THE EVOLUTION AND ORGANIZATION OF ENVIRONMENTAL AGENCIES: FROM GAME LAWS TO HIERARCHICAL BUREAUCRACY

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ABSTRACT
This paper examines public bureaucracy by studying state the evolution of state wildlife agencies, from their inception in colonial game laws to their manifestation as modern hierarchical environmental agencies. The paper focuses on the tradeoffs and evolution of public administration by developing a model of bureaucracy that focuses on contracting and organizational incentives to manage a largescale environmental asset. The empirical analysis examines the history these laws and agencies and employs a panel of the fifty state wildlife agencies to test the model's implications. Empirical estimates show that agency budgets rise with increases in private landowner contracting costs as measured by decreases in the size of privately owned parcels in a state. Evidence also shows there are positive relationships between hierarchical organization and the proportion of budgets spent on non-game and on the amount of budgets originating from a state's general fund (as opposed to user-based revenues). Estimates using panel data from 1950-2008 also find evidence the specific form of hierarchical organization has impacts on agency size.

Key words: Agency, bureaucracy, contracting, jurisdiction, property rights, organization, wildlife.
JEL Codes: D23, H11, H70, Q29

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I. INTRODUCTION

Administrative agencies, are an obvious and important form of economic organization. At the federal level they control vast resources and are involved directly in the production of goods and services, or indirectly in the regulation of private sector activities. In the fifty states, agencies are just as pervasive, where they are involved in many similar endeavors including education, law enforcement, public health and safety, and transportation. For environmental and natural resources, in particular, state agencies have a long history and today nearly all states have agencies involved in agriculture, environmental quality, fish and wildlife, forests, minerals, parks, state lands, and water.

In this paper we study the evolution and structure of environmental agencies by examining state wildlife agencies. We focus on wildlife agencies for two. First they are the oldest environmental agencies and all 50 states have them. Second, they emerged at a time when states' administrative apparatus was limited and passed through several organizational changes -- from simple games law to modern hierarchical environmental agencies -- allowing comparative analysis of agency organization. Our framework for developing models of an environmental agencies is one that focuses on contracting and organizational incentives in the tradition of Coase (1937) and Williamson (1999), as well as on theories of agencies from political science and the economics of organization (Gibbons and Roberts 2014). Our models are used to derive implication about the size, structure, and budget allocation of these agencies. To test our predictions we develop a panel data set that comprises all wildlife and wildlife-related agencies for all states since 1860. The data include measures of agency organization, budgets size and allocation as well as economic and demographic measures from the states at each census year.[1]

[1] To our knowledge this study is the first empirical analysis using detailed data on state agencies to examine these questions. Volden (2002) also uses state level data to examine how state welfare agencies emerged from federal mandates. Garicano and Heaton (2010) examine the productivity of municipal police departments [move this cite]..

Our analysis begins from the premise that environmental assets - including air and watersheds, wildlife populations, scenic vistas and oil-gas reservoirs -- are largescale assets that often require a larger geographic scale of ownership than what tends to dominate surfaces uses for urban and agricultural uses. From this starting point such environmental or landscape assets require an organization to control a relatively large geographic space. An environmental agency then can be viewed as an organization that solves the contracting problem of establishing control over a landscape level assets. For wildlife for example, control over populations tends to require control over habitat that is much larger than that held by surface owners (Lueck 1989). The same condition holds true for airsheds and watersheds that extend for vast areas over which small scale landowners have surface control and access to these assets (Bradshaw-Schultz and Lueck 2015, Libecap 1990). Administrative agencies which control access to and use of largescale environmental assets (e.g. air , wildlife) then offer a view of bureaucracy consistent with Coase (1937) who examined the allocation of resources within organizations, where decisions are made under the constraints of hierarchies and limited decision rights. Our approach is also similar to Williamson (1999), who examines the rationale for bureaucratic governance and focuses on governance structures, arguing that public bureaus arise where output is hard to measure, market are limited or absent, and low-powered incentives are needed.[2]

Figure 1 illuminates the issues at hand for environmental agencies by looking at two specific environmental assets: wildlife and airsheds. The top panel shows how the deer population in the US fell dramatically under open access in the 19th century and then rebounded just as dramatically in the 20th century, even to the point where deer are pests in some areas. The

[2] The formal study of bureaucracy began when Niskanen (1971) postulated budget maximization as an objective and Stigler (1971) postulated interest group capture as an outcome. More recent studies focus on the objectives and incentives of individual bureaucrats rather than on the agency as a whole (e.g., Wilson 1989, Dewatripont, Jewitt and Tirole 1999), the tendency of agencies to act as interest groups (Johnson and Libecap 1994, Moe 2014), and the role of politicians and interest groups in limiting agency discretion (e.g. Macey 1992, McCubbins et. al. 1987, Peltzman 1976, Spiller 1998). This literature has focused on the supply-side of bureaucracy and by and large has not considered the public's demand for bureaucracy. There is also a related literature on bureaucracy within firms (e.g., Prendergast, xxxx).

bottom panel shows similar population paths for additional species, all measured as a percent of their estimated levels in 1700. What can be seen is that the path followed by deer also occurred for many other species. Indeed these population paths suggest an Environmental Kuznets Curve of sorts, but what the charts do not detail is how institutional changes and the rise of environmental agencies facilitated these changes. Our landscape contracting approach provides a framework for examining these phenomenon.

