

Article

## Regulating the Sustainability of Forest Management in the Americas: Cross-Country Comparisons of Forest Legislation

Kathleen McGinley <sup>1\*</sup>, Raquel Alvarado <sup>2</sup>, Frederick Cubbage <sup>3</sup>, Diana Diaz <sup>4</sup>, Pablo J. Donoso <sup>5</sup>, Laércio Antônio Gonçalves Jacovine <sup>6</sup>, Fabiano Luiz de Silva <sup>7</sup>, Charles MacIntyre <sup>8</sup> and Elizabeth Monges Zalazar <sup>9</sup>

<sup>1</sup> US Forest Service, 920 Main Campus Drive, Suite 300, Raleigh, NC 27606, USA

<sup>2</sup> Departamento de Geografía, Universidad de la República, Iguá 4225, Montevideo, CP 11400, Uruguay; E-Mail: alvarado@fcien.edu.uy

<sup>3</sup> Department of Forestry and Environmental Resources, North Carolina State University, 2800 Faucette Drive, Raleigh, NC 27695, USA; E-Mail: fred\_cubbage@ncsu.edu

<sup>4</sup> EEA Concordia, INTA, CC 34, Concordia, Entre Rios, 3200, Argentina; E-Mail: ddiaz@correo.inta.gov.ar

<sup>5</sup> Facultad de Ciencias Forestales y Recursos Naturales, Instituto de Silvicultura, Universidad Austral de Chile, Casilla 567, Valdivia, Chile; E-Mail: pdonoso@uach.cl

<sup>6</sup> Departamento de Engenharia Florestal, Universidade Federal de Viçosa, Viçosa, Minas Gerais 36570-000, Brasil; E-Mail: jacovine@ufv.br

<sup>7</sup> Avenida Joaquim Lopes de Faria 473 apto 201, Santo Antônio, Viçosa, Minas Gerais 36570-000, Brasil; E-Mail: fabianocoop@yahoo.com.br

<sup>8</sup> Forest Policy Consultant, 3920 Wentworth Drive, Durham, NC 27707, USA; E-Mail: cwmacintyre@gmail.com

<sup>9</sup> Departamento de Silvicultura y Ordenación Forestal, Facultad de Ciencias Agrarias, Universidad Nacional de Asunción, San Lorenzo, Paraguay; E-Mail: lizamonges@gmail.com

\* Author to whom correspondence should be addressed; E-Mail: kmcginley@fs.fed.us; Tel.: +1-919-513-3331; Fax: +1-919-513-2978.

Received: 9 May 2012; in revised form: 12 June 2012 / Accepted: 18 June 2012 /

Published: 6 July 2012

---

**Abstract:** Based on theoretical underpinnings and an empirical review of forest laws and regulations of selected countries throughout the Americas, we examine key components of natural forest management and how they are addressed in the legal frameworks of Argentina, Brazil, Chile, Costa Rica, Guatemala, Nicaragua, Paraguay, Uruguay, and the U.S. We consider forest policy directives in terms of legislative, planning, operational,

environmental/ecological, social, and economic aspects and classify them by the type of policy obligation: (1) non-discretionary laws or rules; or (2) discretionary, voluntary directives; and, further, by the type of policy approach: (1) a specific technology or practice required or recommended; (2) a process or system requirement or recommendation; or (3) a performance or outcome based requirement or recommendation. Protection of at-risk species and riparian buffers are required in all countries and include specific prescriptions in most; forest management planning and secure, legal land title or tenancy are commonly required; and mandatory processes to protect soil and water quality are customary. Less common requirements include forest monitoring and social and economic aspects, and, when in place, they are usually voluntary. Implications for improved policies to achieve sustainable forest management (SFM) are discussed.

**Keywords:** forest regulation; sustainable forest management policy; Latin America; North America

---

## 1. Introduction

At the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, the vast majority of the world's nations agreed to international accords to protect biodiversity and mitigate climate change. However, they could not agree on a convention for forests, largely due to disputes over forest sovereignty and finance, as most developing countries asserted their autonomy over forests as sovereign resources that should be compensated for foregone development opportunities, while many developed nations contended that forests should be considered a global common but would not commit to financial support for their protection [1]. Even so, the Earth Summit solidified the precepts of sustainable development and sustainable forest management (SFM) as the widely accepted paradigms for natural resource management and protection [2]. While the means to best achieve SFM remain moot, from biological, social, and environmental perspectives, governmental regulation of forest use through policy and law is considered one of many important tools for advancing forest sustainability.

Since 1992, most countries in Latin America have significantly revised their forest laws, and in some cases the implementation of those laws, in order to better achieve SFM. However, not nearly enough research has been performed to examine the intended and actual effects of these laws and their implementation on forest sustainability or how the laws and their implementation compare among countries. There have been a few compilations of forest laws, and one recent book analyzing forest laws in selected countries, but little else [3,4]. With the exception of McDermott *et al.* (2010) [4], not much theoretical rigor has been applied to the analysis of forest policies and laws and how they address sustainability.

Consequently, based on theoretical underpinnings and an empirical review of forest laws and regulations, we assessed key components of natural forest management and how those components are addressed in the legal frameworks of nine countries throughout the Americas. After a brief description of the background to this study, we describe the theoretical approach we employed to evaluate the legal framework for forests. Then we present the results and discuss the approach and rigor of forest

laws and other legal directives in various countries. Finally, we draw conclusions about the strength of forest law in the Americas, the challenges of implementation, and the implications for achieving SFM.

### *Governmental Regulation of Forest Management*

Governmental regulation of forest use is often “instituted to protect the long-term external values that are not provided well by markets and may be required... to prevent resource exhaustion or to prevent externalities and market failures from leading to damage to other resources” [5]. Though governmental forest regulation can vary within and across countries, in the most general sense, it “sets the minimum standard for forestry practices” and/or defines permissible and prohibited forest practices [6].

In related studies on governmental regulatory forest policy, Cashore and McDermott (2004) [7] and McDermott *et al.* (2010) [4] examine the content of forestry regulations in developed and developing countries, specifically determining if and how riparian zones, clearcuts, road construction, reforestation, and annual allowable cuts are addressed. The authors find a wide range of variation in forestry regulations across and within the 20 countries examined. In particular, forest regulations in developing countries were significantly more “stringent” than those from developed countries (e.g., riparian buffer zone requirements, clearcut size limits). Though policy implementation and enforcement were not systematically examined, the authors note that the developing country case studies frequently exhibited perverse land-use policies, inadequately funded government institutions, and a severe lack of enforcement capacity.

In general, despite long-term efforts to advance governmental regulation of tropical forest management, this policy approach is often criticized for failing to curtail continuing rates of forest degradation and deforestation [4,7–9]. Regulatory failures typically are linked to poor enforcement, corruption, weak legal systems, and conflicting extra-sectoral policies and practices (e.g., agricultural expansion), which have been documented not only in the poorest developing countries, but also in countries in transition, and even developed countries [10,11]. Moreover, not enough is known about the aspects of forest management that are addressed through governmental forest regulation in the tropics and elsewhere, making it difficult to discern if policy failures are due to weaknesses in implementation, or in part at least, to weaknesses in the regulatory policies themselves [12].

Ultimately, a thorough understanding of forest policy statements or directives is fundamental to the accurate assessment of potential and actual policy outcomes [4,12–16]. Hence, we conducted a comprehensive evaluation of the legal frameworks for promoting or enhancing the sustainability of productive natural forest management in nine countries throughout the Americas. While an empirical examination of forest policy implementation and impact was not within the scope of this study, the results of this research provide essential and often overlooked information for regulatory forest policy impact evaluation. We concentrate on the legal frameworks for productive natural forest management, as natural forests comprise by far the predominant forest area in the region, while we also recognize and briefly discuss planted and secondary forests as important components of the total forest estate. Additionally, other legal conservation and preservation measures are obviously important for retaining and protecting all forests, but sustainable timber management that provides benefits to natural forest owners and users is crucial, and the focus of this research.

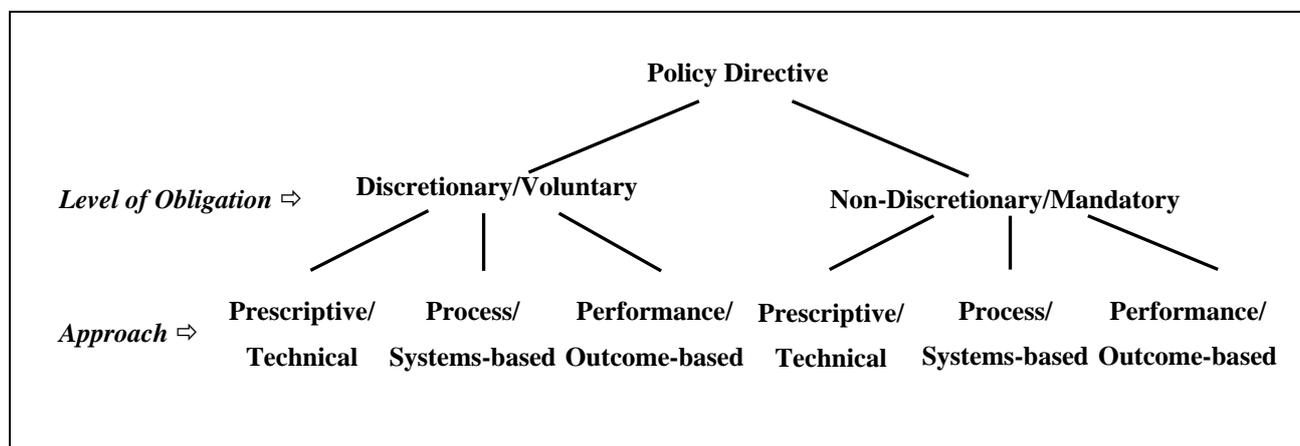
## 2. Theoretical Approach to Evaluating Governmental Forest Regulation

To understand the intended and actual outcomes of public policy, not only is it important to understand the aspects of the public problem that the policy addresses, but also to understand the ways in which the policy intends to address or influence the problem [7,17,18]. Therefore, this analysis focuses on both policy content and policy structure. “Policy content” refers to the range of forest management issues addressed by regulatory forest policy (e.g., legality of forest operations, conservation of forest biodiversity, financial issues). “Policy structure” encompasses the level of obligation (discretionary, non-discretionary) and the approach (prescriptive, process-based, performance-based) associated with a given policy directive.

To evaluate policy content, first we reviewed international and regional frameworks of Criteria and Indicators for SFM at the forest management unit level and international and national standards for forest certification to determine a common suite of SFM indicators that address the environmental, social, and economic aspects of natural forest management [19]. These 23 SFM indicators were also found to be compatible with other global analyses of soft and hard law standards for forest management [20,21]. We used this suite of SFM indicators to evaluate the content of forest policies and laws in the selected countries. Table 1 lists the SFM indicators for analyzing governmental forest regulations and identifies associated descriptive and quantitative aspects.

To better understand the way in which these 23 SFM indicators are explicitly addressed in public policy, if at all, next we developed an analytical framework of policy structure that takes into account the level of obligation (discretionary, non-discretionary) and the approach (prescriptive, process-based, performance-based) represented by a particular policy directive (Figure 1). Discretionary policies are voluntary, while nondiscretionary policies are mandatory. A “prescriptive” policy identifies a preventive action or prescribes an approved technology to be used in a specific situation [18,22,23]. A “process-based” policy identifies a particular process or series of steps to be followed in pursuit of a management goal [18,22,24]. A “performance-based” policy specifies the management outcome or level of performance that must be met, but does not prescribe the measures for attainment [18,22,25].

**Figure 1.** Policy Structure by Level of Obligation and Approach (Adapted from: Gunningham and Grabsoky 1998 [18]; Bluff and Gunningham 2003 [22]; Cashore and McDermott 2004 [7]).



**Table 1.** Key indicators of sustainable forest management.

D/Q*	Issue—Description, threshold
Legislative/Legality issues	
D	Legislative compliance—Is compliance with national laws/legislation specified or mandated?
D	Forest tenure—Is proof of property, tenure, or usufruct rights required for authorization of forest use/harvest?
D	Forest boundaries—Is marking of forest boundaries required? Are specific measures required to protect against illegal trespass or possession?
Planning	
D	Forest inventory—Are forest inventories required? Are specific inventory methods/measures mandated?
D	Management plan—Are specific forest management plan (FMP) components and/or format required? Is a specific person/group designated to develop the MP? If applicable, how often must FMPs be renewed?
D/Q	Harvest Calculations, Thresholds—Are there specific rules for determining a sustainable harvest? If applicable, what is: the annual allowable cut (% of species abundance permitted for harvest)? The minimum diameter cut? and/or the minimum cutting cycle or rotation in years by forest type?
D/Q	Monitoring—Is forest monitoring required? If applicable, are there specific aspects to be measured/monitored? Are permanent sampling plots (PSPs) required? Is there a minimum number of plots/% of area/or acreage required for PSPs?
Operations	
D/Q	Forest roads—Are there specific rules for road network development and/or installation? If applicable, what is the % of area permitted to be cleared for road network?
D/Q	Slope limits—Are there specific limits to harvests or operations on steep slopes?
D/Q	Clearcuts—Are there specific rules on clearcuts? If applicable, what is the limit on “clearcut” area?
D	BMPs—Are there mandatory or voluntary best management practices manuals or other management guidelines?
Environmental/ecological aspects	
D	At-risk species—Are there specific rules on at-risk species of flora and fauna and their conservation or protection?
D/Q	Riparian buffer zones—Are there specific rules on riparian zones? If applicable, what are the limits around bodies of water?
D	Regeneration/reforestation—Are there specific rules on (securing) regeneration/ reforestation? Are specific silvicultural treatments permitted/ promoted?
D	Land Use Change—Is land use change in managed forests permitted/prohibited?
Social issues	
D	Indigenous rights—Are there specific rules for dealing with indigenous groups?
D	Community involvement—Are there specific rules for involving or dealing with local communities?
D	Public consultation—Are there specific rules for consulting the public?
D	Public reporting—Are there specific rules on public reporting?
D	Training and safety—Are there specific rules on training? on safety?
Economic/Financial issues	
D	Financial analyses—Are financial analyses or cost benefit analyses required?
D	Wood utilization and waste minimization—Are there specific rules on wood utilization and/or on waste minimization?
D	Chain of custody—Are there specific rules on chain of custody?

\* D: descriptive; Q: quantitative.

