Changing Timberland Ownership in the Northern Forest and Implications for Biodiversity

> John M. Hagan Lloyd C. Irland Andrew A. Whitman



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John M. Hagan¹ Lloyd C. Irland² Andrew A. Whitman¹

¹Forest Conservation Program Manomet Center for Conservation Sciences 14 Maine St., Suite 305 Brunswick, ME 04011 (207)721-9040 jmhagan@ime.net

> ² The Irland Group 174 Lord Rd. Wayne, ME 04284 202-685-9613 <u>irland@aol.com</u>

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Executive Summary

In recent years vertically-integrated forest products companies have been selling their timberlands throughout the U.S. Nowhere has this change been so dramatic as in the Northeast. Our goal with this project was to quantitatively document timberland ownership change, with special emphasis on implications to biodiversity in the Northern Forest Region of the northeastern U.S. Using a variety of data sources and personal interviews, we constructed a database of timberland transactions that occurred in the region between 1980 and 2005 to assess landowner change. We classified all landowners into 14 landowner types (e.g. Industry, Financial Investors, Public, Non-profit, etc.). We assessed the implications of landownership change for biodiversity through a survey of landowners (n=36 respondents). The major conclusions of this study are:

Between 1980 and 2005, approximately 23.8 million acres changed hands in the Northern Forest Region, an area nearly equal to the entire 26 million acre region. Many acres were sold multiple times; some ownerships were relatively stable, such as Old-line Family lands.

The shift from industrial forest ownership to various new owner types is nearly complete. In Maine in 1994, forest industry owned about 60% (4.6 million acres) of the large tracts (>5000 ac) of timberland and financial investors owned about 3%. By May, 2005, financial investors owned about one-third of the large forest tracts and industry owned only 15.5% (1.8 million acres, mostly in a single ownership).

Several landowner types have emerged or expanded in the last 10 years, including various Financial Investors (e.g., Timber Investment Management Organizations), Real Estate Investment Trusts, timber barons (often former or current logging contractors), private individuals (e.g., "kingdom" buyers), and non-profit conservation organizations.

Unlike the former forest products industry landowners, which concluded that forest certification was necessary to maintain a social license to cut wood, many of the new owners are less inclined to participate in a social dialogue on sustainable forestry, such as forest certification.

Despite the intense turnover of timberland in the last decade, most forest blocks have remained intact. However, there is a trend toward more forest owners with smaller parcel sizes. For example, the 2.3 million-acre Great Northern Paper ownership of 1989 now resides among at least 15 different landowners. We may be entering an incipient stage of ownership fragmentation where the fringes (e.g., township-sized parcels) are flaking off to financially motivated buyers.

Industry had the strongest overall biodiversity practice scores in our survey. Some new owners excel in biodiversity conservation, but many have weaker biodiversity practices than industry. At the regional scale, overall biodiversity practices have likely declined in quality as a result of the loss of forest industry land ownership. Many of the new landowners declined to participate in our biodiversity practices survey.

Landowners that were certified sustainable under either SFI or FSC had significantly stronger biodiversity practices than landowners not certified. There was no difference between FSC and SFI in terms of overall biodiversity practice scores.

Forestland under a no-development easement *did not* have stronger biodiversity practices than forestland with no easement at all. Forestland with no-development easements *and some stipulations for biodiversity protection* did have stronger biodiversity practices than forestland with no easement.

Most landowner types report timber management activity consistent with sustainable timber harvesting. However, two new owner types, Contractors and New Timber Barons may manage their forests at or beyond sustained yield (of wood). Industry reported high levels of even-aged and intensive management but also reported harvest levels in line with timber growth. Financial investors reported low levels of even-age management but harvest levels in line with timber growth. Non-profits and public landowners used little even-age management and harvested much less than growth.

This study revealed that we lack data sources on landowner biodiversity policy or the condition of biodiversity on the ground. The public relies almost completely on sustainable forestry certification for assurance that biodiversity is being maintained, but even certification does not provide quantitative information about biodiversity. Thus, one of the major goals of sustainable forestry (maintenance of biodiversity) is nearly impossible to quantify or assess reliably.

We submit the following recommendations as a result of this study: (1) development of new data streams that can help assess forest biodiversity at the state and landowner (or township) level, (2) development of incentives to encourage landowners to participate in sustainable forestry certification, and (3) development of state-level processes for annual tracking of large parcel transactions.

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Introduction

This recently, the traditional owners of large tracts of private timberland in the U.S. had been vertically-integrated forest products companies (VIFPCs, e.g., Champion, International Paper, Georgia Pacific) that owned mills and needed a timberland base to keep the mills constantly supplied with fiber. In the 1980s and 1990s, a complex mix of global and financial circumstances converged to precipitate dramatic changes in timberland ownership in the United States (Binkley et al. 1996, Zhang 1997, Sampson et al. 2000, Block and Sample 2001).

As a result, in the 1990s, VIFPCs began to sell their timberland holdings at a remarkable rate, while in most cases retaining ownership of their mills. In 1981 there were about 58 million acres of publicly-traded forest industry land in the U.S.; in 2005 there were less than 21 million acres, a 60% reduction (Seneca Creek Associates 2005). Most of the new timberland buyers have been various financial investment organizations, such as John Hancock Insurance, TIAA-CREF, CalPERS, and many others (Block and Sample 2001). Private timberland in the U.S. provides a huge array of social, economic, and environmental values to society. Forest stakeholders are beginning to ask—"Will the new owners be responsible stewards of the forest? Will forest values be protected?"

The causes for the shift in forest ownership are complex (Mendelsohn 2002). The shift was initiated by the 1974 Federal Employee Retirement Income Security Act, which encouraged institutional investors holding pension plans to diversify from a reliance on traditional fixed-income investments to other assets, such as stocks, real estate, and timberland (Binkley et al. 1996). Financial investors also realized that forests grow over time and function like both a factory and warehouse (Forest Systems 2003). Forests presented an excellent way to preserve capital because trees could be cut when market prices were favorable or "stored" on the stump to accrue additional value if not.

Also in the 1990s there was a growing perception in forest industry that the stock market undervalued the timberland assets of forest products companies (Zinkhan 1988). Companies began to realize they could take an undervalued asset (their timberland), convert it to sorely needed cash (i.e., sell it), all the while continuing to produce paper and other products through long-term wood supply contracts with the new landowners (T. Colgan, pers. comm.). Another major factor was the Tax Reform Act of 1986, which nearly doubled the effective tax rate for corporate timberland (Seneca Creek Associates 2005). Taxes are much lower for individuals, investment partnerships, pension plans, and Real Estate Investment Trusts. Consequently, it made financial sense for forest products companies to sell their timberland to entities with a much lower tax burden on the exact same land asset (in many cases the industrial owners created the new entities themselves), so long as access to the wood fiber was assured. At the same time, global pressure to produce forest products more cheaply was prompting the U.S. forest products industry to invest in wood production in other countries with more favorable tax and environmental regulations (Franklin and Johnson 2004).

This shift in timberland ownership from VIPFCs to other owner types has been extensive throughout the U.S., but perhaps nowhere as dramatic as in the Northern Forest region of the northeastern states (Figure 1). In this region the new timberland owners are diverse: timber investment management organizations (TIMOs), real estate investment trusts (REITs), new timber "barons" (mostly former logging contractors), individuals or families with varied recreational and/or financial interests, developers, and land conservation organizations.

In the mid 1990s, as this ownership change was just beginning to unfold in the Northeast, Binkley et al. (1996) hypothesized that the new financial investors would result in improved forest stewardship. With timberland decoupled from the fickle and cyclic appetites of pulp and paper mills, the new *non-industrial* timberland owners could concentrate



Figure 1. The 26-million acre Northern Forest region of the northeastern U.S.

on maximizing long-term return on investment, which *should* result in sound silviculture focused on growing the best trees for the highest-paying markets. However, in 2005 it is far from clear whether Binkley et al.'s hypothesis is true. In the late 1990s, nearly all industrial forest products companies were voluntarily enrolling in sustainable forestry certification programs with third-party (independent) evaluations. By contrast, many of the new owners, for various reasons, feel less compelled to engage in social discourse on sustainability. The story is extremely complex; it can be difficult, even misleading, to try and generalize about the new landowners with respect to social, economic, or environmental values.

This study was conducted for the National Commission on Science for Sustainable Forestry (<u>www.ncssf.org</u>). Our goal was to understand the implications of timberland ownership changes in the Northern Forest Region to biodiversity. Has Binkley's hypothesis that forest stewardship would improve born true, or are we entering a more uncertain future about forest biodiversity in the Northern Forest region? We hope to shed light on this question in this report.

Overall Approach

To understand how landowner change has affected biodiversity policy, we first needed to understand how forestland ownership has changed in the region. The first section of this report (Part 1) describes forest ownership patterns of change. Second, we needed to understand how different landowner types are addressing biodiversity conservation. The second section of the report (Part 2) provides an assessment of landowner forest management practices and policies for biodiversity. Through a combination of understanding how landownership has changed and how different landowner types address biodiversity conservation, we can begin to understand the implications of the divesture of timberland by the forest industry.

Part 1 – Timberland Ownership Changes

Approach

Because we were interested in understanding change in forest ownership among types of owners (e.g., forest industry, financial investors), we first developed a landowner classification (Table 1). Our classification system contained 14 types. With this classification system we could describe which owner types gained forestland and which lost forestland. Most landowners could easily be assigned to a type. However, some landowners were difficult to classify. For example, J.D. Irving, a New Brunswick-based company, could have been classified as either Industry or Old-line family. When such conflicts occurred, we selected the single type that we felt best described the landowner. Irving was classified as Industry because it manufactures a variety of forest products from its timberland, even though it is a family-owned business.

We took two approaches to describing landownership change. First, we developed a comprehensive database of land transactions in the Northern Forest region between 1980 and 2005. We developed the database through our own knowledge, interviews with many knowledgeable individuals throughout the region, and from miscellaneous grey literature sources. We limited our database to transactions that involved at least 5,000 acres. Our transactions database is probably >90% complete, and is sufficient to describe major changes in landownership in the region.