Figure 1

We provide a detailed examination of the emergence and evolution of the oldest environmental agencies and show how the structure has changed in ways consistent with solving difficult contracting, incentive, and coordination problems. To date the bureaucracy literature has had a dominant focus on federal agencies, usually case studies, and can be divided into three categories. First, there are a number of empirical studies of federal bureaucracy casting doubt on the Niskanen budget-maximization thesis (Wilson 1989, Weingast and Moran 1983, Johnson and Libecap 1994, Blais and Dion 1991). Second, there are studies examining the mechanisms of political control over public agencies (e.g., Weingast and Moran 1983, Volden 2002). Third, there are some econometric studies examining a range of issues relating to the behavior of bureaucracy and bureaucrats.[3] By examining a panel extending over 100 years we will not only be able to test theories of agency organization and behavior but also generate fundamental empirical understanding of how agencies emerge, evolve and operate.

We begin in Section II with a history and description of state wildlife agencies, emphasizing the historical evolution of these agencies and the empirical features we are able to examine with our data. In Section III we develop models of agency size, budget allocation, and

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[3] For example, Ando (1999) examines how interest group pressures influence the administration of federal endangered species regulations by the US Fish and Wildlife Service. Moe (2006) estimates the effect of teachers unions on school board makeup. Kosnik (2006) studies the re-licensing of hydroelectric dams by the Federal Energy Regulatory Commission to determine whether regulatory delay is explained by regulatory capture, congressional dominance, or bureaucratic discretion theories of agency behavior

organization. In doing so, we consider the demand for agency services as well as the costs of providing those services under different organizational regimes. In Section IV we examine the economic history of wildlife agencies and use data from a panel of U.S. states to test the implications of our models and the existing literature by estimating agency budgets and the allocation of those budgets between game and non-game and endangered species management. Section V is a brief summary of our findings and a conclusion.

II. HISTORY: FROM GAME LAWS TO BUREAUCRATIC HIERARCHIES

Today, all states have administrative agencies for managing environmental assets such as fish, wildlife, forests, parks, minerals, water, and air quality as well as related agencies involved in administering public health and agriculture. These agencies emerged across states at different times and different rates as Table 1 illustrates. It shows the timing of the emergence of a commissioner, commission, or board for the public governance of select environmental assets. Among the six assets, fish and wildlife agencies emerged first, in the late 19th century whereas and air quality agencies emerged last, in the mid-20th century.

Table 1

State fish and wildlife agencies have their origins in the game laws passed by colonial governments whose goals were to prevent the over-harvest of valuable game animals (see Tober 1981, Lueck 1989). Slowly these agencies evolved from specialized game wardens (who enforced hunting and fishing laws), to the modern hierarchical bureaucracies we observe today. These agencies are responsible for administering and enforcing a system of hunting and fishing licenses (this includes setting season closures and setting bag (take) limits, regulating the methods by which wildlife can be taken) conducting research and monitoring wildlife populations, managing state controlled habitat for wildlife, protecting non-game and endangered species,[4] and administering wildlife (and recently environmental) education programs.

This section describes the history of these agencies from their colonial origins to the present, focusing on major organizational changes that may affect the demand for public governances and how resources are governed. The general path begins with a period of (near) open access exploitation that generated a demand for state action. Next was the passage of state law to limit this exploitation but without the apparatus of an agency. A primitive agency later emerged typically with a narrow focus on wildlife management. The modern trend has been to merge these narrow agencies into larger hierarchical agencies that have jurisdiction beyond wildlife.[5]

A. Precursors: Laws and Wardens

Laws to limit the harvest of wildlife emerged in the U.S. during the colonial period (see table 1). The first of these game laws were passed by colonial governments whose goals were to prevent overharvest of valuable game animals. The basic method of protecting wildlife was to close parts of the year to killing or 'taking.' These closed seasons held sway over all lands public or private within a state's jurisdiction. Massachusetts had a closed season for deer in 1694, and by the end of the colonial period all the colonies but Georgia has closed seasons for deer. West of the Mississippi there were no game laws in any state or territory, other than restrictions on Indian lands, until 1851.[6] By the 1880s, however, all the 48 continental states (or their respective territories) had approved game legislation, primarily in the form of statewide closed seasons and limits on trade in game and game products (e.g., meat, hides, feathers). In addition to season closures, bag limits soon emerged as a standard method of controlling hunting.[7] A bag

[4] As we note below, there is also federal authority over federally listed endangered species and migratory waterfowl.
[5] There is a similar history for agencies that govern air and water quality and oil-gas conservation.
[6] There were also numerous local laws during the colonial period. For example, Texas' first closed seasons was for quail on Galveston Island in 1860.
[7] Hunting on Sunday was often banned as well and still is in about 10 states.

limit is a daily or seasonal quota on the number of animals that can be taken during a legal hunting season. Iowa implemented the first bag limits for wild birds in 1878 (25 birds per hunters per day, extremely generous by modern standard) and by 1912 all but three states had some bag limits.[8]

