type



Testing against reality
37 sample plots were reported as "degraded" by field brigades



Confusing results?

- The stocking chart is not able to say about 'quality of management', but field observation does.
- Field observations are not able to see stock of forest directly (trees does not let us see the forest)
- Let's recall the 61 sample plots located under the C-Line, field observation only detected 21 of those, 40 were missed !!.

Conclusion & recommendations

- The stocking chart is an useful tool for aiding recognizing degraded forests.
- The stocking chart assume good management practices.
- The field observations and stocking chart acting together improve the identification of degraded forest.
- It is necessary and required the presence of a national forest inventory under permanent bases.
- The stocking chart allows for objective comparison in time, i.e., monitoring.
- This practice is Tier 3.
- The degradation involves more than stocking, as such hierarchical theory help us to devise suitable tools for measure it.

- Capacitation & training is a key issue in recognizing forest degradation from field.
- Operationalizing imply a practical method for checking degradation from the productive perspective.
- We are trying now a quick method for defining in field the degradation status, by using Variable sampling plots (Bitterlich) and Prodan samples.
- We are also trying approaches for the other hierarchical levels of observations, moving toward Landscape level (remote sensing material, spatial analysis-fragmentation).

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Manejo a floresta é essencial para o sucesso

Measuring ecological impacts from logging in natural forests of Eastern Amazônia as a tool to assess forest degradation

Marco W. Lentini
 Johan C. Zweede
 Thomas P. Holmes

IFT's institutional support

Forest management and reduced impact logging (RIL)

Reduced impact logging

Conventional logging

- ✓ In 1996, an experiment in Paragominas compared costs and benefits of CL and RIL (Holmes et al. 2002).
- ✓ Showed a net income from RIL 19% higher than CL
 - > productivity in skidding and log deck operations (39%)
 - < fixed and variable costs (12%)
 - < timber wasted after logging (78%)
- ✓ Main constraints for adopting sound FM are not related to costs.

Objectives

- ✓ To present a method to assess ecological impacts provoked by logging, based on a study conducted in 1996 at a forest site in Paragominas, Eastern Amazônia
- ✓ This method has been intensively replicated in the last 14 years in IFT's field activities
 - Damage to future crop trees
 - Ground damage
 - Timber waste

Methods

- ✓ The experiment was conducted in three 100 ha forest blocks (1 RIL, 1 CL and 1 unlogged)
- ✓ Before harvesting, IFT conducted censuses of all commercial and potentially commercial trees (> 35 cm D.B.H.) and established permanent plots (1% of the area)
- ✓ In the forest block harvested with RIL, harvesting was planned
 - Liana cutting, planning maps for felling and skidding of logs based on the census, directional felling techniques, skidding with winch and grapple, planning of roads and skid trails as part of the permanent infrastructure.
- ✓ The CL operation was conducted by a logger
 - Harvesting crew with on-the-job-training
 - Sawyers were paid on a piece rate
 - Skidding crews were not provided with precise information from felling crews
 - No census or planning is executed

Damage to future crop trees

Severity class	Crown damage	Bark damage	State of damage	Health class
0	No damage, complete crown	No damage	-	No damage
1	Minor damage, i.e. < 1/3 of crown damaged	Minor damage to < 1,500 cm ² of bark	Felling	Clear signs of recovery
2	Moderate damage, i.e. > 1/3, but less than 2/3 of crown destroyed	Minor damage to > 1,500 cm ² of bark	Skidding	No signs of recovery or establishment
3	Severe damage, i.e. crown unshaded	Moderate damage, i.e. crown bark bark, but < 1,500 cm ² of bark	Road building	Clear signs of death or decline (e.g. loss of fungal attacks)
4	N/A	Severe damage to crown > 1,500 cm ² , e.g. a major loss of broken branches	Log deck construction	N/A
5	N/A	Irreversible damage (crown dead or fallen, no. unshaded hole)	Natural causes (unrelated to logging activities)	N/A

- Adapted version of the method proposed by Johns et al. (1996)

- Only commercial and potentially commercial tree species with good form and DBH > 35 cm

- Survey was conducted about 20 months after harvest.