The first approach to describing landowner change describes "flow" of acres from one landowner type to another. Single land units can (and did) flow multiple times among owners. Flow describes accumulated purchases and sales over time, but cannot provide "snapshots" of how much land is owned by each landowner type at any given point in time. Therefore, we used a second approach that took advantage of a GIS-based landowner dataset for Maine maintained by James W. Sewall Co. (Old Town, ME). Sewall provided us with ownership information from 1994, 1999, and 2005. All major landowners (>5,000 ac owned) were classified by landowner type (Table 1) for each time slice. We then summed acreages of different landowner types at the three points in time. The Maine ownership was current as of April, 2005.

Part 1 Results: Timberland Transactions in the Northern Forest 1980-2005

We documented 253 timberland transactions in the Northern Forest region between 1980 and 2005 that involved 5,000 ac or more. These transactions summed to a total of 23,798,300 acres, an area almost equal to the entire size of the 26-million acre Northern Forest region. However, much of the area sold was sold repeatedly during this time interval, so it should not be concluded that the entire Northern Forest has changed ownership since 1980. Many ownerships remained stable during this time, especially Old-line Family owners such as the Pingree Family Associates (~ one million acres) and Baskahegan (Milliken family, ~100,000 ac) in Maine.

 Table 1. Landowner types and descriptions used in this study. Many landowners did not fit cleanly into a single category. In such cases, we categorized the landowner according to our judgment of the best-fit category.

	Туре	Description
1	Contractor	Landowner that is also a logging contractor; one who owns their own logging equipment and manages their own logging crews. Contractors acquire land primarily to provide a landbase for their logging crews.
2	Developer	Forest landowners that have a primary interest in subdividing/developing the forestland for non- forest uses. Developers often have a combined timber and development interest; categorization can be difficult.
3	Federal	Federal forest owner (U.S. government). These include Department of Defense, National Park Service, USDA Forest Service, etc.
4	Financial Investors (e.g. Timber Investment Management Organizations)	A single organization or a collection of individuals or organizations that purchase timberland as a financial investment. This owner type does not own mills (in our classification system).
5	Individual or Family	Individuals or families that are relatively new landowners in Maine (1 st generation owners). Usually the primary interest is having a large tract of forest available for private use. Timber management may or may not be a dominant landuse.
6	Industry	A forestland owner that also owns either a paper mill or pulp mill and/or sawmill.
7	New Timber Baron	Small in-state family-owned companies (often logging contractors) that are acquiring large tracts of forest land as a long- or short-term investment.
8	Non Profit	An organization with primarily an environmental conservation interest in the land (e.g., The Nature Conservancy, The Trust for Public Land, Appalachian Mountain Club), and private individuals with a clearly-articulated conservation interest.
9	Old-line Family	A non-industrial forestland owner that goes back two or more generations.
10	Other	Other landowners that do not fit cleanly into any category, such as 'Resorts.'
11	Public (state)	State-owned land. Forest could be a state park (e.g., Baxter State Park) or land managed for mul- tiple-use, including timber (e.g., Maine Bureau of Parks and Lands).
12	Real-estate Investment Trust (REIT)	A specialized type of business that is able to pass earnings directly to shareholders, thus avoiding double taxation at the corporate level. All profit must be re-invested in real estate (e.g., timber-land).
13	Tribal	Native-American owners (e.g., Penobscot and Passamaquoddy tribes in Maine).
14	Various	Category used when the number of buyers(sellers) is too large to list separately, or the parcels are too small to warrant tracking separately, e.g. the Bayroot (former MeadWestvaco land) Highest-and-Best-Use sales presently underway.

By far, most of the acres bought and sold in the Northern Forest since 1980 have been in Maine (Table 2). About 84% of the roughly 23.8 million acres sold in the Northern Forest were in Maine alone. Even by proportion of entire state land area, Maine by far had the greatest degree of forestland sales.

The mean timberland sale was 94,064 acres. The median $(50^{\text{th}} \text{ percentile})$ area was 17,000 acres, indicating that

large-area transactions tended to inflate the mean. The single largest transaction was 2.3 million acres in Maine and involved the sale of all Great Northern Paper lands to Georgia-Pacific in 1990. Two years later, nearly this entire landbase was again sold to Bowater (each sale represents a separate transaction in our database).

To look at forestland sale trends over time, we divided the 25-year period into 5-year segments. The number of

State	# Transactions	Acres	Percent of Total	As % of total State area
Maine	150	20,091,000	84.4%	88.7%
New Hampshire	33	1,777,500	7.5%	29.7%
New York	49	1,423,300	6.0%	4.1%
Vermont	21	506,500	2.1%	8.2%
Total	253	23,798,300	100.0%	

Table 2. Timberland acres sold between 1980 and 2005, by state.

timberland transactions per time interval has grown dramatically in the last 25 years (Figure 2a). Nearly one-half (45%) of all the forest land transactions that have taken place in the last 25 years have taken place in the last 5 years (Figure 2a). The total acres sold has steadily increased over time, with the most acres being sold during the last 5 years (Figure 2b). However, the pace of sales will probably slow in the next few years because most major Industry parcels have now been sold relatively recently, and there is only one large parcel still owned by the forest industry (~1.2 million acres owned by J.D. Irving, Ltd.). Now with financial investors as the major landowners, the frequency of turnover may again increase in 5 or 10 years as some timberland investments reach their contractual maturity. Over the last 25 years the median transaction size has remained fairly stable between 10,000-20,000 acres (Figure 2c). The median size was abnormally high in the 1980-1984 period because there were a few very large transactions during that time. The mean transaction size has fluctuated between about 60,000 acres and 180,000 acres, depending on the number of large transactions in any 5-year period (Figure 2d). A few extremely large transactions tend to pull the mean transaction size up.

Transactions by pathway

We documented 70 different transaction pathways (seller type to buyer type) of a possible 196 pathways (i.e., 14 x 14 owner types). Of the 70 pathways observed, just 10



Figure 2. Summary statistics of timberland transactions in 5-yr increments between 1980 and 2005.



Figure 3. The "destination" of Industry timberland sales from 1990 – 2005 in 5-year increments. In the early 1990s, most timberland remained in Industry ownership. Since 2000, most Industry timberland has been sold to Financial Investors.

pathways represented 91% (21,395,300 ac) of the total acres sold (Table 3). Over the 25-year window, approximately one-half of all acres sold were from Industry to Industry (Table 2). The next largest transaction pathway was from Industry to Financial Investors, representing 25% of all acres sold.

The cumulative flow of acres over the full 25-year time span fails to reveal the dramatic shift in transaction pathway that emerged in the last 5-15 years. In 1990-1994, 89% of the Industry timberland sold was sold back to Industry (Figure 3). Between 1995 and 1999, 50% of Industry land was sold back to Industry, and in the last 5.5 years (2000 - April 2005) years, 35% of Industry lands sales went to other Industry landowners while the majority (56%) of Industry lands was sold to various Financial Investors. Even data compiled for the past 5 years masks the ongoing, rapid sale of Industry timberland to other landowner types. *Just since our study got underway in 2004, 2.46 million acres of timberland have been sold in the Northern Forest;* 1.76 million acres (72%) were from Industry to Financial Investors, reflecting the accelerating divestment of timberland by Industry.

Examples of Landowner Change

One of the public's greatest concerns about landowner change in the region pertains to the breakup of large singleowner parcels. When timberland is in large, single-owner blocks, the threat of conversion from timberland use to some other land use (such as house development) has been low. This fact may be changing with Plum Creek Timber Company's recent proposal to develop a small percentage of its roughly 900,000 acres in Maine. Certainly, the ability of government agencies and citizen groups to understand the status and future fate of forest values is facilitated when there are a relatively small number of large forestland owners. In addition, landowners of some types are perceived to be more socially engaged (and responsive) than some of the newer landowner types (e.g., Financial Investors, Contractors, Individuals), so both ownership size and landowner type figure prominently in the minds of forest stakeholders

Table 3. Top 10 pathways of timberland sales between 1980 and 2005, and total acreage sold.

	Transaction Pathway	# Transactions	Total acres	% of Total ac
1	Industry to Industry	30	11,610,500	49.2%
2	Industry to Financial Investor	36	5,899,500	25.0%
3	Industry to REIT	1	905,000	3.8%
4	Financial Investor to Industry	10	864,000	3.7%
5	Other to Financial Investor	5	534,000	2.3%
6	Financial Investor to Financial Investor	19	489,300	2.1%
7	Industry to Non profit	5	315,000	1.3%
8	Financial Investor to Contractor	27	302,000	1.3%
9	Old-line family to Financial Investor	4	248,000	1.1%
10	Industry to New Timber Baron	8	228,000	1.0%



We examined the fate of two large forest landowners to demonstrate patterns of land ownership change that have been taking place in the region. The first example is the breakup of Great Northern Paper (GNP), which was the largest single Industry owner in the region in 1980. The

second example is Hancock Timber Resources Group, a Financial Investor, which entered the region in 1993 and was gone by 2005.

Box 1. Below is a selective listing illustrating the different patterns of ownership tenure in the region. Family-owned forestland has been the most stable ownership type during the last 25 years. J.D. Irving, although classified in our study as Industry because of its paper and wood manufacturing facilities, is actually a family-owned company, which may contribute to their long-term stability. Irving, here since the 1940's, has expanded its ownership substantially. Many owners came and went – they existed briefly during the 1980-2005 period and then vanished. Also striking is the number of longtime owners, part of the region's history, that vanished from the land-owner rolls after 1980 and especially after about 1990. Finally, the current landowner roster includes large areas owned by organizations entirely new to the Northeast.