### 3. Methods and Procedures

We used the SFM indicators (Table 1) and the theoretical framework of policy structure (Figure 1) to assess the policy directives related to natural forest management on private land among nine countries in the Americas—Argentina, Brazil, Chile, Costa Rica, Guatemala, Nicaragua, Paraguay, Uruguay, and the United States. These countries represent a range in forest size and ownership types across the Americas, as well as a large share of the total forest land area. We chose these countries based on their range in forest size, diversity, use and policy. The U.S., Argentina and Brazil operate under a federal system where national laws set a baseline, but individual provinces or states implement the laws, and may have their own set of additional laws and directives. Therefore, we also examined sub-national laws from key states or provinces important to timber production (Maine, North Carolina, and Wisconsin in the U.S.; Misiones in Argentina; Minas Gerais in Brazil). In particular, the U.S. does not have a “national” forest policy that governs forest management throughout the country on private lands. Instead, each state chooses to enact or not enact various levels of laws. However, the U.S. has broad national environmental laws for water quality, air quality, and endangered species, and those laws are implemented through various mixes of federal rule making and oversight and state implementation, depending on the law. These distinctions are clarified in our analysis.

For each jurisdiction (*i.e.*, country, state, province), we collected the laws, regulations, guidelines, and other policy directives related to natural forest management on private land (Appendix A). We first developed country- and state/province-level spreadsheets that documented and summarized in text the legal directive(s) and associated descriptive and/or quantitative features that pertained to each SFM indicator. Next, we classified and coded the recorded directives by policy structure, determining their level of obligation (*i.e.*, discretionary, non-discretionary) and approach (*i.e.*, prescriptive, process- or performance-based) and then transferred the coded results for each jurisdiction and indicator to a master spreadsheet for comparative analysis. To increase inter-rater reliability of classification and coding, we exchanged early versions of country-level spreadsheets among two to three authors to ensure consistency in our assessments.

In cases where multiple policy directives existed that related to one indicator, more than one policy structure may have applied. For example, in Chile, rules on reforestation include the mandate that “any harvest of forest-use lands is obligated to reforest an area equal to or greater than the area harvested,” which we categorized as a nondiscretionary outcome [26]. In addition, Chilean forest regulations state that certain cutting methods in specific forest types “require the establishment of at least 3,000 trees/ha of the same species homogeneously distributed across the area, which we classified as a nondiscretionary prescription [27]. We also documented when no governmental obligation existed and recorded an entry of “not required/regulated”.

In our analysis, national and sub-national forest policies were considered increasingly rigorous as the use of prescriptive measures and conservative thresholds on permissible forest impacts increased (Figure 2). In addition, forest policy was considered increasingly comprehensive as the inclusion of legislative, operational, ecological, economic, and social indicators that are addressed in laws, regulations and other policy directives increased. Finally, based on our assessment and comparative analysis of forest policy structure, rigor and comprehensiveness, and local knowledge of agency resources and reputations, we drew inferences about SFM policy implementation and effectiveness.



the highest percentage of public forestland (81%), of which 63% is administered by government agencies and 37% is administered by local and indigenous communities. Notably, despite seemingly straightforward statistics, significant portions of indigenous, community, and other forest lands in the Latin American case study countries, excepting Uruguay, are under dispute or remain to be clearly demarcated or titled [29].

**Table 2.** Land, forest, and socioeconomic statistics by country.

Statistic	Argentina	Brazil	Chile	Costa Rica	Guatemala	Nicaragua	Paraguay	Uruguay	U.S.	
Total Land Area ('000 Ha) <sup>1</sup>	273,669	832,512	74,880	5,109	10,843	12,140	39,730	17,502	916,193	
Total Forest Area ('000 Ha) <sup>1</sup>	29,400	519,522	16,231	2,605	3,657	3,114	17,582	1,744	304,022	
% Forest/Total Land <sup>1</sup>	11%	62%	22%	51%	34%	26%	44%	10%	33%	
% Forest Planted <sup>1</sup>	5%	1%	15%	9%	5%	2%	n.s.	56%	8%	
Avg. Annual Rate of Change (05–10) <sup>1</sup>	−0.80	−0.42	0.23	0.90	−1.47	−2.11	−0.99	2.79	0.13	
Forest Ownership <sup>1</sup>	% Public	-	81%*	25%	45%	42%	11%	39%	1%	43%
	% Private	-	19%	75%	55%	52%	88%**	61%	99%	57%
Population ('000) <sup>1</sup>	40,738	198,982	17,134	4,665	14,377	5,832	6,460	3,374	314,692	
% Urban	92.4	86.5	89	64.3	49.5	57.3	61.5	92.5	82.3	
% Rural	7.6	13.5	11	35.7	50.5	42.7	38.5	7.5	17.7	
Density (/km <sup>2</sup> )	15	23	23	91	132	45	16	19	32	
GDP (PPP)/capita <sup>1</sup>	15,854	11,239	15,002	11,216	4,885	3,045	5,202	14,296	47,284	
Human Development Index <sup>2</sup>	Score (0–1)	0.775	0.699	0.783	0.725	0.560	0.565	0.640	0.765	0.902
	Rank (1–169)	46	73	45	62	116	115	96	52	4

(1) FAO 2010b [30]; (2) UNDP 2010 [31] The Human Development Index (HDI) combines normalized measures of life expectancy, literacy, education, and GNP per capita. The score given is from 0 to 1, 0 being the lowest level of human development, 1 the highest. The 169 countries indexed also are ranked, 1 being the country with the highest HDI score, 169 is the country with the lowest score.

Decline in forest cover is occurring in five countries, most significantly in terms of total forest loss in Brazil (nearly 2.2 million ha/yr 2005–2010) and in terms of percent forest loss in Nicaragua (−2.11%/yr 2005–2010) (Table 2). Forest area is increasing in the other four countries, with the greatest total forest growth taking place in the United States (383,000 ha/yr 2005–2010) and the highest percent of total forest increase in Uruguay (2.79%/yr 2005–2010). In Uruguay, in particular, forest increase is largely due to an intensive reforestation and plantation forestry campaign.

Population statistics vary significantly among the countries with the smallest populations (*i.e.*, Uruguay, Costa Rica) being only a fraction of the largest (*i.e.*, United States and Brazil) (Table 2). All populations are more urban than rural, except in Guatemala (49%). The smallest countries in terms of land area have the highest population densities (Guatemala 132 pers/km<sup>2</sup>; Costa Rica 91 pers/km<sup>2</sup>). This population pressure is likely a driver of Guatemala's high deforestation rate (−1.47%/yr). Yet, in Costa Rica, forests are increasing (0.90%/yr), largely due to increasing economic opportunities over

the past two decades that have led to the abandonment of agricultural and cattle production and that have permitted the regeneration of forests across much of the country [28].

The U.S., Argentina, and Chile are the wealthiest countries in terms of GDP per capita, while Nicaragua, Guatemala, and Paraguay are the poorest (Table 2). Yet, when life expectancy, literacy, and education are taken into account in addition to GDP per capita in the Human Development Index (HDI), country ranking changes slightly, with Chile outranking Argentina, Costa Rica outranking Brazil, and Nicaragua outranking Guatemala—the lowest ranked country in terms of HDI.

#### *4.2. Analyzing Regulatory Forest Policy in the Americas According to 23 Indicators of Sustainability*

Table 3 summarizes the results from our policy analysis, presenting the list of the 23 SFM indicators by country and state, indicating whether there was a relevant legal directive that regulated that activity in each country, and identifying the associated policy structure of the directive(s). Below, we discuss each indicator and when and how each is addressed in forest laws and other legal directives. Based on these policy summaries, we analyze similarities and differences in regulatory forest law throughout the Americas in terms of policy structure, approach and comprehensiveness related to 23 indicators of sustainability. Finally, we make observations about the relative coverage of key issues, discuss the potential opportunities and challenges for implementation, and speculate about the prospects for achieving SFM.

##### *4.2.1. Legislative and Legality Issues*

The security of forest resources and the legality of forest operations are fundamental to their long term sustainability [32–35]. Illegal forest activities that are noncompliant with forest and other relevant legislation can have “far-reaching economic, social, and environmental impacts including ecological degradation, increased income inequality, and government revenue loss” [32]. The applicable legal framework, property rights or forest tenure, and secure forest boundaries are indicators that we considered in this analysis.

##### *(1) Legal Framework*

While legal compliance of managed forests is outside the scope of this study, we considered if and how forest laws, regulations, and other directives address forest relevant legislation at the national level. Within the legal framework on forest management, most countries and sub-national governments require “full compliance” with the law and refer to (at least some) rules and regulations specific to forest management that must be followed, though the verification of complete legal compliance is in question in many countries. At the national level, only Chile, and at the subnational level, only Maine explicitly cite or list all legislation relevant to forest legality within the legal forest framework. Additionally, Guatemala’s voluntary Forest Management Norms for the Conservation of Water and Soil identify and interpret key legislation related to natural forest management [36].

**Table 3.** Regulation of key components of sustainable forest management by level of obligation and approach for nine countries throughout the Americas.

SFM component	Argentina		Brazil		Chile	Costa Rica	Guatemala	Nicaragua	Paraguay	Uruguay	U.S.						
	Federal	Misiones	Federal	Minas Gerais							Maine	North Carolina	Wisconsin				
Legislative/ Legality	Legislative compliance	P		P		PP	P	P	T	P	na	na	PP	na	na		
	Forest tenure	T		T		T	T	T	T	T	na		T	na	T		
	Forest boundaries	na	na	PP		na	PP	na	na	na	na	na	na	na	P		
Planning	Forest Inventory	P		PP		P	PP	PP	PP	P	na		T,P	T,P	T,P		
	Management Plan	P	PP	PP	PP	PP	PP	PP	PP	PP	P	P	PP	P	PP		
	Harvest Threshold & Calculations	P	T	T	P	T	T,P	P	T,P	T	na	na	na	na	P		
	Monitoring Rules	na	P	P		P	T,P	PP	P	P	na	na	T	na	P		
Operations	Forest roads	na	na	P	na	T,P	T,P,O	P	T,P	na	na	O	T,P	O	T,P	O	T,P
	Slope limits	na	P	T	T	T	T	T	T	T	na		P	na	na		
	Clearcuts	T		T	T	T	T	P	T	T	T		T	na	na		
	BMPs	na	T,P,O	na	na	T,P,O	T,P,O	T,P,O	T,P	na	na		T,P,O	T,P,O	T,P,O		

Table 3. Cont.

SFM component	Argentina		Brazil		Chile	Costa Rica	Guatemala	Nicaragua	Paraguay	Uruguay	U.S.			
	Federal	Misiones	Federal	Minas Gerais							Maine	North Carolina	Wisconsin	
Ecological/ Environmental	At-risk species	T	T,P	T,P	T	T,P	T,P	T,P	T,P	T,P	na	T,P	T,P	T,P
	Riparian Buffer Zones	P	T	T	T	T	T	T	T,P	P	T	P	P	
	Regeneration/ Reforestation	O	T,O	P	T	T,O	P	T,O	O	na	na	T,O	P,O	PP
	Land use change	O,P		P	PP	O	O	P	P	O	P	P	na	na
Social	Indigenous rights	P		P		na	na	na	P	na	na	na	na	PP
	Community involvement	na	na	T,P		na	T,P	na	na	na	na	na	na	na
	Public consultation	EIA: P		EIA: P		EIA: P	EIA: P	EIA: P	P	EIA: P	EIA: P	na	na	na
	Public reporting	na	na	T		na	T	na	T	T	na	na	na	na
	Training and Safety	na	na	T,P		na	na	na	na	na	T,P	na	na	na
Economic	Financial analysis	P		na	na	PP	na	na	na	P	na	na	T	PP
	Wood utilization/ Waste minimization	na	na	na	na	PP	T	T	na	na	na	na	na	P
	Chain of custody	PP		PP	PP	PP	PP	PP	PP	T,P	PP	na	na	na

T = technical, prescriptive; PP = prescriptive process; P= process-based; O = outcome-based; na = not required/regulated; : non-discretionary/mandatory; : discretionary/voluntary.

## (2) Forest Tenure

The security of forest tenure or property rights is also an important factor for the long term sustainability of forest production, particularly because without it, forest dwellers and users may lack the long-term incentives to keep forests as forests and because illegal forest activities often result from weak, deficient, or non-existent control over forest resources [32,33]. Moreover, local level legality and compliance typically improve with secure forest rights or tenure [32]. Not surprisingly, all of the Latin American jurisdictions but Uruguay require proof of tenure or property rights prior to timber harvest authorization by the designated authority. Tenure rights and clarity are not issues in the U.S. or Uruguay per se, though property information must be included in the harvest notification required in Maine and Wisconsin. Uruguay and North Carolina do not explicitly require such information.

## (3) Forest Boundaries

Protection of forest boundaries through mapping, marking, and other means contributes to effective protection of forests from degradation or destruction [37]. Clearly marked and secure forest boundaries help to control against land invasion and illegal harvesting of timber and nontimber products [35]. Costa Rica and Brazil require specific nondiscretionary prescriptive processes related to forest boundary marking and protection to guard against illegal trespass or possession. In particular, the Costa Rican Code of Forest Practices requires that forest boundaries be clearly defined in the field and match the cadastral documentation provided in the management plan [38]. No other country or state regulates or requires this indicator, except Wisconsin, which includes discretionary recommendations for marking and protecting forest boundaries in its voluntary forest management guidelines.

### 4.2.2. Planning

Planning is an integral component of forest management that typically includes practices and metrics regarding forest inventory and mapping, management plan preparation, harvest calculations, road network design, and monitoring. Unplanned operations can lead to numerous externalities including negative impacts on forest composition and structure, decreased forest productivity, and compromised worker safety. In tropical forests in particular, effective forest planning often results in improved operational efficiency and safety, and reduced stand damage and wood waste when compared to conventional logging methods [39–41]. Most of these planning practices are addressed by forest policy directives in the Latin American countries, but are less common in the U.S., where there are no federal laws or other legislation that require forest planning or that regulate harvest quantities.

## (1) Forest Inventory

A forest inventory is a systematic collection of forest data that provides comprehensive information about forest status and dynamics important for harvest and other management planning. It is required in all of the Latin American countries with the exception of Uruguay. In Argentina, Chile, and Paraguay it is a mandatory process that must be carried out as part of the management plan. Brazil, Costa Rica, Guatemala, and Nicaragua go further by mandating a preliminary forest inventory based on statistical sampling, as well as a commercial census (100% inventory of all harvestable trees) of the

annual operating area or logging unit, which serves as a foundation for site mapping and for determining available and harvestable commercial volume. In the US, while a forest inventory is not required in any of the states studied, the process and specific prescriptive techniques are key components of forest practice guidelines or best management practices (BMPs) in most states, as is the case in Maine, North Carolina, and Wisconsin.

## (2) Management Plan

A forest management plan typically encompasses silvicultural, protection, maintenance, and harvest measures, in space and time, to guide forest operations and management. All Latin American countries require a forest management plan with various procedures, components and/or formats mandated. Each requires authorization of timber harvests from natural forests that exceed 5 ha on average. Uruguay requires a planning process built on the concepts of sustainability, but does not prescribe explicit planning elements or methods. Argentine national law requires a planning process that is prescriptively regulated and implemented at the provincial level. A prescriptive process requiring specific analytical techniques and plan components is required in Brazil, Chile, Costa Rica, Guatemala, Nicaragua, and Paraguay. Of these countries, Costa Rica requires the most prescriptive planning process (*i.e.*, greatest number and most specific technical and prescriptive elements required in the forest management plan and other planning documents), while the forest planning process in Paraguay is the least prescriptive.

