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Capstone Research Paper

Policy Enactments of Ecologically Minded Timber Harvesting

Introduction

Previous timber harvesting practices were built upon the foundational conceptions of conservation and preservation. As all techniques modernize and become more efficient through time, so have forestry practices. Ecology, being the study of how organisms act between themselves, others, and their environment has, with modernization, become more applied to forestry practices worldwide beyond 1st world nations due to the study's benefits to the environment in question and those that benefit from the environment's products or existence.

Policy implementations of ecological forestry for forested natural resource scarcity and the subsequent effects on industries and total markets must be observed, understood, and taken into considerable question. Of course, as all new modes of modernization must be questioned, public acceptance of ecological forestry practices should be considered synergistically. With public acceptance, local involvement of natives and local peoples/governments affected will have the most benefit in managing the lands and their products. What lands to be forested with ecological approaches should be pastures or agricultural lands that have been abandoned or in general, lands that would benefit the most from being forested. To the next step, the forested stands will ecologically benefit most from a biodiverse composition being environmentally and

locally selected. With the final step in a plan, forms of management should have retention prescriptions chosen based on the environment and locals in question for public acceptance and product output alongside retention prescriptions for ecological capabilities, incorporating beneficial biological legacies into harvest prescriptions being important structures from the existing stand, intermediate treatments that enhance heterogeneity, allowing for appropriate recovery periods, and involving/endowing locals in forms/applications of management. If a business model is to be chosen, a private industry financed through federal and state subsidies while utilizing local involvement, application, and finance is possibly the most beneficial for either side of the industry. If not fully funded by the private sector, an industry organized through the public sector and coordinated globally is possible to reduce the rate of change for our climate and the rate of natural resource scarcities originating from forested lands. Nonetheless counterarguments do exist such as, could monoculture stands be more beneficial than biodiverse stands? As well as, why using management practices and standard formats aimed at land development and product output not fully in line with wildfire applications is not stable and/or dangerous.

Climate-Forestry on Industries and Commodities Market

As stated, ecological forestry policies should reflect an understanding, observation, and question on the future impacts that global climate change will have on the market of commodities. Specifically, natural resources from forests that are used by markets and industries such as paper with pulp and fiber (Repetto and Austin 2000). The pulp and paper industry whether they align with the ideal or not, will be affected by environmental risks of material significance often not evident in the affected companies' financial statements and are likely not incorporated in current market valuations (Repetto and Austin 2000). Statements offered by a

variety of companies consisted of, "[the company] does not anticipate that compliance with [environmental] statutes and regulations will have a material adverse effect on its competitive position since its competitors are subject to the same statutes and regulations to a relatively similar degree" (Repetto and Austin 2000). These costs will become present in the form of future material costs, energy costs, earnings, and balance sheets as paper and pulp are some of the most energy-intensive industries that rely on forest harvests and recycled paper for raw materials (Repetto and Austin 2000). If future climate policies charge for emissions this industry will see further charges as pulp and paper industries can and mostly emit a wide range of toxic and conventional pollutants to air, water, and land as well as contributing to solid waste streams and being identified with pollution and resource degradation open to regulation and litigation requiring allocations to investments and environmental control programs (Repetto and Austin 2000).

Of 13 companies analyzed, 3 are to expect a negative impact greater than 10 percent of their total market values, 4 are to expect a negative impact between 5-10 %, 5 are to expect a negative impact between 0-5 percent, and 1 company is to expect a positive impact of approximately 2.5 percent (Repetto and Austin 2000). Basic projections for U.S. fiber prices are upward with the biggest influence being domestic timber availability and environmental pressures as harvest rates are above the U.S. Forest Service's projections stating that nearly 15 percent of harvest rates are above their related forest growth rates (Repetto and Austin 2000). This leads to the conclusion that forestry practices need to evolve under ecology. Not only for harvest rates but for sustainable and most importantly, healthy harvest rates.

Public Acceptance of Ecological Forestry Practices

Ecology is not understood by all and consequently, when practice follows an ecological principle that benefits the environment as a whole but is observed as damaging the environment, public acceptance of such principles can be viewed as detrimental. A harvests acceptability derives from differences in designs and subsequent impacts for local biological constraints and policy choices (Ribe et al., 2009). In 2006, 42 percent of Tasmanian land was reserved similar to the PNW having a great deal of land owned by either federal or state agencies (Ribe et al., 2009).