When the game laws were first enacted, the local law enforcement authorities were charged with enforcing them. Massachusetts was the first state to create a specialized game enforcement position; in 1739, special officers called deer wardens were given accountability for enforcing bag limits (Bavin 1978). It was not until the 1880s that the majority of states began to establish game wardens (Palmer 1912, Bavin 1978). Many of these early wardens were either elected or appointed at their jurisdictional level (state wardens by the state, local wardens by city officials).[9] It is unclear how many of these wardens were compensated, but it seems to have varied across states and over time. Washington's first wardens were not paid a salary, but instead, were entitled to half of the fines collected (Warren 1998); in North Carolina, county "game keepers" were paid through the county treasurer by "those interested in the game interest" (Palmer 1912). The first states to have salaried warden positions were Michigan, Minnesota, and Wisconsin. By 1912, 41 states had implemented similar systems, generally known as the "Warden Service" (Bavin 1978).

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[8] States also imposed restrictions on the legal methods of taking game, most of which are still in effect today. For instance, Maryland prohibited hunting by firelight and today 'spotlighting' is almost universally banned. In 1865 Michigan banned the use of 'punt guns' (large swivel shotguns) for waterfowl. Today restrictions include prohibitions on explosives, automatic weapons and type of weapons. Restrictions and prohibitions on game trade also became a component of state (and later federal) wildlife management. By 1912 (Palmer 1912) all states but Maryland had banned exports of all or some game products. In 1900 the federal Lacey Act outlawed the sale or transportation of game taken in violation of state laws. Today states still generally prohibit the sale of wild game and game products, though there are exceptions, most notably for fur bearing animals (e.g., mink, fox). States also adopted refuges for wildlife, where hunting was either prohibited of severely curtailed. Wyoming in 1905 and Pennsylvania in 1907 established the first state refuges, and now all states have state controlled – via ownership, easement, or lease – land for wildlife refuges.

[9] According to Bavin (1978), no experience was required, and appointments were usually based more on politics than on skill. In the Supreme Court case *Missouri v Holland* (1920), Holland, one of the first Inspectors of the Bureau of Biological Survey, is quoted: *In the early years of game management in this country, the game warden was seldom a man to be looked up to in the community. He usually liked to hunt and fish, but as an enforcement officer, he just didn't rate.*

B. Evolution of Hierarchy and Funding during the 1900s

By 1900, seventeen states had multi-member game commissions.[10] Game commissions were, and still are, the governing bodies of the state game department. Commissioners are usually unpaid appointees of the governor of each state. The commissions have the legislative authority to implement game regulations that will be carried out by the bureaucrats in the agencies. By 1950, only four states had game departments headed by a single individual, whereas the other 46 were headed by commissions. The commission structures generally follow the format of the Model Game and Fish Administrative Law, championed by Aldo Leopold and passed in 1934 to discourage political management of wildlife. Following the model law, commissioners have staggered terms designed to prevent radical policy changes in the wake of state elections.[11]

License systems emerged in the late 19th century as a method of funding the wardens and the fledgling agencies (see Table 1). By 1900, roughly twenty states had some form of licensing system. Such a system both limited access to wildlife and generated funds enabling wildlife agencies to enforce the game laws.[12] Even though just five states had nonresident hunting licenses by 1900, the practice spread rapidly. By 1904, thirty-one states had nonresident fees, and by 1912 forty-six states had such licenses. From their inception, nonresident licenses have been substantially more expensive than resident licenses. For example, Reynolds (1913) found that the typical resident licenses were $1 per year; nonresident licenses tended to be at least ten times higher. This discriminatory pricing has been challenged in court many times by nonresidents on the grounds that it violates the privileges and immunities clause of the U. S. Constitution (Art.

[10] In 1865 Massachusetts and New Hampshire established separate fish commissions. Fish and game commissions tended to be separate bodies in most states at the turn of the century. Most were consolidated by 1950. Fishing licenses tended to come later than hunting licenses.

[11] The Model Law was developed at the annual meeting of the International Association of Game, Fish, and Conservation Commissioners. It was intended to serve as an ideal structural plan for states to develop multi-member commissions. This law was designed to free the commission from direct political pressure and to increase professionalism by introducing qualifications for directors (Robinson and Bolen 1989).

[12] In many states, recent poor immigrants were singled out for their disregard of the game laws. For example, in 1903 Pennsylvania prohibited all hunting by resident aliens.