Survivors

J. M. Huber Pingree Heirs (managed by Seven Islands) Many clients of Prentiss & Carlisle Dunn Heirs Baskahegan Co. Hancock Land Co. Robbins Lumber Co. J.D. Irving

Longtime Owners - Now Gone

Diamond International International Paper Brown Company Boise Cascade S.D. Warren Sherman Lumber Lyons Falls Yorkshire Domtar LaValley Whitney estate

Came and Went

Goldsmith/DOFI James River Hancock Timber Resources Group Fraser, Inc. Champion Mead MeadWestvaco Daishowa Enron White Birch Inexcon Kruger/Daaquam SAPPI Ltd The Timber Company

New Owners during Period -- Still here

Timbervest GMO Brascan Canfor Wagner Partnerships The Nature Conservancy Appalachian Mountain Club Various Tribes Timberstar Clayton Lake Timberlands Plum Creek Timber Company New Timber Barons: Haynes, Gardner, Carrier, and others

Great Northern Paper

Great Northern Paper Company was the largest private landowner in the Northeastern U.S. for several decades, having completed assembly of its 2.3-million-acre ownership by the late 1950s. The company originated in Maine, but became engaged in operations across the East as a result of several mergers, which created Great Northern Nekoosa. By the late 1980s, the Maine lands supported two large paper mills and a large sawmill. Until the late 1980s, the ownership was stable, except for rearrangements due to land trades, the State's recovery of the "Public Lots," and the Indian land claims settlement. By the late 1980s, the loss of volume and growth to the spruce budworm outbreak had limited the land's cash generating potential, and the mills began to feel the effects of increasing regional and international competition in groundwood paper grades.

In a 1990 merger, Great Northern Paper was acquired by Georgia Pacific (GP) (Figure 4). As GP had no other operations in newsprint and groundwood papers, it soon sold the Maine operations with all the land to Bowater, Inc., a leading newsprint producer. In 1998, Bowater began to sell off the landholdings in pieces, and the breakup of the original 2.3 million acres began in earnest (Figure 4). About one million acres were sold to J.D. Irving, Ltd., a privately held New Brunswick firm that already owned about 600,000 acres in northern Maine. Another ~656,000 acres were sold to investor partnerships managed by Wagner Forest Management, Ltd. Principal investors in these acres were the McDonald interests of Alabama. These lands were later involved in the West Branch conservation project, which involved a 47,000 acre fee sale to the state in 2003 and a 282,000 acre conservation easement completed in 2004.

Also in 1998, Bowater sold the two paper mills in Millinocket and East Millinocket, and its remaining lands to Inexcon-Maine, Inc., a private group, which operated the business under the old name of Great Northern. Several conservation land transactions followed as part of efforts to sustain the company financially. In early 2003, Inexcon-Maine went bankrupt. Fraser, Inc, a unit of Brascan International of Toronto, bought the operations out of bankruptcy and placed the timberland into a TIMO-like structure, Katahdin Timberlands, which manages the remaining 300,000 acres (282,000 forested). Hence, Brascan is technically not an industrial owner anymore. Of this acreage, 200,000 acres were covered by a conservation easement held by The Nature Conservancy.

Perhaps 1.9 million acres or more of the original GNP lands remain in working forest, under new ownership. About 100,000 acres are in outright reserves, and about 500,000 acres are covered by conservation easements.

In summary, this single original Great Northern Paper ownership of 2.3 million acres now resides among at least 15 owners and involved at least 19 timberland transactions since 1980 (Figure 4). About 60% of the original GNP land is now owned by Financial Investors; about 28% is owned by Industry (J.D. Irving, Ltd.). This example demonstrates the complexity and the shift in landowner type in the region.

Hancock Timber Resources Group

A second example of ownership change involves Hancock Timber Resources Group (HTRG, a division of John Hancock Insurance Company), a Financial Investor in our classification system. In the late 1980s, HTRG took an early lead in the emerging TIMO (Timber Investment Management Organization) market. Until the early 1990s, all of HTRG's acquisitions had been in the U.S. South and Pacific Northwest. HTRG began acquiring land in the Northeast in 1993. The timing coincided with a period of increasing interest in monetizing timberland on the part of industry owners.

In a period of 4 years (1993-1996), HTRG amassed a holding of about 683,000 acres across the Northern Forest. About two-thirds of the acres were purchased from Industry landowners in just five transactions (Figure 5). The largest single purchase was 238,000 acres in 1993 from James River, a company that generally avoided timberland ownership but had made an exception in the Northeast. Some of the James River land had previously been owned by Diamond. Two firms essentially in liquidation, Lyons Falls and Crown Vantage, sold HTRG large tracts in New Hampshire and New York. The other one-third of HTRG's purchase was from three Old-line Family owners, one in New York and two in Maine. The average acquisition size was 85,000 acres. Thus, HTRG amassed its holding from just two landowner types, Industry and Old-line Family (Figure 5).



HTRG began selling its timberland in 1995, even before it had completed its purchases in the region. As of 2005, HTRG had sold all of the 683,000 acres it had acquired in the mid 1990s. Although purchased from only two landowner types, the land has now been dispersed among 11 different landowner types (Figure 5). Only 5% of HTRG timberland went back into Industry; most (28%) turned over to other Financial Investors (Figure 5). New Timber Barons and Contractors (taken together) purchased almost 200,000 acres from HTRG (about 29%), virtually all in Maine and New Hampshire. The ability and willingness of New Timber Barons and Contractors to mobilize capital for long-term ownership is a new development in the Maine ownership picture. Plum Creek Timber Company, a REIT, acquired 81,000 acres (12%) of the HTRG timberland in New Hampshire and Maine. The nonprofit (conservation) sector acquired a significant part of the lands sold, 15.6% or 103,000 acres. Direct sales to state, federal and local governments were very small.

For a brief period, HTRG was, therefore, one of the leading forestland owners in the region. Its role as a landowner in the region lasted about 11 years, a story of accumulating a larger portfolio that may never be repeated again as the ownership becomes more divided and as land prices rise further. Is the roughly decade tenure of HTRG in the region a predictor of what other TIMO's will do? Unlike the Great Northern Paper example above, many of the ownerships of HTRG were moderately fragmented when purchased; the unbundling of this ownership does not necessarily imply spatial fragmentation of contiguous parcels. Several large tracts were sold intact: the New York Yorkshire lands sold intact to GMO Investments (72,000 ac) and the former Great Northern Paper lands in the Jackman, Maine area (~53,000 ac.) were resold to John Malone (an Individual owner). However, the HTRG example does demonstrate how *management* of the forest can become fragmented as the landbase becomes divided among many different landowners, with many different financial and/or conservation goals. Some may have better biodiversity policies, and some worse, than HTRG.

Part 1 Results: Land ownership Change in Maine 1994-2005

The forestland transactions database we compiled provides information about flow of acres among landowner types, but it did allow an assessment of how many acres of timberland were owned by different landowner types at any point in time. An analogy might be derived from the stock market; trading might be heavy on a given day (flow of shares), but the S&P 500 can end up unchanged (i.e., acres within forestland ownership types remain unchanged). The landowner database for Maine that we obtained from James W. Sewall Co. (Old Town, ME) allowed us to calculate the

Table 4. Maine timberland ownership by landowner type in 1994, 1999, and 2005 (source, J.W. Sewall Co., Old Town, Maine). The table is complete through April, 2005.

	199	4	1999		2005		
Landowner Type	acres	% of total	acres	% of total	acres	% of total	
Contractor	76,911	0.7%	106,891	0.9%	159,833	1.4%	
Developer	169,421	1.5%	191,481	1.7%	101,026	0.9%	
Federal	201,860	1.7%	196,722	1.7%	206,490	1.8%	
Financial Investor	371,719	3.2%	1,543,456	13.7%	3,818,596	32.6%	
Industry	6,909,725	59.2%	4,602,108	40.7%	1,818,082	15.5%	
Individual/Family	-	0.0%	8,312	0.1%	105,613	0.9%	
Non profit	30,437	0.3%	250,110	2.2%	352,179	3.0%	
New timber baron	26,398	0.2%	31,543	0.3%	435,694	3.7%	
Old-line family	2,489,683	21.3%	2,412,233	21.3%	2,447,012	20.9%	
Other	71,600	0.6%	42,253	0.4%	67,750	0.6%	
Public (state)	897,947	7.7%	697,394	6.2%	1,023,136	8.7%	
REIT	27,883	0.2%	916,086	8.1%	876,049	7.5%	
Tribal	253,019	2.2%	253,143	2.2%	243,246	2.1%	
Unknown	140,262	1.2%	51,480	0.5%	68,477	0.6%	
Total	11,666,865		11,303,212		11,723,183		

degree of change in timberland ownership by landowner type at three points in time (1994, 1999, and 2005). Because 84% of all acres sold in the last 25 years were in Maine, the Maine GIS dataset provides an excellent description of the fate of forest industry landholdings in the region.

In 1994, Industry represented the largest single landowner type, with about 59% of the 11.7 million acres of Maine classified as "major owners" (>5000 ac)(Table 4). Old-line Family was the second largest owner type, with about 21% of the area. These two landowner types functioned in a similar fashion in that both appeared to be interested in long-term forest management. In 1994, Financial Investors only owned 3.2% of this area.

By 2005, Industry had decreased to 15.5% and Financial Investors had increased their ownership to almost 33% of the area (Table 4). A single large REIT (Plum Creek Timber Company) arrived on the scene in 1997, and now owns about 7.5% of the area (Table 4). New Timber Barons increased their ownership by 16-fold between 1994 and 2005, now owning approximately 435,000 acres, or 3.7% of the area. Logging contractors increased their holdings by about 2-fold during this time. Non-profit conservation groups went from 30,437 ac in 1994 to 352,179 ac in 2005, almost a 12-fold increase in ownership. Grouping several of the new owner types together (Financial Investors, Developers, Contractors, New Timber Barons, REITs), they now own about 5.2 million acres of timberland, or about 50% of the total area of our focus in Maine (Figures 6, 7).

Using the Maine GIS data we examined whether ownership size was changing as a result of the many forest sales in the last 11 years. There was a noticeable increase in the number of forestland owners (> 5000 ac) and a decrease in the mean ownership size since 1999 (Figure 8). The average ownership size is still fairly large (~118,000 ac), but the drop since 1999 is suggestive of increasing fragmentation of ownership. This means that management of the forest will be more fragmented and diverse. That could have either *positive or negative* implications for biodiversity. The key is understanding the forest practices of the various owner types (next section).



Figure 6. The number of acres owned by Industry (red) and by various newer forest owner types combined (blue) in Maine between 1994 and 2005.

