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## **"Disposing of Lands"**

**The importance of the Land Ordinance of 1785 to current forest fragmentation**

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## **Introduction**

The deleterious effects of forest fragmentation are numerous. Ranging from the loss of habitat and species extinction to the alteration of the global carbon cycle, science has come to the realization that not only the amount but also the pattern of forests is of great importance. Often seen as primarily a land use issue, fragmentation can be better understood as a land ownership issue. The factors influencing land ownership vary from individual preferences to biophysical conditions to local and national policy. While an explication of this complex situation is far beyond the scope of this paper, many of the issue can be traced back to the initial method of land division.

Dissecting much of the United States, the method of rectangular survey known as the public land survey system began with the Land Ordinance of 1785. The subtitle of this ordinance reads "An ordinance for ascertaining the mode of disposing of lands in the western territory." Reflected in this title is the predominant view that the seemingly endless lands of the western United States were in need of disposal. For a fledgling, war-depleted nation, the disposal of these lands promised much needed revenue and reimbursement to its soldiers. To achieve these goals, a square mile grid system was unwaveringly applied to land. This grid has provided both the basis for political units (and resulting policies) as aggregations of the sections and ever more parcelized ownership of the land.

This paper aims to lay the foundation for future work towards an understanding of the complex set of influences on land ownership and parcelization through an analysis of the Land Ordinance of 1785. To accomplish this goal, the paper will begin with a description of the importance of forest fragmentation and its relationship to land ownership patterns. Where a concrete example is helpful, the case of Indiana will be used. This will be followed by a discussion of the nature of forest as a complex good and the ways in which this can and has been misunderstood. An institutional analysis of the action arena delineated by the Land Ordinance of 1785 will then be undertaken using the Institutional Analysis and Development (IAD) framework. The paper will conclude with a discussion of how those rules laid out (and those not laid out) by the Ordinance have given rise to current forest fragmentation issues.

## **Forest Fragmentation**

The importance of forest fragmentation is multi-faceted. Most prevalently, fragmentation is often the result of the loss of forest so that more edge and smaller patches are created as larger blocks of forest are broken up by changes in land cover. It is estimated that globally, such land cover change has contributed as much carbon dioxide to the atmosphere as has the combustion of fossil fuels over the past 150 years (Turner et al. 1995). The effect of land cover change on global biochemical cycles has potentially drastic implications for the global environment. It is estimated that 39 percent of all carbon stored in terrestrial ecosystems is held in forests and the degradation and removal of this land cover is responsible for about 20 percent of current emissions (World Resource Institute et al 2000). As the concern over global environmental change has increased, so has the recognition of land cover change as a driving force rather than just an outcome of this process (Reibsame et al. 1994).

Forests contain a majority of the terrestrial ecological regions that have been deemed most important to biodiversity making their removal potentially catastrophic in the still largely undocumented area of biodiversity (Olson and Dinerstein 1998). From the examination of fragmentation effects on avian (Hobson and Bayne 2000) and primate species (Onderdonk and

Chapman 2000) to the relationship between fragmentation and insects (Schiegg 2000), the changing pattern of the landscape is as important as its composition.

Spatially explicit approaches to landscape ecology have examined the relationship of the structure and function of the landscape in terms of patches, corridors and matrices (Barnes et al 1998). Examining the spatial aspects of ecological processes at the landscape level has revealed some frightening possible consequences of current land use and land cover change trajectories. Environmental impacts, including land use and land cover change, have historically been seen as linear processes that can be addressed as they approach critical levels (Levin 1999). Recent research that looks at landscape processes through the lens of complexity theory suggests that such is not the case. The gradual and smooth degradation of ecosystems may be undermining the resilience and stability of those systems to the point where a catastrophic shift can occur (Scheffer et al 2001). Ecosystems may have multiple stable states such that altering them beyond some threshold will result in a permanent shift (Levin 1999). In terms of land use and land cover change and effects on biodiversity, forest fragmentation may produce a landscape where extinction occurs much earlier than is predicted by the linear loss of habitat (Casagrandi and Gatto 1999).