Ecological forestry practices were enacted in both regions with both populations informed with pictures and information of the practice's actions and results to gauge the acceptance of clear fell, aggregated, dispersed, selective retention, and no-cut retention practices (Ribe et al., 2009). Aggregate retentions are less scenically intact than dispersed retentions due to clearcut openings between forest patches being uncut areas within harvest coups with all species and members kept, often viewed as checkered formations (Ribe et al., 2009). Dispersed retentions remove all trees of the prescribed area except a selected species in a random distribution (Ribe et al., 2009). Selective retentions leave behind forest structures being organisms and organic matter from before the prescription was applied (Ribe et al., 2009; Franklin et al., 2007). Some studies do conclude nevertheless that ecological retentions promote habitat fragmentation with negative results (Zavala and Oria 1995).

According to the results of the (Ribe et al., 2009) survey, the clear fell method had product output (such as board feet, sawlogs, etc.), economic value, worker safety, and wildfire risk reduced ranked good. Old growth restoration, soil/water quality, woodwork/honey, and species habitats were ranked low. The dispersed retention method had forest worker safety and old-growth restoration ranked good. Product output, economic value, wildfire risk reduced,

woodwork/honey, and a range of dwelling species habitat ranked medium. The only rank close to poor was soil and water quality. Selective retention and no-cut retention had product output, economic value, worker safety, and wildfire risk reduced ranked poor. Species habitats, soil/water quality, and old growth habitat were ranked good-medium. Finally, the 30/40 percent aggregate retention survey had forest worker safety and old growth restore ranked good. Product output, economic value, wildfire risk reduced, species habitats, and soil/water quality ranked good-medium. Goshawk habitat or old-growth habitat was the only ranking with medium-poor standing. By acceptability and goals of policy implementation referencing probable future market trends with a changing climate, 30/40 percent aggregate retention will most likely be the best and broad management choice at the flexibility of local people, government, and environmental choices. The choice of retention method will also ultimately come down to environmental factors of the area grown in and local's preference.

Involvement of Local Natives and Government in Forest Management

Local involvement arguably has benefits and detriments to place-based management practices. Place-based forestry programs are intended to involve local management and the distribution of forest resources (Peluso 1993). Political, economic, and cultural factors influence the structures of social forestry programs from national to local levels (Peluso 1993). Such as in Java, state structures on forest management do not ordinarily reallocate power to most forest communities, and applied 'scientific' production forestry methods excluding local people are usually confronted against organized protests of forest-dependent people (Peluso 1993). State-ran and supported forestry projects in Java rarely were seen through and often failed to alleviate poverty or improve degraded lands chosen for forestry often failing due to isolation from the populaces and existing infrastructure or internal structural flaws (Peluso 1993). Resisting

institutional and power relations on the local level is common while aiming more towards technologies and species mixtures occurring where field and administrative foresters trained in social forestry do not have the authority to do so (Peluso 1993). Objectives and processes in social forestry programs within social structures are likely to be renegotiated if local actors are not fully included (Peluso 1993).

On top of authority, mismanagement, and non-involvement of locals, the endowment of knowledge and appropriate technology is important to supply the local level of forestry practices. Modern science in the view of many locals cannot compete with the entrenched artefact, sociofact, and mantifact of their ways as there is a discerning difference between improving the quality of life for a people and the quality of the environment (Das 2006). As it was with the Jhumias when they attempted to terrace their cultivations, the Indian Council of Agricultural Research (ICAR) outlined drawbacks being the new settlements cut into socio-cultural life, the locals were not used to cultivating in the differing environment, and locals found production too low during the 1st year process of implementation. Most importantly, the production technology for terracing was not developed appropriately for the local region and there was a high scarcity of trained locals (Das 2006). Local issues with sustainable development must take into consideration population pressures on land, local social organizations, function as a part of the cultural landscape, conserve/manage local biodiversity linked with local natural resources, and land degradation issues (Das 2006). Additionally, food security based on a people's agricultural technologies, traditional foresters' perceptions, and practices of local communities on forest management, energy choices for sustainable land-use practices, and needed institutional changes should have community participation in all these efforts (Das 2006).