Part II - Biodiversity Practices and Landowner Type

Approach

We had two primary objectives for this section: (1) to understand whether different landowner types had different levels of biodiversity practices (and if so, which types had strong or weak practices), and (2) to understand how sustainable forestry certification might be related to a landowner's biodiversity practices.

To assess biodiversity practices of landowners, we developed a structured biodiversity policy survey (available from the authors on request). The survey was comprised of questions about timber management strategies on the parcel and the landowner's policies and practices related to forest biodiversity. Survey questions were organized into nine general areas: (1) ownership description, (2) silvicultural and harvest practices, (3) timber growth and harvest, (4) landowner's ecological assessment and monitoring, (5) use of water quality best management practices, (6) use of forest structure best management practices, (7) species and habitat management, (8) staff training and development, and (9) use of conservation easements. The survey instrument took between 30 and 60 minutes to complete. Most surveys were conducted by phone, but some were filled out and returned by mail. A promise of anonymity was given to all respondents/landowners. Our results, then, are conditioned by the fact that management practices and policies are self-reported by the responding landowner or manager.

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Figure 7. Map of Maine timberland ownership by owner type in 1994 and 2005. See Table 1 for a description of owner types. (GIS data from J.W. Sewall Co., Old Town, Maine).

The results from each survey were translated into a scoring system for quantitative analysis. The scoring system



Figure 8. Number of forestland owners (blue line) and mean parcel size (red line) for Maine landowners that owned ≥ 5000 acres between 1994 and 2005. (data from J.W. Sewall Co. Old Town, Maine).

contained two major subject categories: (1) parcel/ management characteristics, and (2) biodiversity practices. The parcel/management category described the landowners' forest characteristics (parcel size), management strategy (e.g., even-age vs. uneven-aged strategy), and whether a conservation easement was attached to the parcel. The Biodiversity Practices category focused on landowners' biodiversity practices and policies to protect, maintain, and/or enhance biodiversity. The Biodiversity Practices category was divided into nine Subject Areas:

- 1. Biodiversity monitoring/assessment
- 2. Staff biodiversity training
- 3. Forest structure
- 4. Habitat management
- 5. Aquatic/riparian system management
- 6. Rare species and rare habitat
- 7. Landscape management
- 8. Late-successional forest management
- 9. Game species

Each Subject Area contained three to six numerically scored *indicators* (Appendix A). Overall, we developed 37 indicators for the nine Subject Areas. Some of the indicators were used in more than one Subject Area because they were relevant to more than one Subject Area. The indicators reflected forest policies and best management recommendations generated by regional experts (Flatebo et at. 1999, Moesswilde 2004, New Hampshire Forest Sustainability Standards Work Team 1997).

To aid in interpreting the scores among Biodiversity Practices Subject Areas, all Indicators were scaled so that the maximum possible score for a Subject Area was 10 (Appendix A). The Subject Area Score was used in all analyses. Higher scores indicated that a landowner had multiple and/or aggressive policies to manage for the specific Biodiversity Subject Area. We also computed an OVERALL Biodiversity Score by taking the mean of all nine Subject Area Scores. All respondents were categorized by Landowner Type and by whether they were certified sustainable by either FSC or SFI for subsequent analysis.

Sample Population

We drew a sample of landowners from our landowner transactions database (see previous section). We randomly selected landowners from New York (n=15), New Hampshire and Vermont combined (n=15), and Maine (n=29). Parcels, rather than whole ownerships, were selected as the sample unit because single landowners can have different management goals for different land parcels, especially if a multi-state owner.

We conducted the surveys between January and June, 2005. To ensure that our sample contained landowners in the major landowner types (see Table 1), we stratified the sample by landowner type (Contractors, Large Private Investors, New Timber Barons, Financial Investors, Industry/Oldline Family, Public landowners, and Non-profits (conservation). We combined Old-line Family with Industry because we expected that Industry and Old-line Family would score similarly for biodiversity policies. In this combined group four respondents were Industry and one was Old-line Family. We were not able to sample all 14 landowner types represented in Table 1; we concentrated our effort on the most important types in relation to recent landowner change.

Analyses

We used a simple one-way Analysis of Variance (ANOVA) to detect differences among landowner types or between certified and non-certified landowners for parcel/management characteristics and for Biodiversity Practices Subject Area scores (SAS 2001). To determine whether there were overall differences among landowner types with respect to all nine Biodiversity Practices Subject Areas taken together, we used principal components analysis (PCA) (McCune and Medford 1999). PCA integrates the information contained in multiple variables (e.g., all nine Subject Area Scores) into one or two "derived" variables that preserve the information contained within all the original variables. We plotted the respondents' derived scores (PCA Axis 1 and Axis 2) to visually present differences in biodiversity practices among landowner types. We also used PCA Axis 1 scores to test for differences in biodiversity Subject Areas between certified and non-certified landowners.

Table 5. Landowner types, survey sample sizes, and response rates to Landowner Biodiversity Practices Questionnaire.

Landowner Type	Number of Survey Attempts	Number of Responses	Response Rate
Public	8	7	88%
Non-profits	10	6	60%
Industry & Old-line Family ¹	7	5	71%
Financial Investors	18	9	50%
Contractors	7	4	57%
New Timber Barons	8	5	63%
Total	59	36	61%

¹ Old-line family and Industry were combined

Table 6. Number of survey respondents, mean values (±SE) for Parcel/Management characteristics and Biodiversity Practices Subject Areas for different landowner types. Mean values with different letter superscripts were significantly different (P<0.05) among landowner types.

	Landowner Type						
	Contractors	New Timber Barons	Financial Investors	Industry/ Old-line Family	Public	Non-profit	
Number of survey respondents	5	6	7	5	8	5	
Parcel/Management Characteristics							
 Parcel size (x1,000 acres) Even-age management (% of parcel) Intensive management (% of parcel sprayed with herbicide, planted, and/or pre-commercially thinned) Harvest rate¹ 	$10.2 \pm 5.8 \\ 78 \pm 43.7^{a} \\ 1.0 \pm 2.2^{a} \\ 2.4 \pm 0.2^{a}$	$\begin{array}{c} 24.0 \pm 10.3 \\ 74.2 \pm 26.5^{a} \\ 2.5 \pm 2.7^{a} \end{array}$ $1.4 \pm 0.6^{a} \end{array}$	$19.9 \pm 33.4 \\ 26.4 \pm 45.3^{ab} \\ 2.9 \pm 5.7^{ab} \\ 2.2 \pm 0.4^{a}$	$222.7 \pm 425.9 \\82 \pm 16.4^{a} \\7.0 \pm 8.4^{a} \\1.6 \pm 0.4^{a}$	$\begin{array}{c} 11.4 \pm 9.0 \\ 26.3 \pm 36.4^{ab} \\ 0.6 \pm 1.8^{ab} \end{array}$ 0 ± 0^{b}	$\begin{array}{c} 24.8 \pm 9.6 \\ 0.0 \pm 0.0^{\rm b} \\ 0.0 \pm 0.0^{\rm b} \\ 0.0 \pm 0.0^{\rm b} \end{array}$	
Biodiversity Subject Areas							
 Biodiversity staff training/development Biodiversity monitoring/assessment Forest structure Habitat management Aquatic/riparian system management Rare species & rare habitat management Landscape management Late-successional forest management Game species management 	$\begin{array}{c} 5.2 \pm 1.0^{ab} \\ 6.9 \pm 0.6^{a} \\ 3.9 \pm 0.0 \\ 4.3 \pm 0.7^{a} \\ 9.7 \pm 0.4^{a} \\ 5.3 \pm 0.5^{ab} \\ 3.3 \pm 0.0^{a} \\ 1.4 \pm 1.5^{a} \\ 6.3 \pm 3.6^{ab} \end{array}$	$\begin{array}{c} 6.1 \pm 1.4^{\rm b} \\ 4.1 \pm 2.1^{\rm b} \\ 4.8 \pm 1.1 \\ 4.3 \pm 1.0^{\rm a} \\ 6.5 \pm 1.0^{\rm b} \\ 3.6 \pm 2.0^{\rm a} \\ 3.9 \pm 0.9^{\rm a} \\ 3.0 \pm 2.9^{\rm a} \\ 8.1 \pm 0.7^{\rm b} \end{array}$	$\begin{array}{c} 3.7 \pm 1.3^{a} \\ 7.8 \pm 1.7^{a} \\ 4.1 \pm 3.2 \\ 5.4 \pm 1.7^{ac} \\ 6.9 \pm 1.5^{b} \\ 7.6 \pm 2.0^{bc} \\ 4.0 \pm 1.9^{a} \\ 2.4 \pm 2.5^{a} \\ 2.6 \pm 3.5^{ac} \end{array}$	$\begin{array}{c} 6.7 \pm 1.7^{b} \\ 9.4 \pm 0.6^{a} \\ 7.0 \pm 3.0 \\ 8.5 \pm 0.7^{b} \\ 9.3 \pm 1.6^{ac} \\ 9.3 \pm 0.0^{c} \\ 9.3 \pm 1.5^{b} \\ 7.6 \pm 2.6^{b} \\ 7.7 \pm 0.9^{b} \end{array}$	$\begin{array}{l} 7.4 \pm 1.1^{b} \\ 7.9 \pm 1.4^{a} \\ 5.6 \pm 2.3 \\ 7.8 \pm 0.9^{b} \\ 8.2 \pm 1.1^{ac} \\ 8.5 \pm 0.6^{c} \\ 4.0 \pm 2.8^{a} \\ 7.7 \pm 1.9^{b} \\ 8.7 \pm 1.5^{b} \end{array}$	$\begin{array}{c} 6.4 \pm 1.7^{b} \\ 7.5 \pm 1.1^{a} \\ 6.0 \pm 3.9 \\ 7.3 \pm 1.5^{bc} \\ 7.1 \pm 1.7^{bc} \\ 8.4 \pm 2.1^{c} \\ 6.7 \pm 2.4^{ab} \\ 8.5 \pm 1.6^{b} \\ 7.0 \pm 5.1^{bc} \end{array}$	
OVERALL Biodiversity Score (landowner type mean)	5.2 ± 0.4^{a}	4.9 ± 0.7^{a}	5.0 ± 1.5^{a}	$8.3\pm0.9^{\rm b}$	$7.3\pm0.9^{\rm b}$	$7.2 \pm 1.6^{\mathrm{b}}$	

 $(0 = a \text{ lot less than growth } [<85\%], 1 = \text{less than growth } [85-<95\%], 2 = \text{roughly equal to growth } [\sim100\%], or 3 = \text{greater than growth}$

Part 2 Results: Biodiversity Practices

Survey Response Rate

The response rate was 50% or greater for all ownership types (Table 5). We had the most difficulty getting certain types of Financial Investors to respond, especially large single private investors (or their land management representative). We made additional but unsuccessful attempts to get several Financial Investors to participate in this survey. Although we had a relatively large sample of landowners (n=9) from the Financial Investor category, we were concerned that our data may overestimate the biodiversity practices for this category because so many declined to participate, perhaps those with weak policies.