#### *Forest Fragmentation in Indiana*

While such changes can be seen in many parts of the world, the European settlement of the predominantly forested Eastern and Midwest United States provides an extreme case. Prior to European settlement, nearly 90% of Indiana was forested (Lindsey et al 1965). Presently, forest covers only about 20% of the state (LeMasters and Rans unknown year). At the beginning of the 20<sup>th</sup> century the amount of forest in Indiana had reached a low point dipping well below 10 percent of total land cover (Koontz and Jones 1998). Even this small portion was not undisturbed forest, however. Almost without exception, the original forests had been removed and any existing forest was in some stage of regeneration. The forest that has regrown is relatively young and structurally different than the ancient forests that once dominated the area. Except for a very few small plots of remaining old growth trees, these forests have been allowed to return on land that was at one time cleared for agricultural use.

The composition and pattern of this forest regeneration, however, varies greatly across the state. The south central portion of the state is characterized by much more forested land both in terms of total amount and contiguity. The lack of glaciation in the south central portion of the state has resulted in more severe topography that has largely dictated the sustainability of agricultural land uses. The majority of the state, however, is relatively flat with deep, rich soils and therefore dominated by agricultural land uses. In these areas forest generally occurs in highly fragmented, privately owned patches or woodlots. These woodlots exist on land that was originally forested but has either been stripped of its old growth or completely cleared since settlement. The resulting pattern of this process in Indiana varies from a regular checkerboard pattern of small patches in the north to a more riparian pattern in the central to larger contiguous patches in the south.

Currently, Indiana is about 20% forested. Of the 1.7 million ha of forest in the state, 85% is on privately owned land (Peterson et al 1998). Since 1978, the number of private timberland owners in the state has tripled with only a slight increase in overall forest area (Tormoehlen et al 2000). The ownership of the existing forest landscape in Indiana is being fragmented at a very high rate. With the continual increase in rural, non-agricultural population, this process of ownership fragmentation is sure to continue well into the future.

### *The Public Land Survey System*

The method by which almost all of the land in Indiana and much of the United States was initially divided came about with the Land Ordinance of 1785. Under the power of the fledgling Constitutional Congress, the Ordinance dictated that the land should be surveyed into a rectangular grid. Beginning from the eastern boundary of Ohio and generally spreading westward, the growing country was chopped into six by six mile squares that were known as townships. These townships were in most cases broken down into square mile sections. The aggregation of these square cadastral units provided the basis for organization into counties and states. That is, these artificial boundaries became the units of local government. The regular grid was laid down without concern for topography or any physical traits of the land. The goal was to divide the unimaginable expanses of North America into chunks small enough to be sold to the citizens of the new (and financially exhausted) nation. The primary motivation being a source of revenue to fill the war depleted federal coffers.

Prior to the implementation of the rectangular survey system, several systems had been tried in the original colonies. Many areas were not surveyed prior to settlement. In these areas where settlers laid claim by occupation, the meets and bound of natural features were used as property boundaries. Looking at two very similar areas near the border between the use of meets and bounds and the rectangular survey system, Norman Thrower (1966) examines the consequences of the two systems in terms of subdivision. Thrower finds that in the rectangular survey system, parcelization is much higher resulting in a smaller average parcel size (Figure 1).

As stated by Frederick Turner (1893), the history of the settlement of America must be understood in terms of the existence of the frontier. From the reckless clearing of the land to the removal and slaughter of native peoples, the seemingly endless untamed wilderness necessitated no checks on the taking of the continent and its resources. The enactment of the public land survey system clearly comes to existence from within this frontier mentality where the land seemed an inexhaustible resource.