Private or Public Industry

As stated before, a private industry financed through federal and state subsidies while utilizing local involvement, application, and finance is possibly the most beneficial. If not fully funded by the private sector, organizations through the public sector and coordinated globally to reduce the rate of change for climate and natural resource scarcities originating from forests could also be secondhand. However, accepting federal and state financing gives those powers leverage in plantation management decisions. Such as within the Java case, the Java State Forestry Corporation (SFC) was able to veto any horticultural species that would threaten the primary tree crop species possibly regardless of whether the included species were beneficial to the plantation as a whole (Peluso 1993). Additionally, the state power and not the individual farmers or forest farmer groups had stead on horticultural and fuelwood tree placements (Peluso 1993). These decisions through the SFC were influenced by the Indonesian government's goal to emphasize revenue production using coercive tactics to only protect production forests (Peluso 1993). Involving exterior powers in ecology-based forest management could possibly place vested interests in the decisions of the land's health.

Location of Forest Plantations

Where these forest plantations will be planted or allocated is a problematic matter. As of present, there is growing recognition of the value that conservation of plantations can have in reducing logging pressure on natural forests, sequestering carbon, and restoring degraded landscapes (Kelty 2006). To be expanded upon further, utilizing mixed-species plantations in the ecological restoration of degraded landscapes can reestablish a native diversity of tree vegetation and native plant species in the plantation understories (Kelty 2006).

Areas that are in need as recognized before are abandoned pasture and agricultural lands. Costa Rica as an example of restoring small land holdings managed a native timber species mixture and a nitrogen-fixing species to establish an abandoned pastureland (Kelty 2006). The nitrogen-fixing species increased the timber species growth rate by closing the canopy and reducing weed growth ultimately producing usable biomass for fuelwoods and edible fruits (Kelty 2006). With this, tree plantations can contain nurse trees to shade out degrading species such as post-agricultural vegetation and provide a habitat for forest structures to attract animal-native plant dispersers. This method can be low cost and restore native vegetation using successional models of relay floristics (Kelty 2006). Including areas where the growth of tree species improved and where agricultural crops failed but to include fruit-bearing species can be a preemptive tact in influencing local decision-makers (Peluso 1993).

Ecological Benefits of Biodiverse and Heterogenous Stands

Arguably, when most individuals consider ecology, differing species interacting with each other in the same environment is what is conceived. In more depth, biodiversity and heterogeneity refer to the variety of microorganisms, plants, and animals partitioned as diversity within the same species and between differing species including molecular, population, and genetic diversity (Liu et al., 2018). With this, genetic diversity is the most vital and foundational component of biodiversity and heterogeneity (Liu et al., 2018). Genetic diversity is the foundation of ecosystem sustainability and stability and as such, is needed for planned forestry plantations to address climate change issues and natural resource scarcities originating from forests (Liu et al., 2018).

Differing species depend on one another and are connected and dependent to perform ecosystem functions/services supporting life on Earth and thus human economies (Liu et al.,

2018). Such functions and services consist of water quantity and quality, seed and pollen dispersal, nutrient cycles, soil formations, the regulation of pests and human diseases, carbon storage, climate regulation, waste management, cultural services, and many more (Liu et al., 2018). A large number of differing species will be able to perform a large number of differing functions and services (Liu et al., 2018). Ecosystems with higher species diversity will be more efficient in generating productive biomass and resource use, stable avoidance of market shifts and insect/disease impacts, and resistant to disturbances such as natural disasters or anthropogenic influences than those with fewer species in difference (Liu et al., 2018; Kelty 2006). Facilitative reactions of biodiverse stands therefore should be maximized as one species benefits from the growth of another (Kelty 2006).

The complexity of an environment benefits from a high biodiversity and heterogeneity also known as the biological diversity of an environment. Complexity is the number of pathways energy takes to reach a given population and stability is directly related to the changes in population densities of individual species linked to a pathway failure (Zavala and Oria 1995). As such, a stable system can return to an equilibrium state after a perturbation such as a disturbance or anthropogenic influence (Zavala and Oria 1995). A higher biological diversity also promotes the addition of important species such as keystone or indicator species. A keystone species is a non-dominant species that maintains a community through several capable performances (Zavala and Oria 1995). With a keystone species, most harboring communities such as human plantations can rely on the specific species' existence to manage the health of the environment or other species by reducing management costs and related labor. An indicator species is one whose population is directly related to an environmental status (Zavala and Oria 1995). With an indicator species, plantation management can instead of studying the health status of a particular

structure, study the indicator species population to determine the capability of the environment to harbor the species and directly correlate the health of the harboring structure such as a specific tree species status.