Parcel and Management Characteristics by Landowner Type

Industry and Financial Investors had the largest average **parcel size** (some up to about one million acres), but there was no significant difference among landowners in parcel size because of the large variability within each group (Table 6).

There were significant differences among the landowner types in the percent of the parcel in **even-aged management** (Table 6). Of the Non-profits sampled, none had any acres in even-aged management. Public and Financial Investors also had a low percentage of land in even-aged management. Industry/Old-line Family, New Timber Barons, and Contractors had a high percentage of their parcels in even-aged management. **Intensive Management** (the percent of the parcel sprayed with herbicides, planted, or pre-commercially thinned) was notably highest for Industry/Old-line Family (Table 6) (the Old-line Family respondent was an outlier compared to the four Industry respondents for this indicator). Non-profits had no acres in intensive management, and Public landowners had a very low percentage of acres in intensive management. Caution is warranted in interpretation of this indicator; low levels of intensive management (as defined above) can occur for either highly conservationoriented landowners or for landowners with short-term, financially-driven interests. High levels of intensive management typically indicate a long-term interest in the forest resource.

Mean **harvest rate** was lowest for Non-profit and Public landowners (both averaged much less harvest than growth) (Table 6). Contractors and New Timber Barons had the highest average harvest rates (equal to, or greater than growth), and Industry/Old-line Family and Financial Investors had intermediate harvest rates (harvest close to growth rate).

Biodiversity Practices by Landowner Type

The overall Biodiversity Practices Score (the mean of all nine Biodiversity Practices Subject Area scores) was highest for Industry/Old-line Family ($\overline{X} = 8.3$), indicating that these landowners had the strongest biodiversity practices (Table 6). Public ($\overline{X} = 7.3$), and Non-profit ($\overline{X} = 7.2$) landowners also had a high overall Biodiversity score. Contractors ($\overline{X} = 5.2$), New Timber Barons ($\overline{X} = 4.9$), and Financial Investors ($\overline{X} = 5.0$) had weaker overall Biodiversity Practices scores.

All of the individual Biodiversity Practices Subject Areas had significantly different scores among landowner types except for the forest structure Subject Area (Table 6). A summary of the differences among landowner type for the different Biodiversity Practices Subject Areas follows (and see Table 6):

- (1) Public owners ($\overline{X} = 7.4$) had the highest score for the **biodiversity staff training Subject Area** (Table 6). Financial Investors ($\overline{X} = 3.7$) and Contractors ($\overline{X} = 5.2$) had the lowest scores.
- (2) Industry/Old-line Family had the highest score for **biodi**versity monitoring and assessment ($\overline{X} = 9.4$); New Timber Barons ($\overline{X} = 4.1$) were notably weaker than other landowner types.

- (3) Industry/Old-line Family had the highest score for forest structure (X
 = 7.0); Contractors had the lowest score (X
 = 3.9).
- (4) Industry/Old-line Family had the highest score for **habi**tat management ($\overline{X} = 8.5$); Contractors ($\overline{X} = 4.3$) and New Timber Barons ($\overline{X} = 4.3$) had the lowest scores.
- (5) Contractors had the highest score for **aquatic/riparian protection** ($\overline{X} = 9.7$). This may result from the fact that logging contractors are the ones who actually implement stream Best Management Practices. All landowners scored relatively high for aquatic/riparian protection, probably because clean water is a major public value, and because aquatic riparian Best Management Practices are very well established in policy.
- (6) Industry/Old-line Family scored highest for rare species and rare habitats ($\overline{X} = 9.3$), better than Public ($\overline{X} = 8.5$) and Non-profit ($\overline{X} = 8.4$) owners. New Timber Barons scored low ($\overline{X} = 3.6$).
- (7) By far, Industry/Old-line Family exceeded other landowner types for **landscape-level management** ($\overline{X} = 9.3$). Non-profits were a distant second ($\overline{X} = 6.7$). Interestingly, Public owners scored low for landscape-level management ($\overline{X} = 4.0$), and similar to Contractors, New Timber Barons, and Financial Investors.
- (8) Non-profits scored highest (X = 8.5) for latesuccessional forest management, followed closely by Public (X = 7.7) and Industry/Old-line Family (X = 7.6)



Figure 9. A composite index of all 9 Biodiversity Practices scores by landowner type using Principal Components Analysis. Scores toward the left of the graph indicate stronger biodiversity policies; scores toward the right indicate weaker biodiversity policies. Note that the Industry/Old-line Family survey respondents clustered toward the left end to left end of the graph; New Timber Barons tended to have poor biodiversity practices (right). Financial Investors were relatively variable in their biodiversity practices.

Table 7.	Principal Components Analysis (PCA) Axis 1 correlations with each of the nine Biodiversity Practices Subject Area scores (n=36
	respondents). The stronger the correlation the more the Subject Area contributed to differences among the 36 respondents. A
	correlation was considered statistically significant if the correlation P -value was < 0.05 (in bold type).

Biodiversity Subject Area	PCA Axis 1 correlations
1. Biodiversity staff training/development	-0.408
2. Biodiversity monitoring/assessment	-0.709
3. Forest structure	-0.697
4. Habitat management	-0.938
5. Aquatic/riparian systems management	-0.417
6. Rare species & rare habitat management	-0.821
7. Landscape management	-0.665
8. Late-successional forest management	-0.853
9. Game species management	-0.468

owners. Contractors ($\overline{X} = 1.4$), Financial Investors ($\overline{X} = 2.4$), and New Timber Barons ($\overline{X} = 3.0$) scored very low for this Subject Area.

(9) Industry/Old-line Family scored highest for game species management (X = 8.3), followed closely by New Timber Barons (X = 8.1). Financial Investors scored very low (X = 2.6) for this Subject Area.

In contrast to the univariate approach above (a separate analysis for each Subject Area), the multivariate PCA approach generates a new dataset (called PCA scores) that integrates and retains information from all nine Biodiversity Practices scores simultaneously. Each respondent has a PCA 1 and a PCA 2 score as a result of this analysis. The advantage of this approach is that it can reveal statistical differences among landowner types for *all* nine Biodiversity Practices Subject Areas in a single analysis.

The 36 survey respondents clustered moderately well in the PCA plot by landowner type (Figure 9), and there was a statistically significant difference among landowner types for PCA Axis 1 scores (df=5, P<0.001). The most notable clusters were the Industry/Old-line Family landowners on the left end of the graph, indicating a *stronger* suite of biodiversity practices, and New Timber Barons on the right side of the graph, representing *weaker* biodiversity practices. Interestingly, the tight cluster of Industry/Old-line Family supported our decision to lump these two landowner types.

Based on the PCA "loadings" (the correlations of the nine original Biodiversity Subject Area scores to the integrated PCA Axis 1 scores), we concluded that six of the Biodiversity Practices Subject Areas contributed primarily to differences among respondents (biodiversity monitoring/assessment, forest structure, habitat management, rare species and rare habitats, landscape management, and latesuccessional forest management) (Table 7). Because all of these original Biodiversity Practices Subject Area scores were negatively correlated to PCA Axis 1, respondents with *lower* PCA Axis 1 scores had *stronger* biodiversity practices. The PCA results mirror the results of the univariate analysis of Biodiversity Subject Area scores: biodiversity policies were strongest with Industry/Old-line Family, followed by Public and Conservation landowners, and then by Financial Investors, New Timber Barons, and Contractors.

Biodiversity Practices and Sustainable Forestry Certification

Landowners that were certified (n=16) under either the SFI or FSC system had a significantly higher mean overall Biodiversity Score ($\overline{X} = 7.3$) than non-certified (n=20) landowners ($\overline{X} = 5.6$) (P < 0.001) (Table 8). Three of the nine Biodiversity Subject Area scores were significantly different between certified and non-certified landowners (Table 8); in all cases of significance, the certified landowner group had a higher score than the non-certified group. We found no difference in the overall Biodiversity Score between SFI-only ($\overline{X} = 6.7$, n=6) and FSC-only ($\overline{X} = 7.5$, n=6) landowners (t-test, P=0.40), although the sample size for this comparison was low.

Using the multivariate PCA 1 scores, which integrated all nine Biodiversity Subject Area scores simultaneously, landowners certified as sustainable had significantly stronger biodiversity practices than non-certified landowners (Figure 10, df=1, P<0.001). There was no statistical difference Table 8. Number of survey respondents, mean (\pm SE) for Parcel/Management characteristics and Biodiversity Practices Subject Areas, by certification status. Mean values with different letter superscripts were significantly different (P<0.05).