Rather than requiring settlers to explore the land and find the most suitable areas upon which to live, the PLSS uniformly divided hills and hollows, swamps and prairies. At the time of the initial survey, several debates raged between the independent farmers of the north and the plantation owners of the south. First, the southerners favored a system of indiscriminate location that did not rely on survey prior to occupation. In this system of meets and bounds, natural boundaries such as lakes, rivers and hills provided the boundaries to property. The artificial but regular New England model of land division with survey before occupation had alleviated the messy legal situation of disputed boundaries. Given that the land would be surveyed prior to occupation, a debate was then raised about how far the land should be divided for sale. The independent farmers could only afford the land if it were divided into relatively small parcels whereas the plantation owners lobbied (with the support of land speculation companies) for the land to be sold in larger tracts. In the end, smaller tracts were allowed but much of the land was purchased by the speculation companies for later distribution at higher costs.

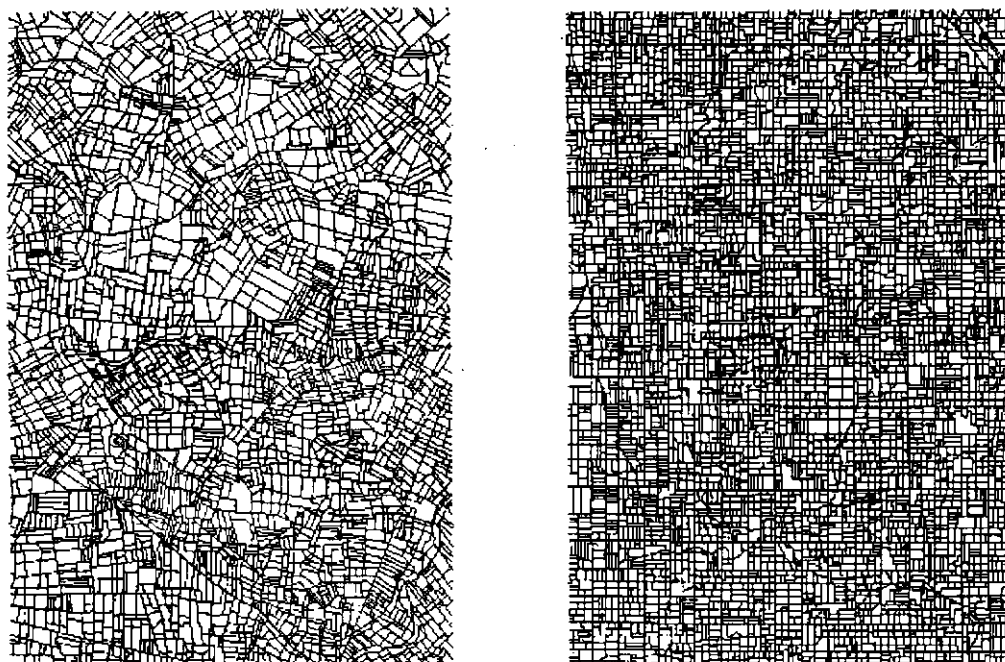


Figure 1. Parcel boundaries resulting from meets and bounds (left) and rectangular survey (right) (Thrower 1966)

While fairly efficient in its stated goals, the greatest shortcoming of the public land survey system was its lack of foresight on natural resource issues. While no ecological type thinking should be expected from that time, the depletion of natural resources, especially forests, was by no means a new issue. From the beginning, once the land was surveyed and divided it was distributed to settlers. The temporary exception to this was the reservation of several sections in each township for future governmental use. The reservation of these sections was soon abandoned as it became clear that settlers were going to occupy them with or without title.

The method of land distribution set up by the Land Ordinance of 1785 is analogous (and related) to urban sprawl issues faced today. Rather than allowing a site appropriate distribution of population to evolve, a structure was implemented that had only the national possession and accumulation of land as its goal. As this process continues today, the landscape outcome toward which it tends is unclear. That is, as the population increases, can the land just continue to be subdivided? At some critical point, the subdivision of land may lead to the incorporation and urbanization of an area, but how and when this point is reached is uncertain. And more importantly to this discussion, how does the continued subdivision of ownership effect the landcover and overall ecological stability of the land?