Another benefit of biodiversity is its effects on species invasions. A species invasion is the spread of a non-native and/or harmful species to an environment (Delavaux et al., 2023). To start with, anthropogenic factors such as a forest stands distance to ports which bring in non-native species largely predicts whether an environment is invaded, is directly related to invasion probability, and in turn may be more important than local native diversity against non-native invasions (Delavaux et al., 2023). In comparison, native diversity has a higher correlation to determining invasion severity and success (Delavaux et al., 2023). Following, native diversity and many tree species are included in a stand to underpin these invasions directly related to the level of biodiversity present (Delavaux et al., 2023). However, arguments are present as to why incorporating and/or managing a biodiverse and heterogenous stand can be counterintuitive to some methodologies and goals most ordinarily in place by those who seek monetary profit at unsustainable rates of harvest.

Management Techniques and Formats

The management techniques and formats utilized for a forest plantation are important decisions to be made taking factors into account such as the environment, location, preferred product output, composition of the stand, and the necessities to be met by the dependent locals. Management should most suitably follow an ecological 3-step ideal. How legacies of biological stands from tree regenerating disturbances and incorporating their existences into harvest prescriptions is an important first concept to understand (Franklin et al., 2007). To further define legacies, they are structures that were from the original stand before prescription or disturbance

was applied such as large healthy trees, decadent trees, snags, boles, and other wood on the forest floor (Franklin et al., 2007). Legacies can be further defined as organisms, organic matter, and created patterns which persisted pre-disturbance and influenced recovery processes of the stand (Franklin et al., 2007). These legacies are capable of living through intense stand replacement events, provide habitat for species, function as modifiers of the physical environment, and are difficult to replace if at all within plantation stands to further function as "lifeboats" and perpetuate genotypes (Franklin et al., 2007). As such, their continued existence should be included in management prescription plans.

A second concept for awareness is to recognize stand development processes such as tree mortality rates, generating structural/compositional heterogeneity within stands, and implementing prescriptions such as thinning which promote these standards (Franklin et al., 2007). Disturbances that influence stand development processes include intense windstorms creating downed boles or snags, fires creating gaps as natural/functional retention patches, bark beetle congregations can create large-scale stand replacements often targeting pure stands of host species arguably increasing stand heterogeneity, and of course general tree mortality from species competition of light and soil to further generate heterogeneous stands (Franklin et al., 2007). While natural tree mortality generally increases heterogeneity, thinning prescriptions tend to homogenize stand compositions but can help in growing large trees and improve standardized tree quality and form (Franklin et al., 2007). Also, incorporating variable density thinning increases the rate at which beneficial structural features develop (Franklin et al., 2007). Recognizing intermediate stand development processes is important to consider when planning and organizing management prescriptions. Although, mimicking natural disturbance regimes and

stand development processes through silviculture practices is challenging, especially for those who cannot recognize the benefits of the former (Franklin et al., 2007).

A final notion is the inclusion and importance of recovery periods between disturbance events for the resilience and development of stands (Franklin et al., 2007). For most forest types, the time period for forests to develop comparable levels of complexity after a disturbance is not long when in comparison to the period of time it takes between considerable disturbances for mortalities to create spatially complex and heterogeneous forests (Franklin et al., 2007). Stands are more often removed before structural complexity is achieved despite the build-up of biomass (Franklin et al., 2007). A small recovery period results in low species diversity as tolerant species cannot grow to co-dominant stances (Franklin et al., 2007). As referenced with the difficulties in working with local federal and state actors, the result of small recovery periods often has to do with economic factors when forest stands are managed for their commodities resulting in recovery periods to be calculated by finances such as discounted present net values over environmental standards (Franklin et al., 2007). In the end, the rotation and rate of development for desired structures or conditions determine the length of recovery periods but it is up to management and studies of the stands to plan for ecological complexities and quotas of natural resources (Franklin et al., 2007).