Ground area disturbed by logging

- ✓ It measures the total impact of heavy machinery on the forest floor
- ✓ Assessment is made by measuring in the field the total area of roads, log decks and skid trails established for harvesting
 - A technician used a 50-m tape to measure the length and width of every road, skid trail and log deck in both harvest areas.
 - The direction of every infra-structure measured was recorded with a compass to permit mapping these features in the office.
 - Surface of these features were calculated.
- ✓ Although compaction was not measured, disturbance severity was estimated.
 - Every 30 meters along all skid trails, it was evaluated whether mineral soil was exposed.
 - Sampling unit was a single line across the width of the skid trail.

Volume of merchantable timber wasted

Photos IFT

- ✓ The volume of timber wasted is the difference between the volume under "ideal" logging and the actual volume recovered
- ✓ Causes of timber wasted
 - timber felled and not found by skidding crew or left in the forest because poor felling caused logs to split and lose merchantability
 - timber left on the log deck
 - timber wasted because cutting stumps were too high or due to poor bucking of felled logs
 - poor felling techniques
- ✓ Volume was measured by a crew of IFT technicians by measuring the area and the length of timber portions which could be harvested but were left in the forest



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Results: Damage to future crop trees

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Health class	Conventional logging		Reduced Impact Logging	
	Felling Damage	Damage from other activities	Felling Damage	Damage from other activities
Recovering	0.14 (54)	0.11 (43)	0.24 (80)	0.17 (57)
No sign of change	0.16 (63)	0.05 (21)	0.18 (58)	0.05 (17)
Dying	0.34 (136)	0.04 (16)	0.16 (52)	0.01 (2)
Total Impacted	0.64 (253)	0.20 (80)	0.58 (190)	0.23 (76)

-felling was revealed as the most important driver of damages to residual trees (> 95% of fawn-induced damages)

- Damages which provoked the death of residual trees were > 2.2 higher in CL than in RIL.

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Results: Ground area disturbed by logging

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Activity	Conventional logging		Reduced-impact logging	
	m ² / tree harvested	ha / 100 ha block	m ² / tree harvested	ha / 100 ha block
Secondary roads	34	1.35	20	0.65
Log decks	26	1.05	19	0.63
Skid trails	193	7.66	120	3.90
Total	253	10.05	159	5.18

In addition, the experiment showed that 100% of the CL skid trails were cleared to mineral soil, whereas less than 10% of the RIL skid trails had mineral soil exposed.

Cumulative disturbance over time in CL tend to intensify, since forest infrastructure tend to be permanent in RIL.

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Results: Wasted merchantable timber

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Source	CL waste (m ³ /ha)	RIL waste (vol./ha)
High stumps	0.28	0.10
Split logs	0.87	0.31
Bucking waste	1.97	0.85
Logs lost	0.96	0.06
Total forest	4.08	1.32
Log deck	1.97	0.60
Total	6.05	1.92


Timber wasted in the CL block was almost 5% (23.3%) of the standard harvest volume. RIL provoked a total wasted of 7.6% of merchantable timber.

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Discussion

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- ✓ The main purpose was to present a simple method to assess forest degradation and ecological impacts provoked by logging.
- ✓ Despite current development of remote sensing techniques able to identify in a coarse scale the overall occurrence of sound FM indicators, field based methods are still necessary to evaluate the quality of forest operations and their ecological impacts over the forest.
- ✓ It is still necessary to replicate the method in other regions in Amazônia, taking into account the diversity of conditions.



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Conclusions

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- ✓ The method used to evaluate forest degradation and ecological impacts from logging presented in this paper has a large potential to be disseminated to other regions in Amazônia and surrounding countries.
 - As main advantages, we can cite its simplicity and viability to be used in different contexts.
 - Measurement of roads, log decks and skid trails can be improved in large scale enterprises using recent GPS technology
 - Methodology still requires validation in other forest types and technological alternatives, mainly considering CFM operations.
- ✓ The method should be disseminated to other FM centers, training centers, universities and forestry foment organizations and agencies.

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