	Certified Sustainable?			
	Yes	No		
Number of responses	16	20		
Parcel/Management Characteristics				
 Parcel size (x1,000 acres) Even-age management (% of parcel) Intensive management (% of parcel sprayed with herbicide, planted, and/or precommercially thinned) Harvest rate¹ 	$\begin{array}{c} 158.8 \pm 318.1^{a} \\ 51.9 \pm 10.8 \\ 3.4 \pm 1.6 \\ 1.3 \pm 0.3 \end{array}$	18.6 ± 10.0^{b} 40.5 ± 10.0 1.3 ± 0.5 1.1 ± 0.3		
Biodiversity Practices Subject Areas				
 Biodiversity staff training/development Biodiversity monitoring/assessment Forest structure Habitat management Rare species & rare habitat management Aquatic/riparian systems management Landscape management Late-successional forest management Game species management 	$6.2\pm2.1 \\ 8.3\pm1.5 \\ 6.4\pm2.5 \\ 7.4\pm1.5^{a} \\ 8.7\pm1.3^{a} \\ 8.2\pm1.4 \\ 6.1\pm3.1 \\ 6.6\pm3.0^{a} \\ 7.0\pm3.2 \\ \hline$	5.7±1.6 6.4±2.1 4.2±2.4 5.4±1.8 ^b 5.9±2.5 ^b 7.6±1.8 4.12 3.9±3.5 ^b 6.5±3.7		
OVERALL Biodiversity score (landowner type mean)	7.2±1.5ª	5.5±1.5 ^b		

¹ (0 = a lot less than growth [<85%], 1 = less than growth [85-<95%], 2 = roughly equal to growth [~100%], or 3 = greater than growth)

among SFI-only (n=6), FSC-only (n=6), and SFI & FSC (n=4) certified landowners for PCA 1 scores.

Certified landowners had significantly larger parcel sizes than non-certified landowners, but there were no differences between certified and non-certified landowners for % of parcel in even-aged management, % of parcel in intensive management, or harvest rate (Table 8). Taken together, these results suggest that biodiversity policies are different between certified and non-certified landowners, but timber harvesting strategies are not (on average).

Using only the Maine GIS data from James W. Sewall Co., we estimated that 6.73 million acres of forestland in Maine were certified under either SFI or FSC in 2005. There was a relationship between landowner type and whether or not the ownership was certified sustainable (Table 9). For example, no Contractors, Developers, New Timber Barons, Tribal, or Federal lands were certified sustainable. About one-third of Financial Investors were certified, but these owners owned about 70% of total Financial Investor acres. About one-fifth of Industry owners were certified, but this represented about 72% of all Industry acres (the largest remaining industry owner, J.D. Irving, is certified). Two of 20 Old-line Family owners were certified, representing about 42% of all Old-line Family acres in Maine. The number of acres certified in Maine has not changed appreciably as a result of the recent changes in ownership described in this report. Most (but not all) Financial Investors that purchased land from Industry continued to subscribe to sustainable forestry certification. If Industry continued to own all the land it owned in 1994, the number of acres certified would probably be 10-15% higher than it is now. Table 9. The number of landowners (and acreage) by landowner type in Maine in 2005, and the number of owners (and acreage) certified and not certified under either SFI or FSC. Only landowners owning at least 5000 acres are included. Landowner data are from James W. Sewall Co., Old Town, Maine.

			Cer	tified ¹	Not Cert	ified	Percent of	Percent of Owner Type	
Landowner Type	Number of Owners	Total Acres	Owners	Acres	Owners	Acres	Owner Type Certified ²	acres Certified	
Contractors	15	159,458	0	-	15	159,458	0.0%	0.0%	
Developers	11	101,026	0	-	11	101,026	0.0%	0.0%	
Federal	4	206,490	0	-	4	206,490	0.0%	0.0%	
Financial Investors	12	3,818,596	4	2,683,341	8	1,135,255	33.3%	70.3%	
Industry	14	1,818,082	3	1,314,868	11	503,214	21.4%	72.3%	
Individual or Family	4	105,613	0	-	4	105,613	0.0%	0.0%	
Non-profit	8	352,179	1	257,277	7	94,902	12.5%	73.1%	
New Timber Barons	3	435,694	0	-	3	435,694	0.0%	0.0%	
Old-Line Family	20	2,447,012	2	1,024,238	18	1,422,774	10.0%	41.9%	
Other	6	68,126	0	-	6	68,126	0.0%	0.0%	
Public (state)	10	1,023,136	1	584,679	9	438,457	10.0%	57.1%	
Real Estate Investment Trust	2	876,049	1	865,413	1	10,636	50.0%		
Tribal	2	243,246	0	-	2	243,246	0.0%	0.0%	
Unknown	1	68,477	0	-	1	68,477	0.0%	0.0%	
TOTAL	111	11,723,183	12	6,729,816	99	4,993,367			

¹ certified under either SFI or FSC.

² number of owners certified divided by total number of owners.

Biodiversity Practices and Conservation Easements

Each parcel in the survey was classified as having (1) no conservation easement, (2) a no-development conservation easement, or (3) a no-development conservation easement with biodiversity requirements.

There was a marginally significant difference in the strength of Overall Biodiversity Practices Scores among the three easement categories (P=0.06, Figure 11). There was no difference in overall Biodiversity Practices Scores between parcels without easements ($\overline{X} = 6.3$) and parcels with no-development easements ($\overline{X} = 5.7$). That is, parcels with no-development easements did not result in improved practices for biodiversity. Parcels with no-development easements ($\overline{X} = 7.7$) provided for the strongest biodiversity practices; significantly greater than parcels with no-development restrictions only.



Figure 9. A composite index of all 9 Biodiversity Practices scores by certification status using Principal Components Analysis. Scores toward the left of the graph indicate stronger biodiversity policies; scores toward the right indicate weaker biodiversity policies. Certified landowners (red symbols) fall significantly farther to the left than non-certified landowners. There were no significant differences among the FSC-only, SFI-only, and dual FSC-SFI respondents in this composite biodiversity practices score.



Figure 11. The mean Overall Biodiversity Practices Score for forest parcels with no conservation easement, with nodevelopment (only) easements, and with nodevelopment and Biodiversity provisions specified in the easement.

Conclusions

Landowner Change

Landowner change in the Northern Forest Region has been rapid and dramatic, especially in the last 10 years. Just since our study began in mid-2004, nearly 2.5 million acres of timberland have been sold in the Northern Forest, mostly in Maine; 72% of this was from Industry to Financial Investors. We have seen the virtual disappearance of verticallyintegrated forest products companies as timberland owners in the region.

The new landowners represent a wide diversity of interests, including conservation interests, but the majority of new landowners are various types of Financial Investors. Most traditional forest products companies had a long-range view of forest management and sustainability. It is not always clear that financial investors have this same view. John Hancock Timber Resources Group, a financial investor and pioneer of institutional timberland ownership, appeared and then disappeared from the region as a timberland owner within a span of about 11 years. GMO Investments, one of the largest new Financial Investors in the Northern Forest, purchased approximately one million acres of former International Paper timberland in 2004. GMO expects to sell the timberland in about 2014 because this timeline was a legal part of the financial instrument used to purchase the land on behalf of its investors (E. Greger, pers. comm.). Though

Financial Investors may have a short tenure, it is not correct to assume they will mismanage the forest or cut heavily. GMO carefully tracks the value of its standing timber in relation to current timber markets. Timberland investment often involves sophisticated financial analysis that integrates current and predicted future timber market values so as to optimize financial return at the end of the investment period; heavy cutting may not be the best pathway to achieve this financial goal (E. Greger, pers. comm.).

Financial Investors are diverse, much more diverse in interest and management strategy than the former industrial landowners. Some Financial Investors are taxable (large investors), while others are nontaxable (pension funds/endowments). Some Timber Investment Management Organizations (TIMOs, a type of Financial Investor) are based on assurances to investors of steady current cash returns. Others are structured to provide returns primarily at the end of the holding period. Most financial investors try to maintain flexibility as to the duration of the investment, but they typically hold timberland for periods of 8-12 years, depending on the needs of sponsors and current market conditions. There are examples of land holdings being sold due to decisions by sponsors to sell prior to the completion of the planned investment period.

Partly as a result of this heterogeneity of interests, some Financial Investors participate in forest certification and some do not. Some contribute to research on biodiversity and forest management and some do not. Some have an interest in development and some do not; almost all landowners (except traditional industrial landowners, which are nearly gone from the region) are alert to the potential financial value of selling development rights; others are more interested in retaining their development rights for potential future opportunities. In essence, the recent turnover in landownership has led to less predictability in the future of the forest.

A case can be made that the recent flux in timberland ownership has been good for conservation (T. Colgan, pers. comm.). Many conservation opportunities, especially easement purchases, have been made possible because financial investors are keenly aware of *any* financial asset they may have, and are more willing to sell a conservation easement on their timberland than former industrial landowners. On the other hand, the rapid turnover in ownership can also lead to less sustainable harvest practices, depending on the new landowner. Even some Financial Investors that have sold conservation easements *do not* subscribe to sustainable forestry certification programs. Forest management for biodiversity and other conservation values is more variable now than when the land was owned mostly by forest industry.

The most public example of the diverse interests of the new landowners is provided by Plum Creek Timber Company's proposed development of some of its timberlands around the Moosehead Lake area of Maine. Plum Creek Timber Company is technically a Real Estate Investment Trust, though it has a primary interest in long-term timber management. Even this one example depicts the conservation paradox of landowner changes that have taken place in the region. Although Plum Creek has proposed to sell 975 house lots and develop 3 resorts on about 9,300 ac of current timberland, it also proposes to place 417,000 acres in a longterm conservation/working forest agreement. The debate is intense about whether the net result of this proposal is good or bad for conservation interests.

For the most part (so far), large tracts of timberland have remained as intact ownerships, though the new owners have more varied interests. In some cases, fringes of large ownerships have been sold off to various new classes of timberland owners, e.g., Contractors, New Timber Barons, Individuals or Families, or even private conservation interests (The Nature Conservancy, Roxanne Quimby [a private investor in conservation and wildland]). Arguably, we are entering an incipient era of ownership fragmentation where the fringes, or small pieces (e.g., township-sized parcels), are flaking off to highly motivated buyers. With respect to conservation goals, sometimes these "flakes" result in positive change for conservation and sometimes in a conservation loss, especially when new owners are interested solely in the timber and development values and not interested in participating in sustainable forestry certification. These new owners may contribute further to parcel fragmentation and ultimately to forest fragmentation as forest cover is converted to non-forest landuses. For most of the Northern Forest, the near-term threat of forest fragmentation remains on the edges of this region and not the interior (Stein et al. 2005).