Forest management plans are not required at the federal level in the U.S. Of the three states studied, only Maine requires a forest management plan for clearcuts greater than 20 ha that “outlines proposed activities to ensure compliance with performance standards and regeneration requirements” [42]. Though North Carolina and Wisconsin do not require a forest management plan, extensive discretionary guidelines for plan preparation are available to forest owners and managers in both states, as well as in Maine.

## (3) Harvest Calculations and Thresholds

Governmental regulation of natural forest management often includes specific rules related to timber harvest levels that are intended to promote sustainability. These may include minimum diameter cutting limits (diameter below which trees cannot be harvested) and minimum cutting cycles (number of years that must pass before re-entering/-harvesting a logging unit) and are often associated with forest type. For example, in even-aged and conifer dominated stands, governments may prescribe limits on clearcuts. In uneven-aged and broadleaf stands, harvest rules also may include limited logging intensity (percent of species abundance or volume permitted for harvest from a logging unit).

Based on and ranging by forest type and species, Brazil, Chile, Costa Rica, Nicaragua, and Paraguay prescribe limits on logging intensity, cutting cycle, and the minimum diameter cut. Guatemala, along with Brazil, Costa Rica, and Nicaragua, require specific processes for determining and/or justifying modifications to the logging intensity and diameter cuts according to forest characteristics and dynamics. In Argentina, harvest rules are regulated at the provincial level. Uruguay does not prescribe any harvest rules for natural forests, nor do the three U.S. states, though Wisconsin does provide discretionary guidelines for determining diameter limits and harvest levels.

While common throughout many parts of the world, harvest limits do not necessarily guarantee forest sustainability. Donoso *et al.* (1998) [43] question the capacity of legally-established selective cutting thresholds to sustain long term production of temperate forests in Chile. For much of the Tropics, there is growing concern that legally established harvest thresholds are inadequate for producing sustained future harvests or for protecting existing stand dynamics, given that all too often harvest volumes outpace the forest's growth rate even when efficiently planned and compliant with governmental regulations [41,44–47]. Moreover, legally established harvest limits are rarely based on timber species population ecology or natural and historical disturbance regimes [46,47]. As summed up by Zarin *et al.* (2007) [45], “differences in species population structures and intrinsic growth rates suggest that sustaining timber yields of many species would almost certainly require some combination of lower initial harvest volumes, longer cutting cycles, and postharvest silviculture”.

#### (4) Monitoring

Monitoring “allows a forest manager to determine the occurrence, size, direction, and importance of changes in key indicators of the quality of resource management” [35] It permits the identification, description, and quantification of forest dynamics and management impacts, providing information important for refining and adapting management goals, objectives, and prescriptions. In fact, many have argued that forest management cannot be sustainable if it is not adaptive [48–51].

Few jurisdictions require forest monitoring, and where mandated, it is not emphasized or enforced as a tool for adaptive management. In Costa Rica, the regulatory code of forest practices mandates monitoring and post-harvest measurement of management impacts and of the road network in particular, including primary and secondary roads, skid trails, and logging decks [52]. In Brazil and Chile, forest operations and regeneration must be monitored as presented and authorized in the management plan, yet monitoring of particular forest or management aspects is not required [53]. Nonetheless, BMPs for Chile's forests do provide detailed prescriptive processes for various forest impacts and aspects. In Argentina, monitoring of forest management is regulated at the provincial level. For example, in Misiones, regulations require that the “forest management plan include measures for monitoring forest dynamics, growth, and impacts from operations” [54].

In Brazil, Guatemala, Nicaragua, and Maine there are annual and/or post-harvest reporting requirements. For example, in Maine, “an owner of forest land who sells forest products or harvests forest products for that owner's commercial use shall submit a report to the director stating the species, volume and stumpage price per unit of measure for each transaction, the municipality or township where the stumpage was located, the estimated acreage of the harvest, the harvest method employed and the extent of whole-tree harvesting of both solid and chipped wood” [55]. However, there are no additional requirements to monitor forest management operations or impacts. Neither North Carolina nor Wisconsin mandate monitoring, but Wisconsin does provide recommendations for monitoring forest operations and impacts in its voluntary BMPs.

#### 4.2.3. Operations

Timber harvest operations can have the most significant impact on the forest, particularly when unplanned and poorly implemented. For instance, forest roads are a “primary cause of erosion and the

main culprit in residual stand damage” [56]. Moreover, damage to soil and water resources, harvested trees, and the residual stand generally increases with harvests on increasingly steeper slopes [39,41,57]. And, even in forests where clear cuts are silviculturally warranted (e.g., uniform light-demanding populations), poor implementation that results in negative forest impacts have led to increasing opposition to the practice at local to global levels.

Forest legislation in all of the Central and South American countries requires that management plans include measures to protect soil and water resources. Furthermore, most of the Latin American countries directly address several aspects of timber operations through mandatory, prescriptive forest law and other policy directives. Uruguay is the least regulatory in this sense, largely addressing forest operations through a mix of nondiscretionary and discretionary procedural policy directives.

In the US, soil erosion and other impacts from forest operations are largely controlled through outcome measures. The federal Clean Water Act (CWA) of 1972, as amended in 1977, aims to “restore and maintain the chemical, physical, and biological integrity of the Nation’s waters” [58]. Sections 208 and 319 of the CWA require state planning to control nonpoint source pollution from silvicultural, agricultural, and mining operations. States use various approaches and levels of obligation to meet these federal nonpoint source requirements. Most states in the South primarily use voluntary BMPs; most West Coast states use mandatory regulatory state forest practice acts; northern states vary in their combined use of voluntary and mandatory regulatory approaches. Section 404 of the CWA also controls the dredging and filling of pollutants (including sand, rock and other fill materials) into the nation’s waters and wetlands, and prescribes a permitting process that is implemented by the States. Section 404 exempts forestry activities from this permitting process, provided that operations are in compliance with 15 mandatory BMPs that mainly are outcome measures designed to address pollution and erosion problems.

Most U.S. states establish additional rules to regulate the outcomes of soil erosion in water ways and bodies. For example, in Maine, “a person who conducts, or causes to be conducted, an activity that involves filling, displacing or exposing soil or other earthen materials shall take measures to prevent unreasonable erosion of soil or sediment beyond the project site or into a protected natural resource as defined in section 480-B. Erosion control measures must be in place before the activity begins. Measures must remain in place and functional until the site is permanently stabilized. Adequate and timely temporary and permanent stabilization measures must be taken and the site must be maintained to prevent unreasonable erosion and sedimentation” [59].

### (1) Forest Roads

Maximizing the area of forest accessed by the least total road distance, while taking into account the location of trees to be extracted and protected, site topography, and sensitive areas (e.g., steep slopes, riparian zones), can minimize the negative impacts on the forest from the forest road network. In general, well-planned and spatially efficient timber extraction from a carefully installed road network “effectively reduces stand damage caused by roaming bulldozer and skidder extraction methods,” particularly in tropical forests and heterogeneous stands [39].

We examined if there are specific rules for road development and/or installation, and if applicable, the percent of area permitted to be cleared for the road network. Some Latin American countries

include nondiscretionary procedural requirements for planning the forest road network (Brazil, Costa Rica, Guatemala, and Nicaragua). Also, Costa Rica and Nicaragua mandate specific technical requirements, such as water bars, culverts, and post-harvest road treatments. For example, in Nicaragua “the construction of temporary primary and secondary roads is prohibited, as is the use of earthen dams as provisional bridges for stream crossings, being obligatory the construction of filters, culverts, and bridges that permit the free passage of water” [60]. Only Costa Rica prescribes specific outcome thresholds for the maximum area affected by the road network (15% of the total productive forest area can be impacted by the road network) [61]. Argentina, Chile, Paraguay, and Uruguay do not directly regulate forest roads on private lands. However, Chile does provide extensive recommendations for designing and implementing the forest road network in its voluntary BMPs.

In the U.S., forest roads are indirectly regulated through the CWA as outcome measures, via the federal Section 404 wetlands rules mentioned above, or through voluntary or regulatory state BMPs to control nonpoint source pollution. North Carolina, Maine, and Wisconsin have additional state-level nondiscretionary rules on water pollution that have some bearing on forest activities (e.g., Maine Erosion and Sedimentation Control Act; NC Sedimentation and Pollution Control Act; Wisconsin Water Quality Standards for Wetlands). Also, these states provide discretionary guidelines for forest road planning, construction, and maintenance to supplement the CWA BMPs and to facilitate compliance with related state level outcome requirements. For example, North Carolina’s Forest Practices Guidelines include topics on: Access Road and Skid Trail Stream Crossings, Access Road Entrances, and Rehabilitation of Project Site [62].

## (2) Slope limits

In Brazil, Guatemala, and Nicaragua, timber harvests are prohibited in sloped areas, yet these prescriptions range widely across countries (Brazil: prohibited > 45%; Guatemala: prohibited > 32% in soils < 20 cm; Nicaragua: prohibited > 75%). In Chile and Paraguay, specific harvest practices are limited in sloped areas (e.g., see “clearcuts” section below). In some cases, mechanized timber extraction also is prohibited in sloped areas (*i.e.*, Brazil: >25%; Costa Rica: >60%; Nicaragua: >35%). Operations in sloped areas are regulated at the state level in Argentina (e.g., Misiones: forests on slopes  $\geq 15\%$  for more than 100m may not be converted to other land uses... and must be submitted to protection or sustainable authorized use) [63]. Other operational controls in sloped areas include restrictions in Brazil that prohibit timber harvests above 1,800 masl (5,905 fasl) and on mountain ridges and tops [64]. Maine requires an authorized permit for timber extraction in areas above 2,700 fasl (823 masl) [65]. North Carolina and Wisconsin do not prescribe slope limits in forest operations.

## (3) Clearcuts

The practice of clearcutting in forestry typically involves the uniform clearing of all commercial (and noncommercial) trees from a logging unit, but may encompass the maintenance of patches, strips, or reserves of trees [66]. In certain cases (e.g., uniform light-demanding populations), it can serve as an efficient and effective means for harvesting commercial timber and facilitating regeneration. However, inadequate planning and execution that have resulted in negative impacts on biodiversity, water and soil processes, and aesthetic values have resulted in increasing opposition to the practice even where

silviculturally warranted. In most tropical, uneven-aged, or mixed forest types, selective harvesting of key commercial species is the more commonly promoted prescription, as clearcutting rarely leads to regeneration of the same or similar forest types.

We considered if there were rules on clearcuts within managed forests in each jurisdiction and if clearcut size was limited, in particular. Clearcutting of natural or “native” forests is prohibited in Costa Rica, Nicaragua, and Uruguay, except with authorization in the case of forests affected by pest, disease, fire, or other natural phenomena. In Argentina, clearcuts are only permitted in forests classified as “areas of low conservation value” (Category III) and these areas require an environmental impact study and an authorized plan [67]. In Brazil, up to 20% of rural private property in forested areas and up to 65% in savanna areas of the Amazon region can be cleared. Outside the Amazon, up to 80% of forested land can be cleared [68]. Clearcuts may be further regulated at the state level, such as in Minas Gerais, Brazil where they are prohibited in all forest types, except in “special cases that have been authorized” [69]. In Chile, clearcuts are authorized only in two of the 12 forest types (*i.e.*, Roble-Hualo and Roble-Rauli-Coihue) [70]. In these two forest types, clearcuts are prohibited on slopes greater than 45%, limited to 20 Ha on slopes 30–45%, and require authorization on slopes less than 30%. In Paraguay, clearcuts are prohibited on slopes greater than 15%, while clearcuts on slopes less than 15% cannot exceed 100 ha and must maintain forest patches [71]. In Guatemala, clearcuts in managed forests require silvicultural justification and authorization. In Maine, clearcuts cannot exceed 250 ac (about 100 ha) and must be buffered by forest patches of 100 ac [72]. North Carolina and Wisconsin do not regulate or restrict clearcuts.

#### (4) Best Management Practices

As defined by Kilgore (2007) [73], “best management practices represent a compilation of technically feasible and politically acceptable ways of addressing the potential negative environmental impacts that can be associated with forest management and timber harvesting activities”. BMPs are often developed as a key mandatory or voluntary approach for protecting soil and water resources and achieving other forestry objectives. Costa Rica’s Code of Forest Practices is a nondiscretionary regulatory instrument, as are Nicaragua’s obligatory technical norms for the sustainable management of broadleaf and coniferous tropical forests [74]. Discretionary BMPs or forest management guidelines are available to forest managers in Argentina (at the subnational level in some provinces), Chile, and Guatemala.

As noted, the U.S. CWA includes 15 BMPs and prompts states to control nonpoint source pollution and so that forest owners and operators do not need Section 404 permits for silvicultural operations in the waters and wetlands of the U.S. [75]. Maine, North Carolina, and Wisconsin have developed nonpoint source pollution prevention BMPs, as well as broader sets of BMPs and/or forest management guidelines that address the overall sustainability of forest operations on private land. These BMPs are termed “voluntary” in North Carolina and Wisconsin, but like all U.S. states, water quality standards must be maintained or are punishable by law. Thus, the Federal and state level BMPs might be better termed “quasi-regulatory” since their use is not mandatory, but forest operators and owners must meet associated mandatory water quality standards.

#### 4.2.4. Environmental/Ecological Aspects

Careful planning and implementation of harvest operations are intended in large part to mitigate the environmental impacts of timber extraction. Yet, even in the most cautious of cases, any forest intervention has at least some effect on forest composition, function, or structure [57,76,77]. In addition to planning and operational indicators, we considered how forest policy directives address key ecological aspects of forest systems, such as forest species at risk of decline or extinction, riparian zones and other sensitive areas, forest regeneration and changes in forest land use.

##### (1) At-Risk Species

Some species or populations of species are particularly susceptible to the impacts of logging and other forest interventions, including many endemic and rare species, as well as those that have already been subject to overharvesting. These species are often at risk of population declines or possible extinction without measures to preserve, recover, conserve or sustainably use them. Given the impact that forest interventions can have on at-risk species, we determined if there were specific rules related to the protection of at-risk species and/or their habitat.

At the international level, all of the countries are signatory parties to the Convention on the International Trade of Endangered Species of Wild Fauna and Flora (CITES). CITES places certain controls on the international trade of select species that have been identified as threatened with extinction or whose survival may be impacted by uncontrolled trade [78]. Numerous species of forest plants and animals from these countries are covered by the Convention and therefore, may require authorization for export, import, re-export and introduction activities.