IV., sec.2.). These challenges have been defeated at all levels, including the Supreme Court. More expensive licenses for nonresidents are found in all states today.[13]

By the 1930s state game commissions and their agencies were well established and operating in a manner quite similar to what we now observe. Still, one crucial adjustment was on the horizon. In 1937, the Pittman-Robertson Federal Aid in Wildlife Restoration Act directed existing federal excise taxes on guns and ammunition to state agencies for the protection and restoration of wildlife.[14] This federal revenue was available to states only on the condition that each state dedicate all of its hunting license revenue to state wildlife management programs. Pittman-Robertson (P-R) allocates federal funds to states (after deducting 8% for administration) using a formula based on state land area, state population and state hunter numbers. In 1950, a Dingell-Johnson (DJ) Act similarly allocated federal tax dollars on fishing equipment to states for fisheries programs.[15]

Figure 2, Table 2

During the 1900s many wildlife agencies were merged into larger hierarchies. Figure 2 illustrates the dominant forms of hierarchy and Table 2 summarizes the evolution over time. The basic organizational distinction is between autonomous and hierarchical agencies.[16] Autonomous agencies are those separated from other administrative agencies while hierarchical agencies are those with divisions as part of a larger bureaucracy. The first agencies were typically autonomous "game and fish" departments with a narrow jurisdiction over species valued by sportsmen. While many agencies still retain this organization and jurisdiction, others are part of larger "natural resource" agencies that also have regulatory jurisdiction over state parks, state forests, and environmental policy. Today there are 18 autonomous agencies (38% of the lower 48 states),

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[13] The case upholding this practice was *Baldwin v. Fish and Game Commission* 436, U.S. 371 (1978).
[14] 16 U.S.C § 669.
[15] Federal Aid in Fish Restoration and Management Projects Act, 16 U.S.C § 777. This program was expanded in 1984 by the Wallop-Breaux Amendments.
[16] Panel B of Figure 4 shows the typical hierarchy but there are some states with even more hierarchical 'super' agencies that are comprised of all the autonomous agencies found in Panel A.

down from 30 autonomous agencies in 1950.[17] Although the general trend has been towards hierarchy, we note that some wildlife agencies in some states switched back and forth between autonomous and hierarchical over time. Wildlife agencies in eleven states switched between autonomous and hierarchical more than once between 1930 and 2010, and many hierarchical wildlife agencies shared cabinets with a changing assortment of other environmental assets (e.g, parks, forests, water quality) over time.

C. The Modern Agency

Modern state wildlife agencies are rather small bureaucracies compared to the other major state agencies. The aggregate budget (expenditures) across the lower 48 states was $3.53 billion in 2008, ranging from a high of $425 million (California) to a low of $5.3 million (Rhode Island). On a per capita basis, aggregate expenditures were $11.71 in 2008, ranging from a high of $101.1 (Wyoming) to a low of $2.67 (New York). The figures amount to $17.70 in expenditures for every 10 acres, ranging from a high of $177.6 (Maryland) to a low of $2.34 (North Dakota). Across all agencies, the expenditures on fish and wildlife in 2008 amounted to 0.24 percent of total state revenues, ranging from a high of 1.36 percent (Montana) to a low of 0.04 percent (New York). For point of comparison, state parks agencies spent $6.3 billion in 2008 and forestry agencies spent $2. 5 billion. All natural resource agencies combined (fish and wildlife, parks, forests, agriculture) spent $22.0 billion whereas state health agencies had collective budgets of $59.3 billion.

General appropriations to wildlife agencies account for the growing difference between user fee revenues and expenditures. In 2008, general funds totaled $1.48 billion across all states, accounting for 41.9 percent of total expenditures. The amount of general funding received by each state varies considerably, ranging from close to zero in many states to well over 50 percent

[17] Even these distinctions do not include all the possibilities. For example, Pennsylvania still has a Game Department that is separate from its Fisheries Department, and a few states (e.g., Maryland) have separate departments for marine fisheries that are often focused on commercial species.

in other states. Agencies derive general funds from a variety of sources including sporadic and regular appropriations from state legislatures, tax check-off programs, lotteries , wildlife license plates, dedicated taxes (e.g., cigarette taxes whose revenues are exclusively budgeted to a wildlife agency), and miscellaneous fees (e.g., refuge entry fees).

Agency funding still comes mostly from hunters and anglers, either directly through licenses or indirectly through (federal) taxes on equipment. An increasing amount of license revenue comes from non-resident licenses. At the national level, a mere 0.87 percent of hunting licenses went to non-residents in 1925 but this amount increased to 8.9 percent by 2008. This percent varies across states, ranging from a high of 35.6 (Wyoming) to a low of 1.7 (Michigan). The revenue from non-residents has also trended upwards since 1965, the first available year of data. Nationwide, 30.4 percent of license revenue came from non-residents in 2002, up from 22.1 percent in 1965. At the state level, three states generated more than 70 percent of their license revenue from non-residents in 2002 (Colorado, Montana, and Wyoming) and four states generated less than 10 percent from non-residents (California, Massachusetts, Ohio, and Washington). The incentives of wildlife agencies to focus on non-residents for revenue plausibly depends on agency organization and land ownership patterns as our theory below will emphasize.

III. ECONOMIC FRAMEWORK

In this section we develop a series of models that generate implications about the size and structure of an environmental agency involved in the management of wildlife resources, and how it evolved over time. Beginning with the problem of contracting for control of a large scale environmental asset, our models feature both the demand for bureaucracy and the costs of bureaucratic output. Demand for output from a public bureau depends on income and preferences but also the transaction costs of private production. The costs of bureaucratic production depend on complementarities in inputs and tasks and on the incentives and constraints of bureaucrats, which in turn depend on agency organization.