A hidden conservation cost of all the forestland turnover in the last decade pertains to debt burden of some of the new owners. Some landowners purchase timberland by borrowing money. In order to pay down their new debt, the landowner must cut the land hard. The next time the land is sold, the new owner incurs yet another debt, which must also be repaid. When money must be borrowed to purchase timberland, the trees usually bear the burden of paying down the debt, which can lead to depletion of the standing timber resource. This is less of a problem with many financial investors, which tend to be cash rich and do not need to borrow money to purchase timberland.

Another interesting phenomenon is beginning to emerge in association with timberland turnover-escalating timberland prices. A New Timber Baron paid approximately \$1,024 per acre for about 24,000 acres of timberland adjacent to Baxter State Park in 2004 (Austin 2004). The traditional price of timberland in Maine has been between \$200 and \$350 per acre for the last decade. What prompted this new landowner to pay about four times the going rate for timberland? Has the conservation easement market led to a new type of land speculation? Some new owners may have reasoned that they can pay a premium for timberland, cut most of the wood, and still sell the land, or sell an easement on the land, to anxious conservation interests. Easement buyers have been most interested in preventing future development. That is, the current conservation condition of the forest may be of secondary interest to the easement buyer, and therefore factor weakly, or not at all, in the purchase or easement price. In short, the conservation market, being as hot as it has been, may be contributing to inflation of timberland values.

We suggest that conservation easement prices be adjusted up or down to reflect the current condition of biodiversity on the parcel. That means that the current biodiversity condition should be evaluated, which can be relatively straightforward if the owner has up-to-date timber stand maps. Landowners interested in selling conservation easements should understand that there may be a market value in protecting biodiversity, and a concomitant cost associated with putting biodiversity at risk. *However, the responsibility is incumbent on the easement buyer to establish this market force.*

Biodiversity Practices

Based on our survey, many of the new landowner types do not have biodiversity practices and policies as strong as Industry landowners, which are now virtually gone from the region. Because of their size, history of land ownership, and central corporate administrative structure, industrial forest owners have felt compelled to engage in social discourse about sustainability. As a result, industry developed a rather structured approach to addressing biodiversity through forest certification. Many of the new landowners are not motivated (or simply cannot afford) to participate in sustainable forestry certification. Also, because many of the new owners have not been involved in the development of forest certification systems, as has industry, they may be relatively new to the social responsibilities commonly associated with owning timberland.

Other studies comparing behavior of different landowner types had similar findings. In Maine, Investor landowners were rated to have lower use, and less effective use, of water quality Best Management Practices compared to other landowner types in Maine (Maine Forest Service 2005). Industry owners were rated to have performance that was the same as public landowners. In Maine, contractors were much more likely to conduct liquidation harvests than other landowner types (Maine Forest Service 1999). In Minnesota, industrial landowners less frequently left large logs (a biodiversity value) on site than public landowners and small non-industrial private landowners; but industry more frequently left retention patches (leave tree clumps) than public and non-industrial landowners, possibly to compensate for the more intensive harvest levels (Phillips 2001). In Mississippi, TIMOs and industrial landowners were determined to manage their land similarly (Rogers and Munn 2002).

Three newer landowner types, Financial Investors, Contractors, and New Timber Barons, tend to manage timberland more aggressively and with fewer biodiversity considerations than other landowner types. Overall, their management strategies most probably entail greater risk and less protection for forest biodiversity than other landowner types. Of these three landowner types, Financial Investors are more variable and diverse and have made purchases that make them the largest owner type. It is not clear why some Financial Investors choose to participate in sustainable forestry and others do not.

Another approach to conserving biodiversity on private lands is the use of conservation easements (deGooyer and Capen 2004, Byers and Ponte 2005). Our study suggests that parcels with conservation easements do not have stronger biodiversity practices than parcels without conservation easements. The purchase of development rights alone does not guarantee better biodiversity practices, though almost certainly biodiversity will benefit in the long term. Easements that included provisions for biodiversity conservation had significantly stronger biodiversity practices than easements without biodiversity provisions. We suggest that all easements buyers who have an interest in biodiversity provisions in the easement language.

The existence of strong or weak biodiversity practices, however, is only one part of the conservation story. Another key factor is how aggressively the forest is cut and/or how intensively it is managed. A landowner with weak biodiversity practices may actually be *better* for biodiversity if they harvest well below annual timber growth. Some landowners that harvest and manage more aggressively (e.g., Industry) also tend to have stronger biodiversity policies, possibly in part to maintain their social license to cut wood. It is not clear why some new owner types, such as New Timber Barons and Financial Investors, do not appear to need such a social license. This may change as the public begins to fully appreciate exactly who the new timberland owners in the region are.

We have developed an objective, systematic scoring system that can be used to evaluate, compare, and contrast biodiversity practices for forest ownerships. However, our scoring system is limited for at least two reasons. First, Biodiversity Subject Area indicators are self-reported by the landowner or manager; we depended on honest and accurate answers from the landowner or manager. Second, our evaluation did not assess the level of implementation of policies on the ground, or the effectiveness of those policies at reducing risk to forest biodiversity. It is impossible to accurately assess the true biodiversity practices of different landowner types without some quantitative information about what is happening on the ground (e.g., how much of the ownership is in different forest types and age classes, how much forest is in a late-successional or old-growth condition, what is the level of habitat fragmentation in the landscape). Such quantitative biodiversity information is generally lacking in any public data source. Even forest certification systems do not publicly report such quantitative information; the public must rely on the good judgment of thirdparty auditors to make sure that no component of biodiversity is being compromised on the ground. More rigorous reporting of on-the-ground biodiversity-related conditions and trends would enable a more accurate assessment of landowner contributions to sustaining biodiversity. A scoring system that includes on-the-ground measurements (i.e., Condition Indicators, see Hagan and Whitman in press) would greatly improve our ability to understand forestland contributions to biodiversity.

Unfortunately, such public reporting is unlikely due to tensions related to public influence or control of private land. At present, encouraging all major landowners to participate in certification programs may be the best available approach to reducing risk to forest biodiversity. Encouragement might come in the form of tax incentives or simply greater access to wood and paper markets of certified landowners. Certification programs will very likely improve in the quality of their public reporting over the coming years (Anon. 2002, Maine Certification Advisory Committee, 2005)

Recommendations

Because the implications of landownership change in the Northern Forest for forest biodiversity are currently so difficult to evaluate, even with a focused study such as this, we offer the following recommendations:

- New data streams should be developed that track 1. and monitor biodiversity (and other) values. Quantitative, science-based, and practical (affordable) biodiversity indicators need to be developed at state levels and at the forest-owner level. The latter could be implemented through forest certification. Monitoring of use and effectiveness of water quality Best Management Practices by state agencies is becoming more common. This monitoring could be expanded to include monitoring of the use and effectiveness of other biodiversity practices across different landowner types. Satellite imagery may provide a means of monitoring timber harvesting (Sader et al. 2005), which can be correlated with biodiversity condition. Monitoring would allow forest stakeholders, policy makers, scientists, and the public to: (1) identify and promote effective biodiversity practices, (2) determine whether any landowner type may pose a high threat to forest biodiversity, and (3) develop appropriate policy programs to promote the use of effective biodiversity practices.
- Strategies that engage the new owner types in a social discourse on sustainable forestry need to be developed. Though many of the larger landowners (>100,000 acres) subscribe to forest certification, many owners do not, especially many of the new owners. The new landowners need to be engaged on issues of public interest, such as biodiversity. Incentives for subscribing to certification are needed. Regulatory approaches are a last option but may be needed if many landowners choose not to participate in certification.
- Landownership change should be tracked throughout the region. Since the original Northern Forest Lands Study report, observers have been advocating better tracking of ownership change, yet little has been done. State governments or nonprofits would be logical candidates for this effort. Similar tracking should be instituted for conservation easements.

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Appendices

Appendix A: Biodiversity Practices Subject Areas and Indicators.



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FORESTLAND OWNERSHIP CHANGE

Appendix A: Biodiversity Subject Areas and indicators. Indicators within a Subject Area were summed to yield the Subject Area scores used for analysis. To standardize all Subject Area Scores on a scale of 1-10, each indicator score was multiplied by an Indicator Multiplier. Indicators within a Subject Area were given equal weighting.