At the national level, all of the cases studied have rules on the conservation and protection of at-risk species of flora and fauna, though these rules range in terms of their prescriptiveness, rigor and application to forestry activities. Chile, Costa Rica, Paraguay, and the United States include national-level legislation that specifically addresses at-risk animal and plant species and prescribes rules on their protection and conservation. Forestry laws and other forest policy directives in Brazil, Chile, Costa Rica, Guatemala, Nicaragua and Paraguay explicitly prohibit the destruction, cutting, extraction and/or trade of nationally recognized at-risk species that have been listed by delegated authorities. In Chile, two of the twelve forest types are protected and cannot be harvested, as are two forest types in the state of Minas Gerais. Brazil and Costa Rica also require the protection of locally rare tree species (Brazil: <three trees/100 ha in Brazil; Costa Rica: <three trees/ha in Costa Rica) [79].

In Argentina, there is no legislation that specifically addresses at-risk species at the national level. However, the National Parks Law provides for the declaration of national parks, national reserves, and national natural monuments [80]. Animal and plant species may be designated within this last category, which provides them with federal protection. To date, three terrestrial animal species have been classified as “natural monuments” (*i.e.*, *Hippocamelus bisulcus*, *Hippocamelus antisensis*, *Panthera onca*). Also, at the subnational level in Argentina, most provinces have identified, listed, and require protection of endangered and threatened flora and fauna species. In Uruguay, national legislation identifies priority species for conservation in protected areas, but the requirements for their protection do not extend to private land. Forest policy directives require the protection of *palmares*

*naturales* (natural palm groves within forest stands) [81]. No other at-risk forest species are identified in Uruguay.

The U.S. evaluates at-risk animal and plant species for their level of endangerment and lists threatened or endangered (T&E) species for federal protection under the Endangered Species Act (ESA). T&E fauna are protected on all federal and private lands, but T&E flora are protected only on public lands. The ESA makes it unlawful to “take” (*i.e.*, harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect) any listed T&E animal species or to modify its critical habitat, either by intent or negligence. The Act also prohibits the interstate or international sale or trade of listed animal and plant species, including their parts or products, without a Federal permit [82]. When a listed animal species occur on private land, landowners must acquire a “take” permit for land use practices, such as forestry, that may harm T&E species or their habitats and are also required to prepare and follow a Habitat Conservation Plan to mitigate and minimize any potentially negative impacts. Threatened, endangered, and at-risk species are also identified and protected at the state level. In Maine, state listed at-risk species must be protected on all lands. In North Carolina and Wisconsin, forestry operations on private lands are exempt from state listed at-risk species protection requirements, but are prohibited from transporting, processing or selling any state-listed endangered or threatened animal or plant species.

## (2) Riparian Buffer Zones

Riparian zones are transitional areas between terrestrial and aquatic habitats that are perennially or intermittently influenced by fresh water. They are dynamic environments “characterized by strong energy regimes, substantial habitat heterogeneity, a diversity of ecological processes and multidimensional gradients” [83]. These characteristics make them important to biodiversity, wildlife habitat, soil and water quality, and other processes and lead most governments to limit their use or require their protection. Therefore, we considered if there were specific rules on forest land use practices within riparian zones and, in particular, if there were limits to forestry activities around water-ways and bodies.

At the national level, Brazil, Chile, Costa Rica, Guatemala, Nicaragua and Paraguay prescribe riparian buffer zones in which logging activities are prohibited. These range widely from 10m on either side of intermittent streams on slopes less than 35% in Chile to 500m on either side of water courses greater than 500m wide in Brazil. In Argentina, the protection of riparian areas is required at the federal level, but regulated at the provincial level. For example, in Misiones, native forests surrounding springs and along waterways must be protected to a width three times that of the water source or way and cannot be less than 10m along each margin [84]. Uruguay does not protect riparian buffers directly, but native forests, which are found predominantly in riparian zones, required an authorized management plan for harvest.

In the US, Maine prohibits timber harvests within 75ft of Great Ponds and prohibits clearcuts within 75ft of all other riparian zones [85]. Wisconsin requires a permit and specific practices for timber harvests in riparian zones (within 100ft of lakes and navigable streams), but does not prescribe a specific buffer for waterways at the state level [86]. In North Carolina, the State Pollution Control Act requires the maintenance of a buffer along the margins of lakes and natural watercourses during land clearing and grading for development. Forestry activities are exempt from this rule if they are in

compliance with the Forest Practice Guidelines (FPGs). The North Carolina FPGs do not recommend a specific buffer, but require certain outcome measures, including a streamside management zone (SMZ) “of sufficient width to confine within the SMZ visible sediment resulting from accelerated erosion” and that “ground cover, or other means, within the SMZ shall be sufficient to restrain accelerated erosion” [87]. Maine and Wisconsin also provide detailed recommendations to protecting riparian buffers in their voluntary BMPs and guidelines.

### (3) Regeneration/Reforestation

The long term sustainability of forest management obviously is dependent upon the renewal or regeneration of harvested resources. Many of the planning and operational indicators that we reviewed are intended to influence sustained timber yields, such as harvest calculations and thresholds that maintain a portion of the commercial sized trees and protect future crop trees, road network design that minimizes damage to the residual stand, and limits on clearcut size and intensity. Nonetheless, even where initial timber harvests are carefully planned and implemented, subsequent timber yields can decline “where the pattern and intensity of logging are not silviculturally appropriate” [41]. So, additional measures to ensure forest regeneration are often invoked.

All Latin American countries except Paraguay and Uruguay include policy directives related to forest regeneration or reforestation. Most of these directives require procedural regeneration or reforestation measures as part of forest management planning, as well as verifiably established outcomes related to regeneration or reforestation post-harvest. Chile, Guatemala, and Nicaragua, as well as Maine specify a period of time by which regeneration/reforestation must be established (up to 5 years post-harvest) and at what stocking density (e.g., Chile:  $\geq 3,000$  trees/ha). In Brazil, Minas Gerais prescribes additional reforestation requirements related to the amount of wood harvested [88]. North Carolina and Wisconsin do not prescribe related requirements, though North Carolina and Wisconsin do provide discretionary guidelines for establishing and securing forest regeneration.

### (4) Land Use Change

Because SFM is often promoted as one of several important practices and policy tools for curbing changes in forest land use, we also considered if forest policy directives expressly addressed forest land use change. Chile, Costa Rica, and Paraguay prohibit land use change from natural forest to other use categories. In Argentina, the conversion of forests in Categories I and II is prohibited, while the conversion of Category III forests requires authorization based on a Land Use Change Plan and an environmental impact assessment [89]. In Brazil, Guatemala, Nicaragua, and Uruguay forest land use change must be technically justified and authorized by delegated officials. In the U.S., forestry operations that convert an area of the waters (including wetlands) of the US into a use to which it was not previously subject, or that result in the immediate or gradual conversion of a jurisdictional wetland to a non-wetland require a permit from the delegated authority [90]. Additionally, in Maine, forest land use change requires a notification by the landowner to local county officials.

#### 4.2.5. Social Aspects

The human dimension of managed forests is just as important to sustainability as planning, operational, and environmental aspects. Yet, for some, “the loss and degradation of the world’s forests has continued at a high rate owing to neglect of the social and cultural factors of forestry”, as declared in the joint statement of the civil society and private sector major groups to the United Nations Forum on Forests 9th Session in New York in January 2011 [91]. To address the social aspects of forestry, we considered indicators related to indigenous rights, public consultation and reporting, and training and safety. As a whole, these indicators were much less regulated than aspects related to planning, operations and the environment.

##### (1) Indigenous Rights

Many indigenous populations are closely tied to forest environments and the recognition and protection of their related rights is fundamental to forest sustainability. All of the case countries but Uruguay and the U.S. have ratified the International Labour Organization’s Indigenous and Tropical Peoples Convention (C169). This is a legally binding enforceable policy instrument that requires signatory countries to align their legislation, policies and programs with the fundamental principles of the Convention. Taken as a whole, C169 mandates that indigenous peoples be afforded the full measure of human rights and freedoms without hindrance of discrimination against their persons, institutions, property, labor, cultures or environment [92]. Additionally, all of the Latin American countries endorsed the UN Declaration on the Rights of Indigenous Peoples at the UN General Assembly in 2007. The U.S. later endorsed the Declaration in 2010. Though this is not a legally binding instrument, the Declaration outlines the “individual and collective rights of indigenous peoples, as well as their rights to culture, identity, language, employment, health, education, and other issues” as agreed upon by more than 140 signatory countries [93].

All of the case study countries address indigenous peoples and their rights in the national constitution and/or in specific related legislation. The only exception is Uruguay, which does not have indigenous peoples among its population. Forestry laws in Argentina, Brazil, and Nicaragua explicitly require that forest management processes recognize and respect indigenous peoples and their rights. In Costa Rica and Paraguay, for-profit forest exploitation is prohibited in indigenous community lands, though the protection of indigenous rights in forest management practices outside of indigenous lands is not regulated through forest-related legislation. In Wisconsin, forestry practices must respect indigenous/native community and other human burial grounds, but there are no additional related regulations. Protection of indigenous rights is not expressly regulated or required in the forestry laws of Chile, Guatemala, Maine or North Carolina.

##### (2) Community Involvement

Local communities that live in and around forests may depend on them for food, fiber, and other subsistence needs, for employment, and/or for the provision of environmental services and aesthetic values. Therefore, as with indigenous populations, local communities and their actions often are closely tied to the forest and its long-term sustainability. A few countries include specific rules for

working with, involving, or considering local communities. For example, Brazil requires that forest management planning take into consideration the prospects for improving the quality of life of local peoples, identify the benefits of integrating local peoples in forestry activities, and indicate the use of local manpower in the operational workforce [94]. Costa Rica requires that forest management planning take into account and monitor direct employment for nearby, local communities that is generated by forestry activities [95]. No other country or state has related requirements.

### (3) Public Consultation and Reporting

An informed, aware, and participatory public is important in promoting sustainable forest management [96,97]. All countries require public consultation as part of any mandated environmental impact assessment related to forestry activities, such as that required in Argentina and Paraguay for authorization of land use change of native forests and in Chile for management plans for areas greater than 500 ha. Unique to Nicaragua, a public consultation and comment period must be held for 30 days prior to plan authorization for forests larger than 500 ha [98]. Additionally, in Brazil, Costa Rica, Guatemala, and Nicaragua, a summary of the authorized forest management plan must be made available to the public. Maine requires a harvest notice to be filed with local authorities that is made available to the public, but does not require any public consultation or other reporting. North Carolina and Wisconsin do not have any related requirements.

### (4) Training and Safety

Forestry in general and logging in particular continue to be among the most dangerous jobs in the world [99]. Injuries and deaths are attributed to poor organization and supervision, inadequate equipment, poor planning, and lack of skills and competency among workers, supervisors and managers. Moreover, poorly trained or supervised logging crews can significantly increase the negative impacts to the forest stand [41]. Adequate protection, training, and education of the forestry workforce can help to minimize the negative impacts of poor logging practices and contribute to a more socially sustainable forest sector [99].

Most countries have specific regulations on worker health and safety. For example, in the US, the Occupational Health and Safety Administration (OSHA) establish health and safety regulations for industrial operations, including logging operations in the forest. OSHA regulations require employers to obtain insurance that covers the medical expenses of workers injured on the job and mandates worker competency levels required for response actions to chemical and other spills. However, only Argentina, Brazil, and Uruguay include forest policy directives that directly regulate or address forest worker safety and training. In Argentina, the Regulations for Agrarian Activities include a chapter dedicated to the forestry that encompasses numerous aspects of training and safety during planning, harvest, and extraction activities [100]. In Brazil, planning and progress reporting must consider the safety, training and retraining of forest personnel and report all accidents or injuries [101]. Uruguay has specific legislation that regulates the forest industry (*i.e.*, in the management, harvest and transformation of products from planted or natural forests) and its treatment and protection of workers, including requirements related to training and safety [102].

#### 4.2.6. Economic/Financial Aspects

In addition to social aspects of managed forests, such as equitable stakeholder participation in decision making processes, economic efficiency is an equally important criteria for success in sustainable forest management [103]. As reflected in the Forest Principles that came out of the 1992 Earth Summit: “Forests are essential to economic development ... and decisions taken on the management, conservation and sustainable development of forest resources should benefit, to the extent practicable, from a comprehensive assessment of economic and non-economic values of forest goods and services and of the environmental costs and benefits” [104]. Few would argue that forest management must take into account the financial costs and benefits and, perhaps more importantly, must be economically viable to be sustainable. Yet, government’s role in regulating the financial aspects of forest management is a moot point, particularly in the case of private lands. Nonetheless, we considered a few key indicators of the economic aspects of managed forests to better understand how the state treats this third “pillar” of sustainability, if at all.

##### (1) Financial Analyses

Financial analysis of forest management includes tools that are useful for analyzing the long-term sustainability of a working forest, for evaluating management plans, and for determining the profitability of different management options [105]. Only a few countries require financial analyses from managed forests on private lands. Argentina’s law on native forests requires that the forest management plan permit an estimation of financial viability [106]. Paraguay requires a financial analysis as part of management plans for forests greater than 20 ha [107]. In Maine, the requisite post-harvest report for commercial production must include “species, volume and stumpage price per unit of measure for each transaction” [108]. No other case required financial analyses or other economic assessments of forest operations. However, Chile and Wisconsin do provide recommended techniques and processes for evaluating the financial aspects of forest management in their voluntary BMPs.

##### (2) Wood Utilization and Waste Minimization

Some studies have shown that well-planned and implemented forest operations can reduce timber that typically is left-behind or wasted in “conventional” logging operations, ultimately increasing the potential profitability of the activity [40]. “Wood waste incurs direct costs associated with felling, bucking, skidding, and log deck activities and indirect costs by increasing the effective stumpage price [39].” On the other hand, standing and down dead wood and woody debris are important to biodiversity and ecosystem function [109]. For example, standing dead trees or “snags” provide important wildlife habitat, while fallen trees often serve as nurse logs for numerous plant species and are essential to soil nutrient and carbon pools [110–112]. In managed temperate forests, timber extraction may significantly decrease the number of dead trees and the amount of downed wood, while in managed tropical forests, logging can increase disturbance or leave behind an excessive amount of wood, leading to a significant surplus of standing and downed dead wood and debris [113]. Overall, there often are differentiated costs and benefits associated with taking too much wood from the forest

or leaving too much wood behind. The challenge lies in finding a balance that produces both economic and biodiversity benefits.

Costa Rica and Nicaragua require directional felling in order to minimize damage to residual trees and natural regeneration, in particular, and to the soil, water bodies, and biodiversity in general. Notably, the technique is also important for minimizing wood waste. Chile and Wisconsin provide discretionary guidelines for improved wood utilization and wood waste minimization in their BMPs. No other jurisdiction mandates related requirements.