Benefits of Monoculture Stands

Benefits of diversifying forestry stands have comparable benefits to monoculture stands. Monoculture tree stands consist of a single particular variety which consists of the same genotype with almost no variation as all trees are almost all the same (Liu et al., 2018). As a result, all site resources target the growth of a single species with the best-selected attributes for the environment and demand, being growth rate and wood quality (Liu et al., 2018). In further

outcome, as all trees are the same species they can be managed to be mostly even-aged allowing for easy management, high resilience, and higher yields per hectare for more efficient harvesting results as uniform products (Liu et al., 2018). If the trees are more easily managed, operating becomes easier and handling costs can be reduced as it is more difficult to match suitable characteristics of varying species as well as how to manage each one individually and comparatively (Liu et al., 2018). The stands can of course still be used for treating wastewater, water quality, rehabilitating deforested watersheds, and improving degraded landscapes (Liu et al., 2018). Still, in the end most foresters believe that diverse stands generate greater productivity than monocultures (Liu et al., 2018).

Inability for Wildfire Management

While the ecology of forest stands is an important feature alongside the management prescriptions applied it is viable that such practices without taking substantial thinning into consideration can be counterproductive to reducing wildfire risks. Thinning is a silviculture tool effective to a degree in creating fire-resilient stands (Agee and Skinner 2005). However, where thinning occurs will be evident impacts of the removal process (Agee and Skinner 2005). Nonetheless, low thinning can be more effective than other methods for developing a fire resilient stand (Agee and Skinner 2005). With a variety of local's concerns such as in the Tasmanian survey, the locals showed more or equal concern for worker safety and reducing wildfire risks as seen in most survey results when compared to all factors as these risks have been more problematic for their people than in similar regions (Ribe et al., 2009). Wildfire management has varying concerns for varying regions of people.

Fuels are defined as organic material or structures that can combust during or cause a forest fire adding to forest fire indices (Agee and Skinner 2005). Fuel reduction treatments

consist of reducing forest floor fuels, increasing the height to live crowns from the forest floor, decreasing crown densities, and retaining large trees of fire-resistant species (Agee and Skinner 2005). Treatments should reduce fire potential and delineate fire behavior (Agee and Skinner 2005). However, maintaining no change in surface fire behavior requires a reduction in forest floor fuels (Agee and Skinner 2005). Uncut stands containing mostly old-growth trees have the lowest fire damage class with less forest floor fuels compared to harvested stands and as such, managed prescriptions without regard to residual fuels can worsen fire severity rather than improve it (Agee and Skinner 2005). Against many management prescriptions, the selective removal of large trees being fire resistant will increase the presence of smaller trees and fuel loads leading to an intensification of fires capable of jumping up into the canopies to form crown fires (Agee and Skinner 2005). In the end, many of these processes work against most ideals of ecological forestry practices but provide a form of long-term sustainability in a changing climate as the occurrence of forest fires begin to increase.

Retention Prescriptions to Fragmentation

As a last counterargument, many ecologically minded retention prescriptions can or will lead to an increase in fragmentation and habitat edge. As a result, human development and subsequently forest management can lead to the fragmentation of natural resources by forests becoming surrounded with agricultural and urban landscapes or can become islanded old growth among plantation forest stands (Zavala and Oria 1995). Furthermore, the isolation of old-growth populations will head concern to the minimum population size the islanded group can hold to guarantee their persistence in acting as a Minimum Viable Population (MVP) (Zavala and Oria 1995).

Conclusion

By full, policy implementations on forestry for the tree stands of plantations should follow an ecological outlook. Forested natural resources will begin to face scarcities which will have subsequent effects on relying industries and their dependent markets. A changing climate will see biodiverse stands experience the most resilience. Furthermore, the inclusion of local involvement in stand management policies linked with the locations of abandoned agriculture and pasture lands could have the best eventual public acceptance by a private or public business being involved with reforesting and developing degraded lands. In the end, the management of stands will most likely experience the most benefit following retention prescriptions which incorporate legacies, practice intermediate treatments, and allow appropriate recovery periods. However, while diverse stands undoubtedly have benefits monoculture stands do as well. In equal concern alongside the trend in climate change, ecological stands and their retention formats of subsequent treatments without counter-productive thinning against growth will increase the risks of forest fire occurrences. Ecological stand formats as a result of retention prescriptions could or can also lead to forested fragmentation and islanding of old-growth tree stands.

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