A. Model Basics

Our starting point is a landscape such as wildlife habitat, a watershed or airshed, a canyon, or even underground assets such as groundwater or an oil reservoir. The landscape is 'large' in the sense the area within the landscape can potentially be used for other assets that would require a much smaller scale of control. For example, the landscape might be an habitat for a herd of elk that could also be used for cattle in relatively small ranches. It might also be a floodplain potentially used by hundreds of small farmers. Our landscape of size (acres) L has two assets: s is a "small" scale asset (e.g., farmland) whose optimal acreage is less than L, l is a 'large' scale asset (e.g., wildlife habitat) whose acreage is L. The total value of the landscape depend on the value of output from two assets which we write as $V = v_s(s) + v_l(l)$. If both assets were controlled by the same party – either through sole ownership of both assets or through contracting among the small-scale landowners -- the first-best outcome would emerge: $V^* = v_s^*(s) + v_l^*(l)$.

If, however, the largescale asset cannot be controlled it can effectively become open access and the value from the asset would be dissipated so that the value simply $V = v_s^*(s)$ since$v_s(l) = 0$. [18] The optimal value derived from the largescale asset represents the gains from controlled access and optimizing use. Private contractual solutions to the landscape problem will depend on the net benefits of contracting and the costs of such contracts is expected to importantly depend on the number of parties (s/L) that control the landscape by virtue of ownership of the small scale asset. From this basis we develop our analysis of wildlife agencies as a contractual solution to the largescale landscape problem associate with wildlife and other environmental assets.[19] It is also possible to extend the analysis to the consideration of an additional landscape assets, such as a watershed or a scenic canyon. To the extent that the additional landscape asset spatially or otherwise complements the wildlife asset there may be

[18] If there are two assets but they have the same scale then the landscape 'problem' vanishes because a single owner would emerge.
[19] Libecap (1990) and Lueck (1989) both similarly focus on contracting for control of natural resources.

gains from coordinating use of the two largescale assets. Our model of organization considers this possibility.

To focus on wildlife we set aside the management of the small scale asset and focus solely on wildlife management, which can be provided by either private parties (e.g., group of landowners) or a state agency.[20] Wildlife management effort (w) is used to produce wildlife output (W) from a single acre of land. Management effort is a composite variable that includes law enforcement, population regulation (e.g., damage control, harvest rates), habitat manipulation, information and education, and research. The production of wildlife is $W(w)$ and has the standard properties $W'(w) > 0$ and $W''(w) < 0$.[21] The total cost of wildlife management per acre is C with $C'(w) > 0$ and $C''(w) > 0$. We assume the objective is to maximize the net value of wildlife by choosing wildlife management effort. We denote the shadow value of the output as ρ and L is the total acres of land (or potential habitat) in the state, so that the objective is[22]

$$(1) \qquad \max_{w} V = \rho W(w)L - C(w)L .$$

The first-best level of management effort (w^*) satisfies $\rho W'(w^*) \equiv C'(w^*)$ where the per-acre value of the marginal product equals the marginal cost of management.[23] The comparative statics are straightforward. Increases in the shadow value (ρ) will increase per acre management effort, but changes in total acres (L) have no effect on per acre effort. The total amount of management in the state is $(w^*)L$ and the total value of the output is $\rho W(w^*)L$.[24] If ρ

[20] Private wildlife management for game species is a large but relatively undocumented industry until recently. Nationally, 82% of all hunters hunted on private land compared to 40% who hunted on public land. Private land owners now routinely lease out land to guides or hunting clubs, charging from $100 a day to hunt pheasants to more than $10,000 for a bull elk hunt. See Aiken (2005) for more details.
[21] We assume static production technology and thus ignore biological parameters such as growth rates and carrying capacity.
[22] It would be possible to add a physical parameter (e.g., $\alpha > 1$) on L to capture economies of management from larger parcels of habitat.
[23] We ignore the distribution of rents generated. For private management, of course, the rent accrues to the landowner.
[24] Of course larger states will have more management and output in total but not on a per acre basis.

is a monetary price of output, then $\rho W(w^*)L$ is the first-best amount of periodic revenues from wildlife management, R^*.

B. Demand for Agency Management from Private Contracting Costs

In the first-best case private landowners control the wildlife landscape and would implement and benefit from *w**; thus, there is no demand for a wildlife agency. To allow for simultaneous private and public management, let (w_A) represent the effort of the agency and (w_P) represent the effort of private managers. Wildlife output (per acre again) is $W_A(w_A)$ for the agency and $W_P(w_P)$ for the private sector. Wildlife management costs (per acre) are $C_A(c_A)$ for the agency and $C_P(c_P)$ for the private sector. The total land in the state is comprised of public land (denoted l_A) and private land (denoted l_P) so that $L=l_A+l_P$ where L is fixed. The allocation of public and private land is taken to be exogenous to the wildlife management decision. The joint maximization problem is

$$\text{(2)} \qquad \begin{aligned} &\max_{w_A, w_B} V = \rho W_A(w_A)l_A + \rho W_P(w_P)l_P - C_A(w_A)l_A - C_P(w_P)l_P \\ &subject \quad to \quad L = l_A + l_P \end{aligned}$$

Assuming private and public landowners manage wildlife only on land they own, the optimal levels of private and state wildlife management are given by[25]

$$\text{(3A)} \qquad \rho W_A^A(w_A^*)l_A \equiv C_A^A(w_A^*)l_A$$

$$\text{(3B)} \qquad \rho W_P^P(w_P^*)l_P \equiv C_P^P(w_P^*)l_P$$

Note that the agency's budget is the cost of production evaluated at the optimal level of management effort is $B^* = C_A(w_A^*)l_A$.[26] In the case, where private and state production and costs are the same, this implies that the amount of public and private management will be identical on a

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[25] Superscripts denote partial derivatives.