### (3) Chain of Custody

Tracking wood flows of legal or authorized timber products through their “chain of custody” is an important practice for ensuring the legality of harvested wood products, as well as for tracking the financial transactions from timber production through final sale. While chain of custody is not required by law in any of the U.S. cases, all of the Latin American countries studied aim to regulate the chain of custody of wood products from natural forests through the required use of timber transportation permits. These permits typically encompass “*guias de transporte*” (transportation documents) and certificates of origin. For example, in the case of Nicaragua, the certificate of origin is stamped on each transportation document, and indicates the authorized forest management unit from which the wood was extracted and includes the harvest permit authorization number [114]. The number of transportation tags issued by the delegated authority to the forest owner is determined by the projected volume of extracted roundwood in the annual operating plan. Upon payment of the forest use taxes, these transportation documents are provided to the forest manager or owner, who is responsible for their lawful use and accompaniment with all transported wood, and for recording and reporting their allocation back to the designated officials. While these processes for tracking chain of custody are fairly clear on paper, there remain significant challenges in their implementation, effectiveness, transparency and reliability, which have resulted in ongoing problems in the proof and promotion of legal wood production, transport and commerce throughout the region [11,115]. In response to such failures of paper-based timber tracking systems, amendments to the forest law for the state of Minas Gerais in Brazil require the implementation of a satellite-based electronic system for tracking the transportation of forest products and by-products throughout the state [116].

## 5. Discussion

The legal frameworks for regulating forest management on private lands throughout much of the Americas address a broad range of environmental, social, and even some economic issues. Our analysis provides a thorough review of forest policy directives for much of the forest area in the Americas, including the largest countries in South America, a diverse set of countries in Central America, and three states from different regions in the United States.

Overall, forest laws, regulations, and other policy directives in Central and South America, excepting Uruguay, were generally more prescriptive and rigorous (*i.e.*, higher thresholds on management impacts) than those in the U.S. and the three case study states. Latin American countries tended to rely more on specific technical requirements to obtain SFM goals, while the legal directives on forestry activities in the U.S. tended to be more process oriented. Outcome-oriented requirements,

essential for adaptive management, were seldom used in any of the cases, except for directives related to changes in land use (Argentina, Chile, Costa Rica, Paraguay), forest regeneration and reforestation (Argentina, Chile, Guatemala, Nicaragua, Maine), and forest roads (Costa Rica, US, Maine, North Carolina, Wisconsin). Across all the case studies, environmental and forest planning issues were the most regulated; economic and social issues were the least regulated, proportionately.

In the U.S., regulation of forest practices on private land is left largely to the states, except for required compliance with federal legislation on clean water, endangered species, clean air, and occupational safety and health. The U.S. states we analyzed are fairly representative of the region in which they are found. North Carolina and Wisconsin operate with mostly voluntary approaches, similar to other Southern and Midwestern states. Maine is a relatively regulated Northeastern state, as is Massachusetts. Though not included in this analysis, the U.S. West-Coast states do have more and stricter environmental and forestry laws, including detailed, regulatory, State Forest Practice Acts, and large staffs for regulatory enforcement [117].

By and large, Latin America had more nondiscretionary laws and directives than the U.S., with the exception of Uruguay. Latin America also tends to be more prescriptive and technical in terms of natural forest management regulation, while the U.S. is more process and outcome oriented on the aspects of forest management that it regulates (which are far fewer than the number of aspects that are regulated in most Latin American countries). Overall, most Latin American countries have stricter SFM laws and directives than those summarized in the U.S. Only Uruguay's regulatory approach was more similar to the U.S. than the other Latin American countries.

It should be noted that stricter and more prescriptive rules do not necessarily promote greater sustainability. While prescriptions require little interpretation on part of the duty holder and offer administrative simplicity and ease of enforcement, they may also inhibit innovation, discourage adaptive management, and/or reduce the financial viability of forest operations [18,22]. Process-based policies promote a more proactive, holistic approach than prescriptive-based policies. Yet, challenges associated with process-based policies include complicated oversight, compliance "on-paper" rather than on the ground, and an over-reliance on management systems [18,22]. Finally, outcome or performance-based directives seek to control the impacts of activities while allowing the duty holder to determine the means to comply, permitting innovation, and accommodating changes in technology or organization. Nonetheless, these types of policy directives require intensive monitoring, analysis, and related resources, and they make it difficult to detect problems in the forest or in its operations until after they have occurred [18,22]. In short, no single approach, but rather a mix of policy types, is most likely to lead to better forestry on the ground.

## 6. Conclusions

The cross-country comparisons in this study indicate that, on paper, Latin America is not an unregulated frontier, as occasionally claimed by critics in the U.S. and Europe [118–122]. Much of Latin America has more rigorous and comprehensive (*i.e.*, stricter thresholds on more environmental, economic, and social aspects) forestry rules for private land than much of the U.S. Furthermore, from this study we see no direct relation between a country's level of development and its level or stringency of forest regulation [123,124]. For example, Costa Rica and Brazil have the most rigorous

and comprehensive laws on natural forest management on private land, and they demonstrate relatively higher levels of development than Guatemala and Paraguay, which are less regulated in terms of natural forest management. At the other end of the spectrum, the U.S. states and Uruguay have high levels of economic and human development, but the least comprehensive or rigorous regulation of productive forestry on private lands. These results may reflect, in part, the large concentration of clear and secure private property and established forest industry in the three U.S. states and Uruguay, which lend themselves well to preferential reliance on voluntary approaches rather than strict regulations for promoting sustainable forest management. Conversely, the predominance of public lands in much of Latin America, similar to the west coast of the U.S., may predispose governments to view regulation of private forest lands as an extension of already highly regulated public lands. Additional research is required to fully understand these differences and the complex relationships between economic development, land ownership patterns, forest regulation, and other key variables.

While we found a significant degree of rigor and comprehensiveness in the legal frameworks on SFM in several Latin American countries, significant gaps between rules on paper and rules in use persist across much of the region [10–12,125]. For example, in the ITTO 2011 review of the status of tropical forest management, the authors found that while “law enforcement is improving on the ground” in some countries, including Brazil, “a lack of forest law enforcement remains a major problem in many countries in the tropics, and there has been less progress in identifying, demarcating and protecting the permanent forest estates” in most tropical countries [125]. Moreover, as observed by McGinley and Cabbage (2011) in a study of the policies, implementation, and impacts of forest regulation and certification in Costa Rica, Guatemala, and Nicaragua, “effective execution of increasingly comprehensive and rigorous forest regulations required significant human, financial, and material resources, which were limited in all cases [and which] adversely affected the potentially positive impacts of forest policy” on the ground [12]. In another study, Perdomo *et al.* (2002) [126] measured the fragmentation of forests across the landscape in Southern Nicaragua and determined that if forest regulations (e.g., riparian buffers, slope limits) were applied in the field as written on paper, ecosystem connectivity at the landscape level would be largely conserved.

On the whole, despite significant efforts to improve governmental regulation of forests and to increase the transparency and legality of timber production and commerce in the tropics in particular, competing land uses, unclear tenure, and limited institutional capacity for effective implementation and enforcement of legal frameworks on forests continue to be significant challenges for advancing the sustainability of forest management in many Latin American countries [125]. Clearly, more work and research must be done to better understand the constraints and catalysts to effective implementation of SFM laws and governance.

Ultimately for SFM, it is not the number, rigor, or comprehensiveness of rules and regulations that matter, but the implementation and application of sound practices on the ground. The appropriate mix of *laissez faire*, discretionary/voluntary guidelines, and nondiscretionary requirements does depend on the country context; the severity of market, social, and/or environmental problems that need to be redressed; the tolerance of the governed for laws; and the ability of governments to implement rules and regulations efficiently and effectively. While fewer rules and requirements may lead to smarter regulation if too many rules and bureaucrats do indeed impede innovation and adaptive management, experience has shown that a lack of rules and/or their implementation can lead to forest degradation

and loss. Achieving a balance between these two ends of the spectrum is the continuous challenge for forest stakeholders worldwide.

### Acknowledgements

We would like to acknowledge and thank our respective institutions for their support of this collaborative effort over the course of the past four years. Also, we would like to express our gratitude to two anonymous reviewers for their useful and insightful comments.

### Conflict of Interest

The authors declare no conflict of interest.

### References

1. Humphreys, D. *LogJam: Deforestation and the Crisis of Global Governance*; Earthscan: London, UK, 2006.
2. Cashore, B.; Galloway, G.; Cubbage, F.; Humphreys, D.; Katila, P.; Levin, K.; Maryudi, A.; McDermott, C.; McGinley, K.; Kengen, S.; *et al.* Ability of institutions to address new challenges. In *Forests and Society—Responding to Global Drivers of Change*; Merry, G., Katila, P., Galloway, G., Alfaro, R.I., Kanninen, M., Lobovikov, M., Varjo, J., Eds.; IUFRO (the International Union of Forest Research Organizations): Vienna, Austria, 2010; Volume 25, pp. 441–486.
3. FAO. *Leyes Forestales en América del Sur* (In Spanish); Organización de las Naciones Unidas para la Agricultura y la Alimentación: Santiago, Chile, 2010.
4. McDermott, C.; Cashore, B.; Kanowski, P. *Global Environmental Forest Policies: An International Comparison*; Earthscan: London, UK, 2010.
5. Cubbage, F.W.; Harou, P.; Sills, E. Policy instruments to enhance multi-functional forest management. *For. Policy Econ.* **2007**, *9*, 833–851.
6. Moffat, S.; Cubbage, F.W. Forest certification and agenda setting. *For. Policy Econ.* **2001**, *2*, 307–318.
7. Cashore, B.; McDermott, C. *Global Environmental Forest Policies: Canada as a Constant Case Comparison of Select Forest Practice Regulations*; International Forest Resources: Victoria, Canada, 2004.
8. Meidinger, E. Forest certification as a global civil society regulatory institution. In *Social and Political Dimensions of Forest Certification*; Meidinger, E., Elliott, C., Oesten, G., Eds.; Forstbuch: Nordrhein-Westfalen, Germany, 2003; pp. 265–289.
9. Rametsteiner, E.; Simula, M. Forest certification—An instrument to promote sustainable forest management? *J. Environ. Manag.* **2003**, *67*, 87–98.
10. Hickey, G.M. Regulatory approaches to monitoring sustainable forest management. *Int. For. Rev.* **2004**, *6*, 89–98.

11. Contreras-Hermosilla, A. *Law Compliance in the Forestry Sector: An Overview*; World Bank: Washington, DC, USA, 2002. Available online: <http://siteresources.worldbank.org/WBI/Resources/wbi37205.pdf> (accessed on 18 June 2012).
12. McGinley, K.; Cubbage, F.W. Governmental regulation and nongovernmental certification of forests in the tropics: Policy, execution, uptake, and overlap in Costa Rica, Guatemala, and Nicaragua. *For. Policy Econ.* **2011**, *13*, 206–220.
13. *Public Policies and the Misuse of Forest Resources*; Repetto, R.C., Gillis, M., Eds.; Cambridge University Press: New York, NY, USA, 1998.
14. Mazmanian, D.A.; Sabatier, P.A. *Implementation and Public Policy*; Scott, Foresman & Co.: Dallas, TX, USA, 1983.
15. Goggin, M.L.; Bowman, A.O.; Lester, J.P.; O'Toole, L.J. *Implementation Theory and Practice: Toward a Third Generation*; Scott, Foresman/Little, Brown: Glenview, IL, USA, 1990.
16. Glück, P. Policy means for ensuring the full value of forests to society. *Land Use Policy* **2000**, *17*, 177–185.
17. Affholter, D.P. Outcome monitoring. In *Handbook of Practical Program Evaluation*; Wholey, J.S., Hatry, H.P., Newcomer, K.E., Eds.; Josey Bass: San Francisco, CA, USA, 1994; pp. 96–118.
18. Gunningham, N.; Grabosky, P. *Smart Regulation: Designing Environmental Policy*; Oxford University Press: Oxford, UK, 1998.
19. The frameworks of C&I and SFM Websites: ITTO C&I for Sustainable Management of Tropical Forests; Lepaterique Process of Central America on C&I for Sustainable Forest Management; Tarapoto Proposal of C&I for Sustainability of the Amazon Forest; Chilean System for SFM Certification; FSC Brazilian Standard for Forest Management Certification on Terra Firme; FSC US National Standard for Forest Management Certification; and the US Sustainable Forestry Initiative Standard for Forest Certification. Available online: [http://www.itto.int/policypapers\\_guidelines/](http://www.itto.int/policypapers_guidelines/); <http://www.fao.org/DOCREP/004/AC135E/ac135e07.htm>; <http://www.fao.org/DOCREP/004/AC135E/ac135e0a.htm#bm10>; [http://www.certfor.org/documentos/standar\\_nf.pdf](http://www.certfor.org/documentos/standar_nf.pdf); <http://www.fsc.org/bra-terra-firme-std.270.htm>; <http://www.fsc.org/fsc-us-forest-management-standard-v1.299.htm>; <http://www.sfiprogram.org/sfi-standard/sfi-standard.php> (accessed on 3 July 2012).
20. Holvoet, B; Muys, B. Sustainable forest management worldwide: A comparative assessment of standards. *Int. For. Rev.* **2000**, *6*, 99–122.
21. Hickey, G.M.; Innes, J.; Kozak, R.A.; Bull, G.Q.; Vertinsky, I. Monitoring and information reporting for sustainable forest management: An international multiple case study analysis. *For. Ecol. Manag.* **2005**, *209*, 237–259.
22. Bluff, E.; Gunningham, N. Principle, process, performance or what? New approaches to OHS standards setting. In *OHS Regulation for a Changing World of Work*; Bluff, E., Gunningham, N., Johnstone, R., Eds.; Federation Press: Sydney, Australia, 2004; pp. 4–42.
23. McGinley, K.; Alvarado, R.; Cubbage, F.; Diaz, D.; Donoso, P.J.; Jacovine, L.A.G.; de Silva, F.L.; MacIntyre, C. Non-discretionary prescriptive: Harvest intensity cannot exceed 60% of the number of trees per species and is limited to trees with a diameter at breast height > 60cm. Personal observation, 2012.