### **The Nature of the Good**

One useful approach to understanding the institutions that affect the fragmentation of forests is clarifying the nature of the good with which the institutions deal. Especially when concerned with natural resources, it is not adequate to say that the good is simply one thing such as trees or water. Because numerous goods of potentially different types come from a single resource such as a forest, the distinction must be made between a resource system and resource

units. Ostrom (1990) explains that resource systems can usefully be understood as stocks while resource units extracted from those systems can be understood as flows. This distinction is especially useful in understanding the goods associated with a forest.

The nature of a good has been described and categorized in terms of two dimensions, excludability and subtractability. Excludability refers to the cost of keeping beneficiaries from the good and has to do with who may benefit from the good. Exclusion can be achieved through physical separation or through the creation of institutions where rules accomplish the exclusion. Subtractability refers to how use of the good affects the remaining resource stock. A good such as firewood diminishes with use and so is subtractable. The uses of goods that are not subtractable do not diminish the stock and include things such as scientific knowledge or peace.

The combination of these two dimensions allows for the division of goods into four types (Table 1). Private goods are those that are excludable and subtractable. Goods that are not excludable and not subtractable are public goods. These two types of goods have been dealt with extensively by economists. The remaining two types of goods, however, have received less attention. Goods that are excludable but not subtractable are termed club or toll goods. And finally, goods that are not excludable but are subtractable are called common-pool goods.

		<b>Excludability</b>	
		Low	High
<b>Subtractibility</b>	Low	Public Goods	Toll Goods
	High	Common-Pool Goods	Private Goods

Table 1. Types of Goods

Categorizing forests as a good is complicated by the fact that, like many natural resources, forests are a complex system where an understanding of the system is scale dependent. That is, the whole is not equal to the sum of its parts. While it seems straightforward to view trees as a private good, i.e., highly excludable and highly subtractable, such is not the case when the system is viewed at a broader scale. Assuming that the resource system, a forest in this case, is large enough that it will be 'owned' by more than one agent, it then must be understood as a common-pool good. The excludability of the flow of resource units such as biodiversity, carbon storage or water purification is very low. The parceling of the land into units smaller than the resource system is parceling the stock rather than the flow.

The nature of a good is an inherent quality and cannot be altered by humans (Ostrom 1990). What can be altered is the type of property rights that are applied to the good (McKean 1998). McKean (1998) also recognizes that there has been much confusion in the application of the terms 'private' and 'public' to goods, property rights and owners. A misunderstanding of the nature of the good, as in the case of forests, results in an inappropriate combination of property rights and the type of owners. A mismatch between the type of good and the appropriate type of property rights can lead to the over-extraction of resource units from a resource system and degradation or collapse of that system.

Forests as a resource system produce both private goods (e.g. timber) and common-pool goods (e.g. habitat). Private property rights have been given to both of these types of in Indiana by dividing the resource system according to the PLSS. Private, rather than public, property

rights are appropriate, but because the PLSS system employs a smaller spatial division than that inherent in the resource system the resource system must then be inappropriately divided.

### **Institutional Analysis**

To better understand its effect on the fragmentation of forests, the public land survey system, as initially laid out in the Land Ordinance of 1785, will be examined in terms of the Institutional and Analysis (IAD) framework. The IAD framework is centered on an action arena which encompasses an action situation and actors in that situation. The action situation is likewise composed of participants, positions, actions, information, linkages, outcomes and payoffs. (Ostrom et al 1990). Each of these constituents of an action situation potentially have rules that define them. The Land Ordinance of 1785 is broken down into these seven types of rules below.

The IAD also calls for an understanding of the contexts which affect the action arena. The context is divided into three types: the rules-in-use, the attributes of the community, and the attributes of the physical world. These types of context influence the actors and action situation that comprise the action arena which then interact to produce outcomes. These outcomes may then feedback and affect the context and so begin the loop again.