1. Staff Biodiversity Training Scorecard (maximum Indicator value = 2.0) 0.7.21% (1) Landowner staff hours dedicated to biodiversity management (% of total staff hours). 0.7.21% (2) Landowner staff hours dedicated to biodiversity training (% of total staff hours). 0.2.89% (3) Landowner staff annual participation in conferences, symposia, or other meetings where biodiversity as the main topic (no = 0, yes = 1). 0.1 (4) Andowner staff person monitors the literature (scientific or other) for new information about biodiversity (no = 0, yes = 1). 0.1 (5) Landowner has a trained wildlife biologist on staff (no = 0, yes = 1). 0.1 (1) Landowner staff uses GIS to monitor the number of acres in different forest types and age classes (no = 0, yes = 1). (1) 0-1 (2) Year of last timber inventory on parcel (none=0, <1996 = 1, or > 1995 = 2) (2) 0-2 (3) Number of special ecological sites (old-growth stands, rare communities, agle nests, rare plant sites, vernal pools, deer yards, etc.) in a landowner catalog system (4) 0-1 (4) Parcel has been surveyed for biological special places by a professional ecologist (no = 0, yes = 1). (5) 0.1 (5) Field staff screen stands before harvesting for important biodiversity components, rare plants, or special habitats (no = 0, yes = 1). (6) 0-1 (5) Field staff screen stands before harvesting for important biodiversity components, rare plants, or special habitats (no = 0, yes = 1). (6) 0-1	0.277
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 (2) Year of last timber inventory on parcel (non=0, <1996 = 1, or > 1995 = 2) (2) 0-2 (3) Number of special ecological sites (old-growth stands, rare communities, eagle nests, rare plant sites, vernal pools, deer yards, etc.) in a landowner catalog system (4) Parcel has been surveyed for biological special places by a professional ecologist (no = 0, yes = 1). (5) Field staff screen stands before harvesting for important biodiversity components, rare plants, or special habitats (no = 0, yes = 1). (6) Active biodiversity research is underway on this specific parcel (no = 0, yes = 1). (7) Landowner's policies for managing wildlife trees (trees retained for conserving biodiversity) (0 = Does not manage for wildlife trees, 1 = Retains some wildlife trees in most harvest areas, 2 = leaves at least 4 wildlife trees > 6" per acre, 3 = Leaves at least 	1.67
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 (4) Parcel has been surveyed for biological special places by a professional ecologist (no = 0, yes = 1). (5) Field staff screen stands before harvesting for important biodiversity components, rare plants, or special habitats (no = 0, yes = 1). (6) Active biodiversity research is underway on this specific parcel (no = 0, yes = 1). (6) Active biodiversity research (maximum Indicator value = 3.33) (1) Landowner's policies for managing wildlife trees (trees retained for conserving biodiversity) (0 = Does not manage for wildlife trees, 1 = Retains some wildlife trees in most harvest areas, 2 = leaves at least 4 wildlife trees > 6" per acre, 3 = Leaves at least 	0.208
 (5) Field staff screen stands before harvesting for important biodiversity components, rare plants, or special habitats (no = 0, yes = 1). (6) Active biodiversity research is underway on this specific parcel (no = 0, yes = 1). (6) Active biodiversity research is underway on this specific parcel (no = 0, yes = 1). (7) Landowner's policies for managing wildlife trees (trees retained for conserving biodiversity) (0 = Does not manage for wildlife trees, 1 = Retains some wildlife trees in most harvest areas, 2 = leaves at least 4 wildlife trees > 6" per acre, 3 = Leaves at least 	1.67
 (6) Active biodiversity research is underway on this specific parcel (no = 0, yes = 1). (6) Active biodiversity research is underway on this specific parcel (no = 0, yes = 1). (6) 0-1 3. Forest Structure Management Scorecard (maximum Indicator value = 3.33) (1) Landowner's policies for managing wildlife trees (trees retained for conserving biodiversity) (0 = Does not manage for wildlife trees, 1 = Retains some wildlife trees in most harvest areas, 2 = leaves at least 4 wildlife trees > 6" per acre, 3 = Leaves at least 	1.67
 3. Forest Structure Management Scorecard (maximum Indicator value = 3.33) (1) Landowner's policies for managing wildlife trees (trees retained for conserving biodiversity) (0 = Does not manage for wildlife trees, 1 = Retains some wildlife trees in most harvest areas, 2 = leaves at least 4 wildlife trees > 6" per acre, 3 = Leaves at least 	1.67
 (1) Landowner's policies for managing wildlife trees (trees retained for conserving biodiversity) (0 = Does not manage for wildlife trees, 1 = Retains some wildlife trees in most harvest areas, 2 = leaves at least 4 wildlife trees > 6" per acre, 3 = Leaves at least 	
and wildlife tree > $24''$ DDII 9: 2 wildlife trees > $14''$ DDII non agree)	1.11
 (2) Landowner's policies managing large logs (> 12" DBH, >6 feet long) (0 = Does not specifically manage for large logs, 1 = Avoids damaging existing large logs and stumps, aim to leave logs on site and to return slash to forest, and 2 = (1) plus created large stage st logs in most harvest areas) 	1.665
 (3) Landowner's policies for patch retention (0 = Does not apply patch retention, 1= Applies patch retention to some harvest areas, 2 = frequently leaves 5% of harvest areas in retention patches, 3 = frequently leaves 10%+ of harvest areas in retention patches). 	1.11
4. Habitat Management Scorecard (maximum Indicator value = 1.66)	
(1) Landowner has a policy to protect rare habitats and/or rare or endangered species (0 = none, 1 = yes, insufficient detail to evaluate, 2 = survey, manage, and/or maintain	0.83
 (2) Landowner policy for maintaining early-successional forest for biodiversity (0 = 0-2 none, 1 = yes, insufficient detail to evaluate, 2 = actively maintain early-successional forest for biodiversity) 	0.83
 (3) Landowner policy for maintaining late-successional forest for biodiversity (0 = none, 1 = yes, insufficient detail to evaluate, 2 = actively maintain late-successional forest for biodiversity). 	0.83
 (4) Landowner policy to protect habitat for game species (0 = none, 1 = yes, insufficient 0-2 (4) detail to evaluate 2 = maintain habitat for deer and/or upland game birds. 	0.83
(5) Conservation easements on parcel ($0 = none$, $1 = easement with demanding restric-0-2$	0.83

	FORESTLAND OWNERSHIP CHANGE		
Biodiversity Practices Subject Areas (Indicators)		Indicator Range	Indicator Multiplier
(6)	tions on new development, and $2 = (1)$ plus provision for conservation forestry). Number of important habitats (e.g., old-growth stands, rare plant communities, and deer wintering areas) that are cataloged	0-3	0.55
5. Aquatic/	riparian Systems Management Scorecard (maximum Indicator value 2.0)		
(1)	Landowner policies for managing stream crossings ($0 = \text{does not use BMPs}$ at stream crossings, $1 = \text{uses a minimum number of BMPs}$, $2 = \text{practices meet current state BMPs}$, $3 = \text{practices exceed current state BMPs}$).	0-3	0.665
(2)	Landowner policies for managing logging roads (0 = does not use BMPs on logging roads, 1 = uses a minimum number of BMPs, 2 = practices meet current state BMPs, 3 = practices exceed current state BMPs).	0-3	0.665
(3)	Landowner policies for managing riparian zones ($0 = \text{does not use BMPs}$ in riparian zone, $1 = \text{uses a minimum number of BMPs}$, $2 = \text{practices meet current state BMPs}$, $3 = \text{practices exceed current state BMPs}$)	0-3	0.665
(4)	Landowner policies for managing headwater streams (0 = does not use BMPs for class 1 & 2 headwater streams, 1 = uses a minimum number of BMPs, 2 = practices meet current state BMPs 3 = practices exceed current state BMPs)	0-3	0.665
(5)	Landowner policies for managing vernal pools ($0 = \text{does not specifically manage vernal pools, } 1 = \text{identifies and usually avoid vernal pools when harvesting, } 2 = \text{identifies vernal pools, leaves a filter strip and shade, and rarely disturbs when harvesting, } 3= (1) or (2) plus landowner catalogs vernal pools.$	0-3	0.665
6. Rare Spe	cies & Rare Habitats Management Scorecard (maximum Indicator value = 2.5)		
(1)	Number of types of rare species (rare plant species and eagle nests) and rare habitats (old-growth stands and rare plant communities) cataloged	0-4	0.625
(2)	Effort to survey for rare species and rare habitats (0=none, 1 = screening stand be- fore harvesting for rare plant species and special habitats <u>or</u> surveying parcel for bio- logical special places by a professional ecologist, 2 = screening stand before harvest- ing for rare plant species and special habitats <u>and</u> surveying parcel for biological spe- cial places by a professional ecologist).	0-2	1.25
(3)	Landowner has a policy to protect rare habitats and/or rare or endangered species (0 = none, 1 = yes, insufficient detail to evaluate, 2 = survey, manage, and/or maintain rare habitats/species).	0-2	1.25
(4)	Rare species and rare habitat management system ($0 = \text{none}$, $1 = \text{policy to protect}$ rare habitats and rare species and {effort to survey rare species and rare habitats <u>or</u> catalog rare species and rare habitats}, $2 = \text{policy to protect}$, survey, and catalog rare habitats and rare species).	0-2	1.25
7. Landscap	e Management Scorecard (maximum Indicator value = 3.33)		
(1)	Landowner policy to maintain a specific distribution of forest age classes ($0 = none$, $1 = yes$, insufficient detail to evaluate, $2 = describes one or more specific policies to achieve goal)$	0-2	1.665
(2)	Landowner policy for minimizing habitat fragmentation and maintaining connectivity between mature stands ($0 = \text{none}$, $1 = \text{yes}$, insufficient detail to evaluate, $2 = \text{describes one or more specific policies to achieve goal}$).	0-2	1.665
(3)	Landowner landscape management system ($0 = lacks$ either landscape management policies or GIS system to track forest types and age classes, $1 = policy$ for <u>either</u> managing age classes or minimizing habitat fragmentation plus GIS system, $2 = policy$ for <u>both</u> managing age classes and minimizing habitat fragmentation plus GIS system).	0-2	1.665
8. Late-suc	cessional Forest Management Scorecard (maximum Indicator value = 2.5)		
(1)	Landowner policy for maintaining late-successional forest for biodiversity ($0 = none$, $1 = yes$, insufficient detail to evaluate, $2 = actively$ maintains late-successional forest for biodiversity).	0-2	1.25
(2)	Oldest age-class that the landowner actively manages/managed for on ownership (0 = mature [fully stocked stands, > 60' tall, >60% canopy closure, canopy trees typi-	0-2	1.25

FORESTLAND OWNERSHIP CHANGE					
Biodiversity Practices Subject Areas (Indicators)		Indicator Range	Indicator Multiplier		
(3) (4)	cally >=10" DBH], 1 = late-successional forest [have the same as mature stands except there are many canopy trees > 15" DBH], 2 = old-growth forest [many canopy trees reach life span for species, >200 yrs old for most forest types]. Parcel area in a system of ecological reserves (areas managed primarily for ecological purposes but may include light timber harvesting and recreational use) (percent) Landowner OG forest management system (0 = none, 1 = has catalog of old-growth stands and goal to maintain old-growth stands.	0-10 0-1	0.25 2.5		
9. Game Sp	ecies Management Scorecard (maximum Indicator value = 3.33)				
(1)	Landowner policy to protect habitat for game species ($0 = \text{none}$, $1 = \text{yes}$, insufficient detail to evaluate, $2 = \text{intentionally maintains habitat for deer and/or game birds}$).	0-2	1.67		
(2)	Landowner catalog of deer wintering areas $(0 = \text{none}, 1 = \text{yes})$	0-1	3.33		
(3)	Landowner game management system ($0 = \text{none}$, $1 = landowner catalogs deer wintering area and has policies to protect habitat for game species)$	0-1	3.33		