24. McGinley, K.; Alvarado, R.; Cubbage, F.; Diaz, D.; Donoso, P.J.; Jacovine, L.A.G.; de Silva, F.L.; MacIntyre, C. Discretionary process-based: Measures to control hunting, capture and collection of plant and animal species should be considered in the management plan. Personal observation, 2012.
25. McGinley, K.; Alvarado, R.; Cubbage, F.; Diaz, D.; Donoso, P.J.; Jacovine, L.A.G.; de Silva, F.L.; MacIntyre, C. Non-discretionary performance-based: The rate of forest products harvested does not exceed the rate of resource growth. Personal observation, 2012.
26. De las Sanciones. *Ley de Chile*, No. 701, Titulo IV, Art. 22, 1974.
27. De la Calificación de Terrenos de Aptitud Preferentemente Forestal y del Plan de Manejo. *Decreto de Chile*, No. 259, Titulo I, Art. 21–22, 1980.
28. Schelhas, J.; Sánchez-Azofeifa, G.A. Post-frontier forest change adjacent to Braulio Carrillo National Park, Costa Rica. *Hum. Ecol.* **2006**, *34*, 407–431.
29. OAS. Land tenure: Lessons for sustainability through information sharing. *OAS Policy Ser.* **2006**, *10*, 1–4. Available online: [http://www.oas.org/dsd/policy\\_series/10\\_eng.pdf](http://www.oas.org/dsd/policy_series/10_eng.pdf) (accessed on 7 June 2012).
30. FAO (Food and Agriculture Organization). *Global Forest Resources Assessment 2010—Main Report*; FAO: Rome, Italy, 2010.
31. UNDP. *Human Development Report 2010: 20th Anniversary Edition. The Real Wealth of Nations: Pathways to Human Development*; United Nations Development Programme: New York, NY, USA, 2010.
32. FAO. *Best Practices for Improving Law Compliance in the Forestry Sector*; FAO: Rome, Italy, 2005.
33. White, A.; Martin, A. *Who Owns the World's Forests? Forest Tenure and Public Forests in Transition*; Forest Trends: Washington, DC, USA, 2002.
34. Sunderlin, W.; Larson, A.M.; Cronkelton, P. Forest tenure rights and REDD+: From inertia to policy solutions. In *Realising REDD+: National Strategy and Policy Option*; Angelsen, A., Ed.; CIFOR: Bogor, Indonesia, 2009; pp. 139–150.
35. Finegan, B.; Hayes, J.; Delgado, D. *Biological Monitoring for FSC Certified Forest Management in High Conservation Value Forests: A Guide for Certifiers and Forest Managers in the Humid Tropics*; WWF: Washington, DC, USA, 2004.
36. INAB. *Consideraciones Técnicas y Propuesta de Normas de Manejo Forestal Para la Conservación de Suelo y Agua*; Instituto Nacional de Bosques: Ciudad Guatemala, Guatemala, 2003.
37. FAO. *Guidelines for the Management of Tropical Forests—The Production of Wood*. FAO: Rome, Italy, 1998.
38. De Tenencia Clara. *Decreto de Costa Rica*, No. 34559-Minae, Criterio 1.2, 2008.
39. Boltz, F.; Holmes, T.P.; Carter, D.R. Economic and environmental impact of conventional and reduced-impact logging in Tropical South America: A comparative review. *For. Policy Econ.* **2003**, *5*, 69–81.
40. Holmes, T.P.; Blate, G.M.; Zweede, J.C.; Pereira, R., Jr.; Barreto, P.; Boltze, F.; Bauc, R. Financial and ecological indicators of reduced impact logging performance in the Eastern Amazon. *For. Ecol. Manag.* **2002**, *163*, 93–110.

41. Putz, F.E.; Plinio, S.; Fredericksen, T.; Dykstra, D. Reduced-impact logging: Challenges and opportunities. *For. Ecol. Manag.* **2008**, *256*, 1427–1433.
42. Forest Management Plan. *Maine Forest Practices Act*, Section 8868.2, Title 12, 2004.
43. Donoso, C.; Donoso, P.; Gonzalez, M.; Sandoval, V. Los bosques siempreverdes. In *Silvicultura de los Bosques Nativos de Chile*; Donoso, C., Lara, A., Eds.; Universitaria: Santiago, Chile, 1998; pp. 297–339.
44. Wadsworth, F.H. Not just reduced but productive logging impacts. *Int. For.Rev.* **2001**, *3*, 51–53.
45. Zarin, D.J.; Schulze, M.D.; Vidal, E.; Lentini, M. Beyond reaping the first harvest: Management objectives for timber production in the Brazilian Amazon. *Conserv. Biol.* **2007**, *21*, 916–925.
46. Schulze, M.; Grogan, J.; Uhl, C.; Lentini, M.; Vidal, E. Evaluating Ipe (Tabebuia, Bignoniaceae) logging in Amazonia: Sustainable management or catalyst for forest degradation? *Biol. Conserv.* **2008**, *41*, 2071–2085.
47. Sist, P.; Garcia-Fernandez, C.; Frederickson, T.S. Publisher's note: Moving beyond reduced impact logging towards a more holistic management of tropical forests. *For. Ecol. Manag.* **2008**, *256*, 7–11.
48. Raison, R.J.; Brown, A.G.; Flinn, D.W. Application of criteria and indicators to support sustainable forest management: Some key issues. In *Criteria and Indicators for Sustainable Forest Management*; Raison, R.J., Brown, A.G., Flinn, D.W., Eds.; CAB International: Oxon, UK, 2001; pp. 9–66.
49. Lindenmayer, D.B.; Margules, C.R.; Botkin, D.B. Indicators of biodiversity for ecologically sustainable forest management. *Conserv. Biol.* **2000**, *14*, 941–950.
50. Prabhu, R.; Ruitenbeek, H.J.; Boyle, T.J.B.; Colfer, C.J.P. Between voodoo science and adaptive management—The role and research needs for indicators of sustainable forest management. In *Criteria and Indicators for Sustainable Forest Management*; Raison, R.J., Brown, A.G., Flinn, D.W., Eds.; CAB International: Oxon, UK, 2001.
51. McGinley, K.; Finegan, B. The ecological sustainability of tropical forest management: Evaluation of the national forest management standards of Costa Rica and Nicaragua, with emphasis on the need for adaptive management. *For. Policy Econ.* **2003**, *5*, 421–431.
52. De la Simulación de la Condición Disetanea del Bosque Natural. *Decreto de Costa Rica*, No. 34559-Minae, Criterio 2.3, 2008.
53. Do Plano de Manejo Florestal Sustentável. *Decreto do Brasil*, No. 5.975, Capítulo II, Art. 3, 2006.; De los Planes de Manejo y los Planes de Trabajo, *Decreto de Chile*, No. 93, Art. 15, 2009.
54. Contenidos Mínimos de los Planes de Manejo Sostenible. *Decreto de Misiones, Argentina*, No. 67, Anexo A, 2011.
55. Reports by Forest Landowners. *Maine Forest Practices Act*, Section 8885, Title 12, 2004.
56. Quiros, D.; Campos, J.J.; Carrera, F.; Castaneda, F.; aus der Beek, R. CATIE's experiences in the development of low impact forest harvesting systems in Central America. In *Research on Environmentally Sound Forest Practices to Sustain Tropical Forests*; FAO: Rome, Italy, 1997; pp. 15–26.
57. Uhl, C.; Guimaraes-Vieira, I.C. Ecological impacts of selective logging in the Brazilian Amazon: A case study from the Paragominas Region of the State of Para. *Biotropica* **1989**, *21*, 98–106.

58. Congressional declaration of goals and policy. *Navigation and Navigable Waters*, Section 1251, Title 33, 2011.
59. Maine State Statute. *Property of State*, Section 502, Title 1, 1997.
60. Prohibición Para la Construcción de Caminos. *Resolución Administrativa de Nicaragua*, No. 81, Art. 35, 2007.
61. El Área de Bosque Impactada por el Aprovechamiento Forestal. *Decreto de Costa Rica*, No. 34559-Minae, Indicador 2.3.1, 2008.
62. Statement of Purpose, Policy, and Scope. *North Carolina State Statutes*, Section 0203–0209, Title 1, 1990.
63. Ordenamiento Territorial de los Bosques Nativos de Misiones, *Ley XVI de Misiones, Argentina*, No. 105, Art. 6, 2010.
64. De Preservação Permanente. *Lei do Brasil*, No. 4771/65, Art. 2, 1965; Da Área de Preservação Permanente. *Lei do Minas Gerais, Brasil*, No. 14.309, Seção II, Art. 10, 2002.
65. Fragile Mountain Areas. *Maine State Statute*, Section 480, Title 38, 1987.
66. Helms, J.A. *The Dictionary of Forestry*; Society of American Foresters: Bethesda, MD, USA, 1998.
67. Defines Three Categories of Native Forest: Category I–III. *Ley de Argentina*, No. 26331, Art. 9, 2007.
68. As Florestas de Domínio Privado. *Lei do Brasil*, No. 4771/65, Art. 16, 1965.
69. Da Exploração Florestal. *Lei do Minas Gerais, Brasil*, No. 14.309, Capítulo 4, Art. 41-2, 2002.
70. De las Sanciones. *Decreto Ley de Chile*, No. 701, Título 4, Art. 21.
71. Los Desmontes. *Decreto de Paraguay*, No. 18.831 Art. 5, 1986.
72. Clearcut Standards. *Forest Regeneration & Clearcutting Standards*, Chapter 20, Section 5, 1999.
73. Kilgore, M. Best management practices. In *Forests and Forestry in the Americas: An Encyclopedia*; Cubbage, F.W., Ed.; Routledge: Florence, KY, USA, 2007.
74. Estándares de Sostenibilidad Para Manejo de Bosques Naturales: Principios, Criterios e Indicadores, Código de Prácticas y Manual de Procedimientos. *Decreto de Costa Rica*, No. 34559-Minae, 2008.; La Norma Técnica Obligatoria Para el Manejo Sostenible de los Bosques Tropicales Latifoliados y de Coníferas. *Norma Técnica de Nicaragua*, No. 18001-04, 2004.
75. Discharges not Requiring Permits. *Navigation and Navigable Waters*, Section 323, Title 33, 2010.
76. Bawa, K.S.; Seidler, R. Natural forest management and conservation of biodiversity in tropical forests. *Conserv. Biol.* **1998**, *12*, 46–55.
77. Putz, F.E.; Blate, G.M.; Redford, K.H.; Fimbel, R.; Robinson, J. Biodiversity conservation in the context of tropical forest management. *Conserv. Biol.* **2001**, *13*, 2387–2390.
78. The Convention on International Trade in Endangered Species of Wild Fauna and Flora Home Page. Available online: <http://www.cites.org/eng/disc/parties/index.php> (accessed on 18 June 2012).
79. Do Plano de Manejo Florestal Sustentável Para Produção de Madeira. *Instrução Normativa do Brasil*, No. 5/2006, Capítulo III, Art. 8, 2006.; De Mantenimiento de la Condición Disetánea del Bosque Natural. *Decreto de Costa Rica*, No. 34559-Minae, Criterio 2.2, 2008.
80. De Parques Nacionales. *Ley de Argentina*, No. 22351, 1981.
81. Protección de los Bosques. *Ley de Uruguay*, No. 15.939, Título IV, Capítulo I, Art. 25, 1988.

82. US Fish and Wildlife Service Home Page—Endangered Species Act: Overview. <http://www.fws.gov/endangered/laws-policies/index.html> (accessed 29 June 2012).
83. Naiman, R.J.; Decamps, H.; McClain, M.E. *Riparia: Ecology, Conservation, And Management of Streamside Communities*; Elsevier Academy Press: Burlington, VT, USA, 2005.
84. Ordenamiento de los Bosques Nativos. *Ley Provincial de Misiones, Argentina*. No. XVI/105, 2010.
85. Great Pond. *Maine State Statue*, Section 436-A, Title 38, 1989.
86. Wisconsin's Shoreland Protection Program. *Wisconsin State Statues*, Chapter NR 115, Section 30, 2012.
87. Streamside Management Zone. *North Carolina State Statues*, Section 0201, Title 01J, Vol. 15A NCAC, 2007.
88. Que Industrialize, Comercialize, Beneficie, Utilize ou Consuma Produto ou Subproduto da Flora. *Lei de Minas Gerais, Brasil*, No. 18.365, Art. 47, 2009.
89. Autorizaciones de Desmonte o de Aprovechamiento Sostenible. *Ley de Argentina*, No. 26.331, Capítulo 5, Art. 14, 2007.
90. Consumer Information Center Fund. *Public Buildings, Property, and Works*, Section 232, Title 40, 2003.
91. UNFF. Forest loss, degradation blamed on neglect of social, cultural, human aspects as forum holds multi-stakeholder dialogue. In *Proceedings of Ninth Session, 6th Meeting on United Nations Forum on Forests*, New York, NY, USA, 4 February 2011. Available online: <http://www.un.org/News/Press/docs/2011/envdev1191.doc.htm> (accessed on 4 January 2012).
92. C169 Indigenous and Tribal Peoples Convention Home Page. Available online: <http://www.ilo.org/ilolex/cgi-lex/convde.pl?C169> (accessed on 7 September 2011).
93. UN News Centre. United Nations Adopts Declaration on Rights of Indigenous Peoples. UN News Centre, 13 September 2007. Available online: <http://www.un.org/apps/news/story.asp?NewsID=23794> (accessed 2 January 2012).
94. Diretrizes Técnicas Para Apresentação de Plano de Manejo Florestal Sustentável e Plano Operacional Anual. *Meio Social, Norma de Execução de Brasil*, No. 1, Anexo 1, I.2.2.1, 2007.
95. Criterio de Protección del Bosque Contra Alteraciones Humanas. *Decreto de Costa Rica*, No. 34559-Minae, Criterio 3.3, 2008.
96. Shannon, M.A. Foresters as strategic thinkers, facilitators, and citizens. *J. For.* **1992**, *90*, 24–27.
97. Schindler, B.; Cramer, L.A. Shifting public values for forest management: Making sense of wicked problems. *West. J. Appl. For.* **1999**, *14*, 28–34.
98. Bosques Naturales. *Ley de Nicaragua*, No. 462, Sección 2, Art. 22, 2003.
99. ILO. *International Year of Forests 2011: What About the Labour Aspects of Forestry*; ILO: Geneva, Switzerland, 2011. Available online: [http://www.ilo.org/wcmsp5/groups/public/ed\\_dialogue/sector/documents/publication/wcms\\_160879.pdf](http://www.ilo.org/wcmsp5/groups/public/ed_dialogue/sector/documents/publication/wcms_160879.pdf) (accessed on 18 June 2012).
100. Reglamento de Higiene y Seguridad Para la Actividad Agraria que Reglamenta la Ley 24557 de Riesgos del Trabajo. *Decreto de Argentina*, No. 61797, 1997.
101. Estrutura Básica Para Elaboração de Documentos Técnicos Categoria de PMFS. *Instrução Normativo de Brasil*. No. 5, Anexo 1, Capítulo 8, 2006.
102. Reglamentación de las Condiciones de Trabajo, en Materia de Seguridad, Higiene y Salud Ocupacional en Sector Forestal. *Decreto de Uruguay*, No. 372/99, 1999.