#### *Attributes of the Physical World*

One of the most striking and important features of the method of disposing of the public lands laid out in the Ordinance was the nearly complete disconnect from any attributes of the physical world. The land called for the application of a uniform grid to be applied to a very heterogeneous landscape. Although unbeknownst at the time, this method of parsing the land would continue all the way to the Pacific Ocean. Other than rivers that were often used as the beginning and ending of a particular survey project, all biophysical characteristics of the land were subsumed by the grid. Ranging from swamps to mountains, the surveyors job was blaze straight lines running the four cardinal directions.

This absolute disregard for the attributes of the physical world and their potential effects on the outcomes produced by the interactions facilitated by the Land Ordinance is one of the greatest shortcomings of that institution.

#### *Attributes of the Community*

The fact that the Land Ordinance was defining rules for a frontier situation devoid of an *in situ* community makes the delineation of the important community attributes somewhat difficult. The situation is further complicated by the fact that the country and its Continental Congress undertaking this collective-level rule making were very young and still heterogeneous. Although the community in question surely must be characterized as American, the definition of such was still highly influenced by its English, French and other constituents.

The public land was to be disposed of by the Land Ordinance had only recently been ceded by the individual states in the formation of the new Union. Prior to this, the western boundaries of the states had been undefined, as the geographical knowledge of the continent was very limited. In joining the Confederation of States, each had to reach an agreeable definition of its western boundary and cede the remaining lands to the federal government. As the government was in a very poor financial situation as a result of the Revolutionary War, the sale of these lands was seen as an important source of revenue. As payment for participation in the war, soldiers had been given land warrants that entitled them to a certain amount of land. The

warrants varied by rank from hundreds to hundreds of thousands of acres. The western lands would also allow for the repayment of these warrants. Towards these ends, Congress passed the Land Ordinance of 1785.

The tension between small farmers and land companies was also an important attribute of the community affecting the formulation of the Land Ordinance. Comprised of wealth investors and holders of large amounts of military warrants, land companies sought to purchase very large tracts of land at low prices and then divide and resell the land at a profit. Small farmers with limited financial means lobbied for the initial distribution of the public lands to be in units small enough for them to afford. Plantation owners from the south often comprised the land companies while the small farmers were more often from the north. The authors of the Land Ordinance had to try and appease both of these camps in its method of survey and sale.

#### *Rules-in-Use*

Several rules-in-use were important in the formulation of the Land Ordinance. First, the method of dividing the land in a regular fashion prior to its occupancy had been implemented in New England. While it was not seen as the ideal solution by all, it did have several advantages. Probably the greatest perceived benefit of this method was the minimization of land disputes that had to be settled in court. In contrast to allowing settlers to move into an area and make claims on land that they put into production, survey before occupancy clearly defined ownership boundaries.

Several rules-in-use regarding land ownership had been inherited from European traditions. As much of the land had been granted to individuals in large tracts by the various European thrones, the practice of quitrents was (at least in theory) enacted. Once lands that had been granted to smaller landowners came into productive use, a small price per acre to the grantor. This quitrent was to remain in effect no matter how many times the land changed ownership. The practice of primogeniture and entails placed strict legal bounds on the inheritance and subdivision of parcels. Primogeniture provided that the oldest son of the landowner would inherit the land while entails provided that a parcel could only be owned by descendants of the current owner. Each of these practices had developed from the feudal structure of European land ownership but had survived to some degree in the New World. Although quitrents had all but ceased due to the inability of grantors to enforce the law, the Land Ordinance of 1785 did not discontinue the legality of any of these practices.

#### *Delineating the Action Arenas*

An important step in employing the IAD framework is to determine the appropriate action arena. The organization of actors in action situations that comprise action arenas can be very complex. Bounding individual action situations can be very complicated as the situations are potentially both nested within and linked to other situations in the arena. The existence and interaction of operational, collective-choice and constitutional levels of rules further complicate the delineation of an action situations. If the participants in an action situation can cross levels, a single situation may encompass multiple levels of rules. As hierarchical government structures often do not allow a participant to easily move across levels, action situations dealing with such scenarios are often focused at one level.