[26] In a Niskan (1970) budget maximization model the revenues would be identical to expenditures (and both equal to the agency budget) because all rent is dissipated.

per-acre basis and that that relative size of the agency is determined solely by the fraction of public land in the state.[27]

The extent of private management and thus the size of the state agency are also determined by the ability of landowners to contract for control of the wildlife landscape (habitat and populations). It is useful to think of the land that is managed by each party as 'effective habitat' – that amount of land that actually can be controlled for (profitable) wildlife purposes. To clarify, we assume that the per-acre output and costs are the same for the two parties, and they are not affected by private contracting costs. Contracting costs simply determine the amount of habitat under the control of private managers and by implication the amount of habitat under the control of the state agency.

Let h_P be the effective private habitat and h_A be the effective agency habitat, where $L = h_A + h_P$. Effective private habitat is the amount of private land less the land not controllable because of contracting costs, so that $h_P = l_P - \chi$ where χ is the amount of land that cannot be controlled privately because of contracting costs. On the public side effective habitat is public land plus the private land not controlled privately, or $h_A = l_A + \chi$. The total amount of land in the state remains unchanged, or $h_A + h_P = l_A + \chi + l_P - \chi = L$. We use a simple formulation in which the uncontrolled land -- $\chi(n)$ -- depends solely on the number of private landowners and takes the specific form

$$\chi = \begin{cases} \left[n - 1/K \right] l_P & if\ n \le K+1 \\ l_p & if\ n > K+1 \end{cases}$$

[27] If they did differ then the most efficient party would have the largest budget even with identical land holdings. Adding a market for land would then reallocate the land as well.

where K is a threshold number of private landowners for which contracting becomes prohibitively costly.[28] The amount of uncontrolled private land is zero if there is a single landowner and approaches the entire amount of private land as the number of landowners increases.[29]

The optimal (per-acre) levels of private and state wildlife management do not change since they are determined by the per-acre returns to wildlife management, but the amount of land controlled by the agency and by private landowners is affected. This, of course, affects the size of the agency, which now becomes

$$(4) \qquad B = C_A(w_A^*)h_A = C_A(w_A^*)\left[L - l_p + l_P\left(n - 1/K\right)\right]$$

The agency's effective habitat is the total state area less private land plus the amount of private land lost because of contracting costs. Thus, the size of the agency is increasing in the number of private landowners (n) and decreasing in the average size of private land holdings (l_p / n), which is a prediction directly testable with the data.[30] The size of the agency is also decreasing in the contracting threshold number of parcels (K), and is increasing in the size of the state L.[31] The predictions can be summarized:

Prediction 1A. An increase in the size of the state (L) will increase the size of the agency budget (B^*).

Prediction 1B. An increase in the amount of open access public land (l_A) in a state will increase the size of the agency budget (B^*).

Prediction 2. An increase in the average size of private land holdings (l_A/n) will decrease the size of the agency budget (B^*).

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[28] More generally contracting costs should depend on the number of landowners, the size of private holdings, the variance in the size of private land holdings, and the territorial habitat requirements of the wildlife (Libecap 1989, Lueck 1989).

[29] The mean size of landholding is simply l_P/n. One might use alternative specifications for $\chi(n)$ but the main point is that contracting costs are increasing at a decreasing rate in the number of contracting parties. This formulation of χ also assumes that habitat requirements for wildlife exceeds the size of individual private parcels.

[30] We do not allow for the possibility that the agency can acquire private land or that the gains from private control of habitat might change. For example, the threshold value of parcels might depend on the shadow value of wildlife – $K=K(\rho)$ and $K'<0$ -- so that an increase in this value would increase the gains to private ownership and thus indirectly reduce the size of the agency.

[31] The agency size is also increasing in the value of wildlife since this is positively related to the optimal level of wildlife management. The comparative statics for the size of the private budget are the opposite (e.g., increases in landowners decrease private wildlife management).

C. Autonomous versus Hierarchical Agencies.

In this section we examine the tradeoffs between and implications of autonomous and hierarchical agencies which are the two basic types described in section II. We combine the approaches of Tadelis and Williamson (2014) who examine the tradeoffs between markets and hierarchies in private firms, and Brynjolfson & Milgrom (2014) who stress the importance of complementarity in shaping organizations. To start we define an autonomous agency to be one that has a rather narrow jurisdiction of tasks or areas of expertise (e.g., wildlife or water quality) and is not part of a larger agency. The typical mid-20th century wildlife agency is an example and such an agency was described by (4).[32] We define a hierarchical agency to be one that is part of a larger agency with a director or set of administrative controls that govern both the wildlife division and the other (environmental) division within the hierarchy.