103. Wang, S.; Wilson, B. Pluralism in the economics of sustainable forest management. *For. Policy Econ.* **2007**, *9*, 743–750.
104. UN General. *Non-Legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of all Types of Forests*; Technical Report for the United Nations Conference on Environment and Development: Rio de Janeiro, Brazil, 3–14 June 1992.
105. Gómez, M.; Quirós, D. Análisis financiero del manejo de bosques (In Spanish). In *Silvicultura de Bosques Latifoliados Húmedos con Énfasis en América Central*; Louman, B., Quirós, D., Nilsson, M., Eds.; CATIE: Turrialba, Costa Rica, 2001; pp. 231–263.
106. Plan de Manejo Sostenible de Bosques Nativos. *Ley de Argentina*, No. 26.331 Art.4, 2007.
107. Los Planes de Manejo Forestal. *Ley de Paraguay*, No. 542-93, Art.57, 1994.
108. Harvest Report. *Maine Forest Practices Act*, Section 8885.1, Title 12, 2004.
109. *Biodiversity and Dead Wood*; Stokland, J.N., Siitonen, J., Jonsson, B.G., Eds.; Cambridge University Press: Cambridge, UK, 2012.
110. Carey, E.V.; Brown, S.; Gillespie, A.J.R.; Lugo, A.E. Tree mortality in mature lowland tropical moist and tropical lower montane moist forests of Venezuela. *Biotropica* **1994**, *26*, 255–265.
111. Bull, E.L. *The Value of Coarse Woody Debris to Vertebrates in the Pacific Northwest*; PSW-GTR-18; Technical Report for U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: Portland, OR, USA, 2002.
112. Lachat, T.; Peveling, R.; Attignon, S.; Goergen, G.; Sinsin, B.; Nagel, P. Saproxylic beetle assemblages on native and exotic snags in a West African tropical forest. *Afr. Entomol.* **2007**, *15*, 13–24.
113. Jonsson, B.G.; Siitonen, J. Dead wood and sustainable forest management. In *Biodiversity and Dead Wood*; Stokland, J.N., Siitonen, J., Jonsson, B.G., Eds.; Cambridge University Press: Cambridge, UK, 2012; pp. 302–331.
114. Del Transporte de los Productos Forestales. *Resolución Administrativa de Nicaragua*, No. 81, Capítulo IV, 2007.
115. Bird, N.; Thiel, H. *New Technologies in Support of Improved Forest Governance: Factors Influencing Success*; Briefing Paper No.7; Technical Report for VERIFOR: London, UK, 2007. Available online: <http://www.odi.org.uk/resources/details.asp?id=8&title=technologies-forest-governance> (accessed on 22 January 2012).
116. Da Exploração Florestal. *Lei do Minas Gerais, Brasil*. No. 18.365, Capítulo 4, Art. 43, 2009.
117. Ellefson, P.V.; Hibbard, C.M.; Kilgore, M.A.; Granskog, J.E. *Legal, Institutional, and Economic Indicators of Forest Conservation and Sustainable Forest Management: Review of Information Available for the United States*; SRS-82; Technical Report for U.S. Department of Agriculture, Forest Service, Southern Research Station: Asheville, NC, USA, 2005.
118. Tonelson, A. *The Race to the Bottom*; Westview Press: Boulder, CO, USA, 2000.
119. Wheeler, D. Racing to the bottom? Foreign investment and air pollution in developing countries. *J. Environ. Dev.* **2001**, *10*, 225–245.
120. Dorgan, B; Brown, S. How Free Trade Hurts. *Washington Post*, 23 December 2006. Available online: <http://www.washingtonpost.com/wp-dyn/content/article/2006/12/22/AR2006122201020.html> (accessed on 7 June 2012).

121. Knill, C.; Tosun, J.; Heichel, S. Balancing competitiveness and conditionality: Environmental policy-making in low-regulating counties. *J. Eur. Public Policy* **2008**, *15*, 1019–1040.
122. Konisky, D.M. Regulatory competition and environmental enforcement: Is there a race to the bottom? *Am. J. Polit. Sci.* **2007**, *51*, 853–872.
123. Kimmins, H. *Balancing Act—Environmental Issues in Forestry*; PBC Press: Vancouver, BC, Canada, 1997.
124. Panayotou, T. Demystifying the environmental kuznets curve: Turning a black box into a policy tool. *Environ. Dev. Econ.* **1997**, *2*, 465–484.
125. Blaser, J.; Sarre, A.; Poore, D.; Johnson, S. *Status of Tropical Forest Management 2011*; ITTO Technical Series No. 38; Technical Report for International Tropical Timber Organization: Yokohama, Japan, 7 June 2011.
126. Perdomo, M.; Galloway, G.; Louman, B.; Finegan, B.; Velázquez, S. Herramientas para la planificación del manejo de bosques a escala de paisaje en el sudeste de Nicaragua (In Spanish). *Rev. For. Centroam.* **2002**, *38*, 51–58.

**Appendix A.** Laws and other policy directives reviewed by McGinley *et al.*

Policy Directive	Year	Internet Address
<b>Argentina—Federal-level</b>		
Ley No. 13.273 Defensa de la Riqueza Forestal	1948	<a href="http://www2.medioambiente.gov.ar/mlegal/foresta/ley13273.htm">http://www2.medioambiente.gov.ar/mlegal/foresta/ley13273.htm</a>
Ley 22351 de Parques Nacionales	1981	<a href="http://www.parquesnacionales.gov.ar/_DN_2008/_leyes_dn_08_.htm">http://www.parquesnacionales.gov.ar/_DN_2008/_leyes_dn_08_.htm</a>
Decreto 617/1997 Reglamento de Higiene y Seguridad para la Actividad Agraria que Reglamenta la Ley 24557 de Riesgos del Trabajo	1997	<a href="http://www.trabajo.gov.ar">http://www.trabajo.gov.ar</a>
Ley No. 26.331 Presupuestos Mínimos de Protección Ambiental de Los Bosques Nativos	2007	<a href="http://www.ambiente.gov.ar/archivos/web/SUBordenamiento/file/ley_26331_presupuestos_minimos_bosques_nativos.pdf">http://www.ambiente.gov.ar/archivos/web/SUBordenamiento/file/ley_26331_presupuestos_minimos_bosques_nativos.pdf</a>
Decreto 91/2009 Reglamentación de la Ley No. 26.331	2009	<a href="http://www.ambiente.gov.ar/archivos/web/DB/file/decreto91_2009_reglamentacion_ley_26331.pdf">http://www.ambiente.gov.ar/archivos/web/DB/file/decreto91_2009_reglamentacion_ley_26331.pdf</a>
<b>Argentina—Province-level—Misiones</b>		
Ley 854 Regimen legal sobre bosques y tierras forestales	1977*	<a href="http://www.misiones.gov.ar/legal/leyes/854.htm">http://www.misiones.gov.ar/legal/leyes/854.htm</a>
Ley 1279 de Conservación de la Fauna Silvestre	1982	<a href="http://www.misiones.gov.ar/legal/leyes/1279.htm">http://www.misiones.gov.ar/legal/leyes/1279.htm</a>
Ley provincial 3426 sobre Bosques protectores y fajas ecológicas	1997	<a href="http://www.ecologia.misiones.gov.ar/ecoweb/index.php?option=com_content&amp;view=section&amp;layout=blog&amp;id=11&amp;Itemid=57">http://www.ecologia.misiones.gov.ar/ecoweb/index.php?option=com_content&amp;view=section&amp;layout=blog&amp;id=11&amp;Itemid=57</a>
Ley XVI No. 105 Ordenamiento de los Bosques Nativos	2010	<a href="http://www.ot.misiones.gov.ar/adjuntos/ley_bosques.pdf">http://www.ot.misiones.gov.ar/adjuntos/ley_bosques.pdf</a>
Reglamentación de la Ley XVI No. 105	2011	<a href="http://www.boletin.misiones.gov.ar/index.php/boletin-digital/doc_details/2789-boletin-12985-miercoles-4-de-mayo-de-2011">http://www.boletin.misiones.gov.ar/index.php/boletin-digital/doc_details/2789-boletin-12985-miercoles-4-de-mayo-de-2011</a>

## Appendix A. Cont.

Policy Directive	Year	Internet Address
<b>Brazil—Federal-level</b>		
Lei No. 4.771 Novo Codigo Florestal	1965*	<a href="http://www.ecolex.org/ecolex/ledge/view/RecordDetails;DIDPFDSIjsessionid=F96A168BD9555464EFB75506FEDEDA5D?id=LEX-FAOC012382&amp;index=documents">http://www.ecolex.org/ecolex/ledge/view/RecordDetails;DIDPFDSIjsessionid=F96A168BD9555464EFB75506FEDEDA5D?id=LEX-FAOC012382&amp;index=documents</a>
Lei No. 5.197 Protection of fauna and hunting activity	1967	<a href="http://www.ecolex.org/ecolex/ledge/view/RecordDetails;DIDPFDSIjsessionid=956830FA5C2AFD3CBDAC894A57D73E13?id=LEX-FAOC012803&amp;index=documents">http://www.ecolex.org/ecolex/ledge/view/RecordDetails;DIDPFDSIjsessionid=956830FA5C2AFD3CBDAC894A57D73E13?id=LEX-FAOC012803&amp;index=documents</a>
Lei No. 9.605 sanções penais e administrativas derivadas de condutas e atividades lesivas ao meio ambiente	1998	<a href="https://www.planalto.gov.br/ccivil_03/Leis/L9605.htm">https://www.planalto.gov.br/ccivil_03/Leis/L9605.htm</a>
Decreto 4340/2002 Reglamenta artículos de Lei 4.771	2002	<a href="http://www.planalto.gov.br/ccivil_03/decreto/2002/D4340.htm">http://www.planalto.gov.br/ccivil_03/decreto/2002/D4340.htm</a>
Resolução CONAMA No. 378 (defines undertakings that may potentially cause national or regional environmental impact and makes other provisions; and subjects forest exploitation to permits issued by IBAMA)	2006	<a href="http://www.mp.ba.gov.br/atuacao/ceama/material/legislacoes/reserva/resolucao_conama_378_2006.pdf">http://www.mp.ba.gov.br/atuacao/ceama/material/legislacoes/reserva/resolucao_conama_378_2006.pdf</a>
Resolução CONAMA No. 379, establishes technical standards to be adopted in the formulation, presentation, technical evaluation and implementation of PMFSs for logging purposes in native forests and their succeeding formations in the Amazon biome	2006	<a href="http://www.sbs.org.br/normas_florestais_2edicao.pdf">http://www.sbs.org.br/normas_florestais_2edicao.pdf</a>
Decreto No. 5.975 Reglamenta artículos de Lei 4.771	2006	<a href="http://www.mp.ba.gov.br/atuacao/ceama/material/legislacoes/reserva/decreto_5975_2006.pdf">http://www.mp.ba.gov.br/atuacao/ceama/material/legislacoes/reserva/decreto_5975_2006.pdf</a>
Instruções Normativas (Norms for forest management planning and operations, and timber documentation and transport)	various	<a href="http://www.sbs.org.br/normas_florestais_2edicao.pdf">http://www.sbs.org.br/normas_florestais_2edicao.pdf</a>
<b>Brazil—State-level—Minas Gerais</b>		
Lei No. 14.309 Florestal do Estado de Minas Gerais	2002	<a href="http://servicos.meioambiente.mg.gov.br/legislacao/leisdec.asp">http://servicos.meioambiente.mg.gov.br/legislacao/leisdec.asp</a>
Decreto No. 4371 que Reglamenta Lei No. 14.309	2004	<a href="http://servicos.meioambiente.mg.gov.br/legislacao/leisdec.asp">http://servicos.meioambiente.mg.gov.br/legislacao/leisdec.asp</a>
Lei No. 18.365 que Altera a Lei No. 14.309	2009	<a href="http://www.siam.mg.gov.br/sla/download.pdf?i dNorma=10490">http://www.siam.mg.gov.br/sla/download.pdf?i dNorma=10490</a>
<b>Chile</b>		
Decreto Ley No. 265 Ley Forestal	1931	<a href="http://faolex.fao.org/docs/pdf/chi9302.pdf">http://faolex.fao.org/docs/pdf/chi9302.pdf</a>
Decreto Ley No. 701 Fomento Forestal	1974*	<a href="http://faolex.fao.org/docs/pdf/chi7311.pdf">http://faolex.fao.org/docs/pdf/chi7311.pdf</a>
Decreto No. 259 Reglamento del Decreto Ley No. 701	1980	<a href="http://faolex.fao.org/docs/pdf/chi9301.pdf">http://faolex.fao.org/docs/pdf/chi9301.pdf</a>
Decreto No. 193 Reglamento del Decreto Ley No. 701	1998*	<a href="http://www.sii.cl/pagina/jurisprudencia/legislacion/complementaria/dl701.htm">http://www.sii.cl/pagina/jurisprudencia/legislacion/complementaria/dl701.htm</a>