The action arena of the initial division and distribution of public land in the United States can be broken down in several ways corresponding to the linked and nested nature of action situations. The surveying of the land along with its distribution through auctions can both be



understood as action situations that exist primarily at the operational level. The creation of the Land Ordinance of 1785 can be understood as an action situation that worked primarily at the collective-choice level and in which the survey and distribution action scenarios are nested. It is this primarily collective-choice level action situation upon which this analysis is focused. Again, because of the limits provided by the hierarchical government structure, the constitutional level rules governing the arena and the individual situations come generally from the set of actors that defined the rules that governing the Constitutional Congress. A highly simplified diagram of the actors and their relationships in the action arena is given in Figure 2.

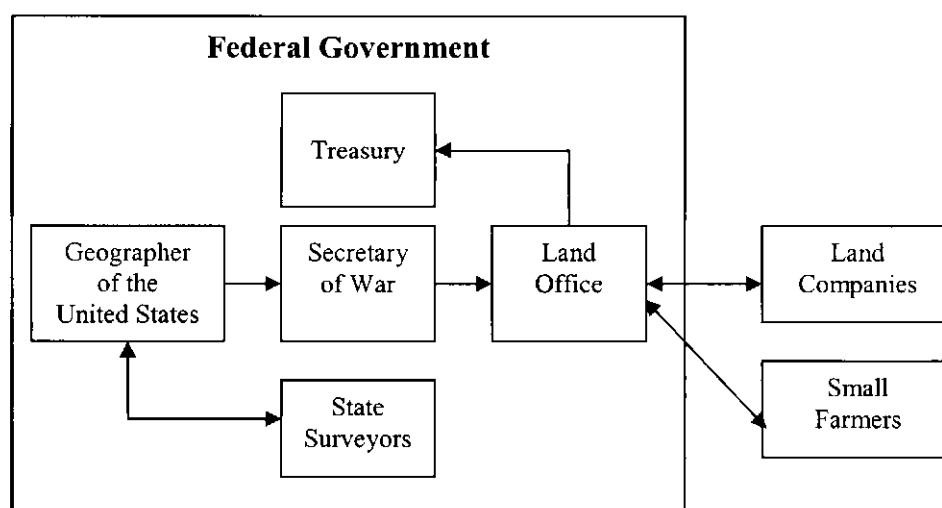


Figure 2. Relationship of Actors in the Action Arena

### Rules

The Land Ordinance of 1785 defined a set of rules to govern the survey and distribution of the public lands. The dictates of the Land Ordinance can be better understood in terms of the seven types of rules delineated by Ostrom et al (1990). Corresponding to the elements of an action situation the types of rules are as follows:

- position rules define what positions can occur,
- boundary rules specify how participants enter and exit the possible positions,
- authority rules delimit what actions are available to the positions,
- aggregation rules define how actions are tied to outcomes ,
- scope rules specify what outcomes are possible,
- information rules specify what information must be available to each position, and
- payoff rules define how costs and benefits are to be allocated.

### Position Rules

The Land Ordinance explicitly creates new positions for an official surveyor from each state and a crew of workers called chain carriers. Although not explicitly stated in the text of the Land Ordinance, the position of landowner was also created. The creation of this position was important in the formulation of the Ordinance in that the two types of potential participants that would fill this position, land companies and small farmers, hoped for different methods of disposing of the land. Another position necessitated but not explicitly created from the Ordinance was that of the land office.

### Boundary Rules

The surveyors from each state were to be appointed by Congress and were required to take an oath in order to enter the position. The chain carriers were chosen by the surveyors and also had to take the oath. To become a landowner, an actor needed to purchase land at one of the land office auctions where cash payment had to be produced at the time of sale.