The tradeoff between autonomous and hierarchical agencies is straightforward.[33] Autonomous agencies have relatively higher powered incentives because they are narrow and constrained by the groups who gain from their decisions.[34] Autonomous agencies have little incentive to be concerned with related assets (e,g., forests, watersheds, parks) and have little incentive to coordinate with administrators or these related agencies. Hierarchical agencies have tighter administrative control which allows for coordination among the subordinate divisions (e.g., wildlife and forests, wildlife and parks). These gains from coordination are most important when the agency assets are complementary.[35] The cost of the hierarchical agency is that there are

[32] See Wilson (1989) on autonomous agencies.
[33] The incentives here are related to discussions of moral hazard in public agencies, which can manifest itself in two ways as a reduction in effort as in a principal-agent model, or as a shift in effort across tasks as in a multi-task agency model (Holmstrom and Milgrom1991 Mookerjee (2006) discusses some of this issues from a mechanism design approach, noting that decentralized systems imply better incentives (less moral hazard) but make less efficient use of information and coordination than do centralized systems.
[34] Giles (1978) also argues that wildlife divisions within "super-departments" have to aggressively compete for funds with other divisions such as forestry and parks even when the funds are generated through hunting and fishing license revenues.
[35] Williamson (1975, 1999) has observed that hierarchy is a form of administrative control and is utilized to gear work towards a common goal or mission (of the board of directors or the agency director) and used to survey and monitor workers.

lower powered incentives for each division because they are not as tightly governed by benefitting groups and because this hierarchical constraint will impede the ability of an agency to pursue self-interested behavior by requiring that decisions made by the agency go through a long and tedious approval process.[36]

Agency organization influences the type of employees that staff the agencies.[37] Autonomous agencies with will be staffed by employees will similar backgrounds and qualifications (e.g., traditional game managers) and will have incentives to cater to a narrow range of constituents and interest groups (e.g., hook and bullet-cast and blast organizations). Hierarchical agencies, on the other hand, must employ a variety of different professionals and will face pressure from a broad range of interest groups (e.g., environmental and nongame wildlife organizations). A broader employment composition and broader interest group pressures weaken bureaucratic incentives to focus only on wildlife.[38]

To examine the tradeoffs between autonomy and hierarchy we consider an additional generic landscape asset which we is managed by choosing environmental management (e).[39] If there are two autonomous agencies then, relying on our earlier model the total value of the two autonomous agencies' asset management would be

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[36] For example, a wildlife division as part of a wildlife and air quality agency might want to improve the number and quality of hunting opportunities by planting winter forage and burning underbrush. This might conflict with goals of an air quality division and may prevent the burning of underbrush. Thus the action of a division might impeded by the goals of the larger agency. To be sure, an autonomous air quality agency can also try to stop an autonomous wildlife agency from taking certain actions but as Wilson (1989) notes, conflicts between agencies with lateral authority can be difficult to resolve. A hierarchical wildlife division must simply comply with the administrator of their dominant agency.

[37] These and related effects are discussed in the literature on bureaucracy, though the focus there is often on the effort of bureaucrats rather than on the size of the agency. For example, in the career concern model, bureaucrats are motivated to improve performance in an effort to increase the market value of their human capital. This incentive is strongest when agency missions are narrow and well defined so that the market can infer the marginal product of workers from their job positions (Dewatripont, Jewitt, and Tirole 1999).

[38] Macey (1992) notes that expanding the jurisdiction of an agency gives more interest groups influence over agency policy.

[39] Environmental management could include the provision of state parks, protection of forest watersheds, and the regulation of air and water quality.

(5) $V_A = [v_A(w^*) - c_A(w^*)] + [v_A(e^*) - c_A(e^*)]$.

In (5) w^* and e^* represent the levels of wildlife and environmental management chosen by an autonomous agency. The budgets of the two agencies are $B_A^w = c_A(w^*)$ and $B_A^e = c_A(e^*)$. Here we assume the relevant state land area is fixed to simplify the notation.

The potential gains from creating a hierarchical agency arise because of the complementarity in managing landscape assets. Following Brynjolfson & Milgrom (2014) we define assets to be complementary if $C_H(w,e) \leq c_A(w) + c_A(e)$; that is, when the costs decline with coordinated management.[40] This cost structure is consistent with the writings of wildlife administration scholars from Connery (1935) to Cannemela and Warren (1999) who argue that wildlife and environmental protection are delivered more efficiently under a combined administration by a broad agency.[41] The value of management from a hierarchy is

(6) $V_H = v_h(w') + v_A(e') - c_A(w',e')]$.

In (6) w' and e' represent the levels of wildlife and environmental management chosen in a hierarchy. The budgets of the two divisions within the hierarchical agency are $B_H^w = c_H(w')$ and $B_H^e = c_H(e')$.

The tradeoffs between the two organizations can be seen by comparing V_A to V_H. Because a hierarchy has lower powered incentives compared to autonomous agencies $[v_h(w) + v_A(e)] < [v_A(w) - c_A(w)]$; that is, value of management (for a given level of effort) is lower under hierarchy. For $V_H > V_A$ the gains from complementarity (and administrative coordination) must be large enough so that they outweigh the value reduction from lower powered incentives. This yields the following predictions.