## Appendix A. Cont.

Policy Directive	Year	Internet Address
Decreto No. 75 Reglamento para la Clasificación de Especies Silvestres	2005	<a href="http://www.leychile.cl/Navegar?idNorma=237791">http://www.leychile.cl/Navegar?idNorma=237791</a>
Ley No. 20.283 Ley Sobre Recuperación del Bosque Nativo y Fomento Forestal	2008	<a href="http://www.cifag.cl/_file/file_160_ley%20n%C2%BA%2020.283.pdf">http://www.cifag.cl/_file/file_160_ley%20n%C2%BA%2020.283.pdf</a>
Decreto No. 93 Reglamento General de la Ley Sobre Recuperación del Bosque Nativo y Fomento Forestal	2009	<a href="http://www.leychile.cl/Navegar?idNorma=1006865&amp;idParte=&amp;idVersion=2009-10-05">http://www.leychile.cl/Navegar?idNorma=1006865&amp;idParte=&amp;idVersion=2009-10-05</a>
<b>Costa Rica</b>		
Ley No. 7575 Ley Forestal	1996*	<a href="http://www.acto.go.cr/descargas/Ley7575.pdf">http://www.acto.go.cr/descargas/Ley7575.pdf</a>
Decreto No. 25721-MINAE Reglamento a la Ley Forestal	1997	<a href="http://www.mag.go.cr/legislacion/1997/de-25721.pdf">http://www.mag.go.cr/legislacion/1997/de-25721.pdf</a>
Decreto No. 25700-MINAE Veda de Especies Arbóreas en Peligro de Extinción	1997	<a href="http://www.bvsde.paho.org/bvsacd/cd38/CostaRica/D-25700.pdf">http://www.bvsde.paho.org/bvsacd/cd38/CostaRica/D-25700.pdf</a>
Decreto No. 34559-MINAE Estándares de Sostenibilidad para Manejo de Bosques Naturales: Principios, Criterios e Indicadores, Código de Prácticas y Manual de Procedimientos	2008	<a href="http://www.sirefor.go.cr/Documentos/Legislacion/34559.pdf">http://www.sirefor.go.cr/Documentos/Legislacion/34559.pdf</a> ; <a href="http://www.sirefor.go.cr/Documentos/Normativa/PCI_MFS_2009.pdf">http://www.sirefor.go.cr/Documentos/Normativa/PCI_MFS_2009.pdf</a>
<b>Guatemala</b>		
Decreto No. 101-96 Ley Forestal	1996*	<a href="http://www.sice.oas.org/investment/NatLeg/GTM/Forestal_s.pdf">http://www.sice.oas.org/investment/NatLeg/GTM/Forestal_s.pdf</a>
Resolución 01.13.2004 Reglamento de Transporte de Productos Forestales	2004	<a href="http://www.infoiarna.org.gt/media/file/areas/biodiversidad/legislacion/reg_transporte.pdf">http://www.infoiarna.org.gt/media/file/areas/biodiversidad/legislacion/reg_transporte.pdf</a>
Resolución 01.43.2005 Reglamento de La Ley Forestal (deroga Resolución 4.23.97 reglamento de la ley forestal)	2005	<a href="http://www.camaradelagro.org/docs/agrarias/RESO01.pdf">http://www.camaradelagro.org/docs/agrarias/RESO01.pdf</a>
<b>Nicaragua</b>		
Ley No. 462 Ley de Conservación, Fomento y Desarrollo Sostenible del Sector Forestal	2003	<a href="http://legislacion.asamblea.gob.ni/Normaweb.nsf/(\$All)/376155B1768A24B70625723300578EDA?OpenDocument">http://legislacion.asamblea.gob.ni/Normaweb.nsf/(\$All)/376155B1768A24B70625723300578EDA?OpenDocument</a>
Decreto No. 73-2003 Reglamento de La Ley No. 462, Ley de Conservación, Fomento y Desarrollo Sostenible del Sector Forestal	2003	<a href="http://legislacion.asamblea.gob.ni/Normaweb.nsf/(\$All)/BA58507A747A5A94062572370068596F?OpenDocument">http://legislacion.asamblea.gob.ni/Normaweb.nsf/(\$All)/BA58507A747A5A94062572370068596F?OpenDocument</a>
La Norma Técnica Obligatoria para el Manejo Sostenible de los Bosques Tropicales Latifoliados y de Coníferas NTON 18 001-04	2004	<a href="http://faolex.fao.org/docs/pdf/nic66077.pdf">http://faolex.fao.org/docs/pdf/nic66077.pdf</a>
Resolución Administrativa No. de 81-2007 Las Disposiciones Administrativas para el Manejo Sostenible de Los Bosques Latifoliados, Coníferas, Plantaciones Forestales y Fincas	2007	<a href="http://www.inafor.gob.ni:8080/legislacion_normas/PDF/Resoluciones%20Administrativas/RESOLUCION%20ADMINISTRATIVA%20No.%20DE%2081%20-2007.pdf">http://www.inafor.gob.ni:8080/legislacion_normas/PDF/Resoluciones%20Administrativas/RESOLUCION%20ADMINISTRATIVA%20No.%20DE%2081%20-2007.pdf</a>

## Appendix A. Cont.

Policy Directive	Year	Internet Address
<b>Paraguay</b>		
Ley No. 422/73 Ley Forestal	1973	<a href="http://www.infona.gov.py/Leyes_web/ley_n_422-73_forestal.pdf">http://www.infona.gov.py/Leyes_web/ley_n_422-73_forestal.pdf</a>
Decreto 11681/75 Reglamento de la Ley Forestal	1975	<a href="http://www.infona.gov.py/Decretos/decreto1883-86_por_el_cual_se_establecen_normas_de_proteccion_del_medio_ambiente.pdf">http://www.infona.gov.py/Decretos/decreto1883-86_por_el_cual_se_establecen_normas_de_proteccion_del_medio_ambiente.pdf</a>
Decreto No. 18.831 Normas de Protección del medio ambiente	1986	<a href="http://www.infona.gov.py/Decretos/decreto1883-86_por_el_cual_se_establecen_normas_de_proteccion_del_medio_ambiente.pdf">http://www.infona.gov.py/Decretos/decreto1883-86_por_el_cual_se_establecen_normas_de_proteccion_del_medio_ambiente.pdf</a>
Resolución No. 76-92 Reglamento de la elaboración de los planes de aprovechamiento y manejo forestal	1992	<a href="http://faolex.fao.org/docs/pdf/par42424.pdf">http://faolex.fao.org/docs/pdf/par42424.pdf</a>
Resolución No. 323-94 Ampliación y Modificación del Reglamento de la elaboración de los planes de aprovechamiento y manejo forestal	1994	<a href="http://faolex.fao.org/docs/pdf/par42426.pdf">http://faolex.fao.org/docs/pdf/par42426.pdf</a>
Ley no. 542/93 de Recursos Forestales	1994	<a href="http://www.ecolex.org/ecolex/ledge/view/RecordDetails;DIDPFDSI?id=LEX-FAOC023976&amp;index=documents">http://www.ecolex.org/ecolex/ledge/view/RecordDetails;DIDPFDSI?id=LEX-FAOC023976&amp;index=documents</a>
Ley no. 536/95 de Fomento a la Forestación y Reforestación	1994	<a href="http://www.infona.gov.py/Leyes_web/ley_n_536-05_de_fomento_de_forestacion_y_resforestacion.pdf">http://www.infona.gov.py/Leyes_web/ley_n_536-05_de_fomento_de_forestacion_y_resforestacion.pdf</a>
Resolución No. 001-94 Normas para la protección de los bosques naturales de producción	1994	<a href="http://www.icasa.com.py/web/LEYES/AMBIENTE/resoluciones/Resolucion_001_FORESTAL.pdf">http://www.icasa.com.py/web/LEYES/AMBIENTE/resoluciones/Resolucion_001_FORESTAL.pdf</a>
Ley No. 816/96 Medidas de defensa de los recursos naturales forestales	1996	<a href="http://www.infona.gov.py/Leyes_web/ley_816-96_que_adopta_medidas_de_defensa_de_recursos_naturales.pdf">http://www.infona.gov.py/Leyes_web/ley_816-96_que_adopta_medidas_de_defensa_de_recursos_naturales.pdf</a>
Resolución No. 7-02—Reglamenta la elaboración y presentación de los planes de manejo forestal	2002	<a href="http://faolex.fao.org/docs/pdf/par41316.pdf">http://faolex.fao.org/docs/pdf/par41316.pdf</a>
Ley 2524-04 de prohibición en la región oriental de las actividades de transformación y conversión de superficies con cobertura de bosques (and amendments)	2004	<a href="http://www.infona.gov.py/Leyes_web/ley2524-04_de_prohibicion_en_la_region_oriental_de_las_actividades_de_transformacion_y_conversion_de_superficies_con_cobertura_de_bosques.pdf">http://www.infona.gov.py/Leyes_web/ley2524-04_de_prohibicion_en_la_region_oriental_de_las_actividades_de_transformacion_y_conversion_de_superficies_con_cobertura_de_bosques.pdf</a>
Resolución No 2.243-06 El listado de las especies protegidas de la vida silvestre en peligro de extinción (Partially modified by Res. 2.531/06)	2006	<a href="http://www.ecolex.org/ecolex/ledge/view/RecordDetails;DIDPFDSIjsessionid=108B755EBE26B5938B5214F78AE8F5B0?id=LEX-FAOC087580&amp;index=documents">http://www.ecolex.org/ecolex/ledge/view/RecordDetails;DIDPFDSIjsessionid=108B755EBE26B5938B5214F78AE8F5B0?id=LEX-FAOC087580&amp;index=documents</a>
Resolución No. 2.531/06 Modifica parcialmente la Resolución No. 2.243, exceptuando las especies que provengan de planes de manejo aprobados por la autoridad competente.		<a href="http://www.idea.org.py/gfx/espanol/normativa/actual/res-seam-2531-06-modifica-parcialmente-la-resolucion-n-2.243-06">http://www.idea.org.py/gfx/espanol/normativa/actual/res-seam-2531-06-modifica-parcialmente-la-resolucion-n-2.243-06</a>

## Appendix A. Cont.

Policy Directive	Year	Internet Address
<b>Uruguay</b>		
Ley 15.939 Ley Forestal	1988	<a href="http://www0.parlamento.gub.uy/leyes/ AccesoT extoLey.asp?Ley=15939&amp;Anchor=">http://www0.parlamento.gub.uy/leyes/ AccesoT extoLey.asp?Ley=15939&amp;Anchor=</a>
Decreto No. 22/993 Protección y aprovechamiento del bosque indígena	1993	<a href="http://www.guayubira.org.uy/1993/02/decreto-n%c2%ba-22993-normas-de-proteccion-del-monte-indigena/">http://www.guayubira.org.uy/1993/02/decreto-n%c2%ba-22993-normas-de-proteccion-del-monte-indigena/</a>
Decreto No. 24/993 Disposiciones para la explotación del monte indígena	1993	<a href="http://www.guayubira.org.uy/1993/02/decreto-n%c2%ba-24993-disposiciones-para-la-explotacion-del-monte-indigena/">http://www.guayubira.org.uy/1993/02/decreto-n%c2%ba-24993-disposiciones-para-la-explotacion-del-monte-indigena/</a>
Decreto No. 330/993 Corte y extracción de productos del monte indígena, autorizaciones y guías para el transporte	1993	<a href="http://www.guayubira.org.uy/1993/07/decreto-n%c2%ba-330993-corte-y-extraccion-de-productos-del-monte-indigena/">http://www.guayubira.org.uy/1993/07/decreto-n%c2%ba-330993-corte-y-extraccion-de-productos-del-monte-indigena/</a>
Decreto No. 372/99—Reglamentación de las condiciones de trabajo, en materia de seguridad, higiene y salud ocupacional en sector forestal	1999	<a href="http://www.guayubira.org.uy/1999/12/decreto-n%c2%b0-37299-reglamentacion-de-las-condiciones-de-trabajo-en-materia-de-seguridad-higiene-y-salud-ocupacional-en-sector-forestal/">http://www.guayubira.org.uy/1999/12/decreto-n%c2%b0-37299-reglamentacion-de-las-condiciones-de-trabajo-en-materia-de-seguridad-higiene-y-salud-ocupacional-en-sector-forestal/</a>
<b>United States—Federal-level</b>		
Clean Water Act, 33 U.S.C. Sections 1251–1376	1972*	<a href="http://uscode.house.gov/download/pls/33C26.txt">http://uscode.house.gov/download/pls/33C26.txt</a>
Endangered Species Act, 7 U.S.C. Section 136, 16, U.S.C. Section 1531	1973*	<a href="http://epw.senate.gov/esa73.pdf">http://epw.senate.gov/esa73.pdf</a>
Occupational Health and Safety Act, 29 U.S.C. 651–678	1973*	<a href="http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=2743&amp;p_table=OSHACT">http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_id=2743&amp;p_table=OSHACT</a>
<b>United States—State-level—Maine</b>		
Protection and Improvement of Waters Law (State Statute 38.3 361-571; includes Erosion and Sedimentation Control Act (Section 420); Natural Resources Protection Act (Section 480))	1973*	<a href="http://www.mainelegislature.org/legis/statutes/38/title38ch3sec0.html">http://www.mainelegislature.org/legis/statutes/38/title38ch3sec0.html</a>
Maine Forest Practices Act 12 MRSA §8867-A to §8888	1989*	<a href="http://www.maine.gov/doc/mfs/pubs/htm/fpa_04.html">http://www.maine.gov/doc/mfs/pubs/htm/fpa_04.html</a>
Maine Forest Service Rules	Varios	<a href="http://www.maine.gov/doc/mfs/rules_regs/index.htm">http://www.maine.gov/doc/mfs/rules_regs/index.htm</a>
<b>United States—State-level—North Carolina</b>		
NC Sedimentation Pollution Control Act (1973, c.392, s.1)	1973*	<a href="http://www.dlr.enr.state.nc.us/pages/sedimentpollutioncontrol.html">http://www.dlr.enr.state.nc.us/pages/sedimentpollutioncontrol.html</a>
NC Endangered and Threatened Wildlife and Wildlife Species of Special Concern (GS Article 25 Sections 113/331–13/337)	1973*	<a href="http://www.ncga.state.nc.us/EnactedLegislation/Statutes/HTML/ByArticle/Chapter_113/Article_25.html">http://www.ncga.state.nc.us/EnactedLegislation/Statutes/HTML/ByArticle/Chapter_113/Article_25.html</a>
NC Forest Development Act (1977, c.562, s.1)	1977*	<a href="http://www.cals.ncsu.edu/wq/lpn/statutes/nc/forestdevelopmentact.pdf">http://www.cals.ncsu.edu/wq/lpn/statutes/nc/forestdevelopmentact.pdf</a>
NC Forest Practices Guidelines Related To Water Quality (FPGs): 15A NCAC 01J.0100-0209	2007	<a href="http://ncforestservice.gov/publications/Forestry%20Leaflets/WQ01.pdf">http://ncforestservice.gov/publications/Forestry%20Leaflets/WQ01.pdf</a>

## Appendix A. Cont.

Policy Directive	Year	Internet Address
<b>United States—State-level—Wisconsin</b>		
S. NR 115, Wis. Admin. Code—Wisconsin's Shoreland Management Program	1980*	<a href="http://docs.legis.wisconsin.gov/code/admin_code/nr/115.pdf">http://docs.legis.wisconsin.gov/code/admin_code/nr/115.pdf</a>
S. 30, Wis. Stats.—Navigable Waters, Harbors and Navigation	1983*	<a href="http://docs.legis.wisconsin.gov/statutes/statutes/30.pdf">http://docs.legis.wisconsin.gov/statutes/statutes/30.pdf</a>
S. NR 103, Wis. Admin. Code—Water Quality Standards for Wetlands	1991*	<a href="http://docs.legis.wisconsin.gov/code/admin_code/nr/103.pdf">http://docs.legis.wisconsin.gov/code/admin_code/nr/103.pdf</a>
S. 157.70, Wis. Stats.—Burial sites preservation	1993*	<a href="http://docs.legis.wisconsin.gov/code/admin_code/hs/1.pdf">http://docs.legis.wisconsin.gov/code/admin_code/hs/1.pdf</a>
S. 29, Wis. Stats.—Wild Animals and Plants	1997*	<a href="http://docs.legis.wisconsin.gov/statutes/statutes/29.pdf">http://docs.legis.wisconsin.gov/statutes/statutes/29.pdf</a>
S. 26, Wis. Stats.—Protection of Forest Lands and Forest Productivity	2001*	<a href="https://docs.legis.wisconsin.gov/statutes/statutes/26">https://docs.legis.wisconsin.gov/statutes/statutes/26</a>
S. NR 27, Wis. Admin. Code—Endangered and Threatened Species	2004*	<a href="http://dnr.wi.gov/org/land/er/wlist/wi_et_laws_list.pdf">http://dnr.wi.gov/org/land/er/wlist/wi_et_laws_list.pdf</a>
S. NR 125, Wis. Admin Code—Generally accepted forest management practices, including the Wisconsin Forest Management Guidelines (PUB-FR-226)	2011	<a href="http://dnr.wi.gov/forestry/publications/guidelines/toc.htm">http://dnr.wi.gov/forestry/publications/guidelines/toc.htm</a>

\* Including amendments and/or revisions

© 2012 by the authors; licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/3.0/>).