### Authority Rules

According to the Land Ordinance, the surveyor and chain carriers were to begin at the Ohio River and the western edge of Pennsylvania and proceed west dividing the land into 6 by 6 mile partitions. These partitions, called townships would be further subdivided into 36 one square mile units called sections. During the surveying process, the surveyor was to keep detailed notes on the biophysical character of the land.

Once seven ranges were surveyed, the Secretary of War randomly selected one-seventh of the land to be used for repayment of military warrants. In each of the townships, the federal government also reserved four sections for itself and the center section for use in establishing a public school system. The remaining land was then distributed to and auctioned off by land offices at no less than \$1 per acre. According to the Land Ordinance, no one was excluded from purchasing land as long as they could pay for it. The Ordinance also provided that the land offices auction the land alternating between whole townships and townships sold in sections. This enabled both land companies and small farmers to purchase land. The proceeds of this sale went to the federal treasury. Even after the land was sold, the federal government retained one-third of the mineral rights to the land.

### Aggregation Rules

The Land Ordinance itself might be understood as an aggregation rule in that it specifies who gets to decide what. Within the situations delineated by the Ordinance, there seem to be no situations where multiple actors have partial control and so would need any aggregation rules.

### Scope Rules

The possible final outcomes allowed by the Land Ordinance essentially all fall into the categories of distributing the land and collecting the revenues. The land was distributed amongst the government itself, war veterans, and those purchasing the land. All revenues went to the federal treasury.

### Information Rules

Conspicuously few information rules were specified in the Land Ordinance. The surveyor's field notes on the biophysical nature of the land were to be made available to the land purchasers. Also, information on township boundaries was to be provided by clearing those boundaries during surveying.

### Payoff Rules

Again, the major costs and benefits delineated in the Ordinance had to do with how the land was distributed and that the revenue was to go to the federal treasury. No rules were specified about how auctioned land could be used or sold.

### *Patterns of Interactions and Outcomes*

The Land Ordinance created several action situations in which repeated interactions amongst actors took place. The actual survey of the land was carried out by actors whose positions were created by the Ordinance. The outcome of their interactions was an intermediate outcome and can only be described as partially successful. The Land Ordinance was written to start the process of surveying the western public lands but called only for the first seven ranges to be completed. Progress was slow enough that after two years only four ranges had been completed. The second action situation created by the Ordinance was that of the sale of land. This situation was somewhat more successful than the surveying of the land and much of what had been surveyed was quickly disposed of. Although the public land survey system was not overwhelmingly successful in its initial goals, it set up a model for the disposal of the vast western United States that was successful and whose effects are still strongly felt.

The intermediate outcomes accomplished by the Land Ordinance of 1785 became the context for further generations of land policy. Because the Ordinance was successful in its goal of distributing the land but gave no direction for its management, the Northwest Ordinance of 1787 was delivered only two years later. This ordinance more explicitly specified how the ownership of the land was to be managed including the dissolution of practices such as primogeniture and entails.

Many further policies have developed on the foundation laid by the Land Ordinance. As the consequences of dividing up the land in such an ecologically insensitive manner have become more clear, policies addressing the subdivision of the land have instituted.

### **Conclusion**

Although many additions and changes have been made to the system initially set out in the Land Ordinance of 1785, its basic structure still remains today. The system of rectangular survey can still clearly be seen in patterns of ownership and land cover. While the system accomplished its goals of getting people on the land and money to the treasury, the lack of consideration for the biophysical context in the division of the land has and will increasingly have negative ecological consequences. The geometrically regular but ecologically dissociated rectangular grid of parcels stemming from the public land survey have formed the basis for the current units of local government. Because these units are completely disconnected from their ecological context, the region for which policy can be written is also ecologically inconsistent. To address concerns of forest fragmentation caused by the system of land division initiated in the Land Ordinance of 1785, landowners have had to move from operational level action to higher levels in order to organize themselves into ecologically sensible units. While private property

rights may be the appropriate type for forest as a complex common-pool good, the ever shrinking, individual ownership of forests is an issue that will continue to worsen until such self organization occurs.

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