Prediction 3. Agencies with complementary assets are more likely to be organized as divisions within a hierarchy.

[40] We assume no direct complementarity in the value of management.
[41] Cost reductions could result from less duplication of effort, a greater diversity of management techniques, shared information, and because of "increased employee performance resulting from an increased awareness and understanding of our ecosystem" (Cannemela and Warren 1999, 1062).

Prediction 4. As asset values increase hierarchical organization becomes more likely with complementary assets.

Prediction 5: Hierarchical agencies with complementary assets will have larger division budgets than autonomous agencies.

V. EMPIRICAL ANALYSIS

In this section we test the predictions using historical data on agency organization as well as cross section and panel data from U.S. states. Our historical analysis relies on historical accounts and records of various agencies as well as other data we use in our econometric analysis. For our econometric analysis of agency size and budget allocation we use pooled cross section data from the 1990 and 2000. To examine the effects of agency organization we use data from a panel data set from 1860-2010.

A. The Economic Evolution of Wildlife (and Environmental) Agencies

This section examines the evolution wildlife agencies from their inception in the simple game laws of the colonial period. Tables 1 and 2 (in section II) show the evolution of law and agencies from the period 1700-2000. To show an economic rationale to the major regimes changes that have occurred over the past two centuries we divide this period into five organizational regimes: 1) open access because of high landowner contracting costs; 2) game laws with wardens for enforcement; 3) primitive agencies with limited professional staff and few political constraints; 4) autonomous Pittman-Robertson (PR) agencies in which states could not exploit wildlife-based revenues for other purposes; and 5) modern hierarchical agencies. Table 3 is a summary of the summary of incentives under these five regimes.

Table 3

Origins from open access landscapes. Table 1 shows that during the 1700s there were a few game laws with enforcement the responsibility of local authorities. If enforced, these laws had the potential to limit open access waste, but from the perspective of local law enforcement officials these game laws were additional costs without clear benefits. Historians (e.g., Warren

xxxx) find that little enforcement effort was made and open access did not change much. The law at the time granted ownership of game only to animals possessed (i.e., captured or killed and landholdings were small and land use was not intensive (Lueck 1989).

The 19th and 20th centuries saw stark changes in wildlife habitat and land ownership patterns. During the 19th century the federal lands were generally privatized via sale or homesteading. From the late 19th century forward, however, federal land was removed from privatization and retained as national forest, national parks and other public lands. Figure 3 summarizes the changing pattern of private land ownership by showing the acreage of land in private farms and the average size of those farms over time. The total acreage of farmland grew steadily until around 1960, when a steady decline began. By contrast, the average size of farms declined from 1850 to 1880, and bottomed out at around 150 acres from 1880 to 1920. Average farm sizes rose from 1920 to 1990, remaining at over 400 acres from 1980 to 2010. The period 1850-1900 was a period in which landholdings were small and much land was still unsettled. It was also during this period that the US Supreme Court began to uphold the states' authority to regulate wildlife (Lueck 1989).[42] It was during this period that private contracting costs were relatively high and stimulated state action. It was also during this period that wildlife markets grew dramatically (Tober 1981) and open access exploitation took the largest toll on populations (see Figure 1 in section I).

Figure 3

Agency emergence and transformation. Fish and wildlife were the earliest environmental agencies as shown in Figure 4 (see also table 2). By 1900 all 48 states and territories had such agencies. Agencies replaced the simple law enforcement system in which wardens were often

[42] During the late 1800s there were many legal challenges to state authority to regulate fish and wildlife. A series of Supreme Court cases upheld this authority, culminating with *Geer v Connecticut* 161 U.S. 519 (1896).

paid in shares of fines.[43] Figure 4 also shows the emergence of other state agencies involved in managing landscape assets. The temporal pattern of this emergence suggests an economic rationale. Forest and parks come after wildlife, followed by water quality, and then finally air quality. Our model suggests state involvement when contracting costs are high and when potential rents exist. Water quality becomes an issue in the early 20th century as urban and industrial waste generate health costs. Air quality becomes as issue later with increases in population density and automobile use.

Figure 4

When, in 1937, the Pittman-Robertson (and later Wallop Breaux in 1950) became law a new organization emerged. Prior to the passage of these Acts, state politicians often distributed license fee revenues to other government programs, such as highway maintenance and schools (Lund 1980, Connery 1935), and wildlife agencies had weak incentives to increase wildlife related revenues. The new authority to keep license revenues increased agency incentives to improve the quality of hunting and fishing and reduced some of the peripheral political interest in wildlife policy. Perhaps because of this pay-for-use funding scheme, Wilson (1989) notes that wildlife departments are unique in their relative autonomy from legislative control.

Modern hierarchical agencies and optimal asset clustering. Our model of agency organization implies that agencies will become hierarchical when (cost) complementarities exist. Table 2 shows that wildlife agencies have tended to be merged into larger agencies with parks and forestry where complementarity seems self-evident. Indeed, the most common and simpler merger is with game and fish which has been the dominant 'wildlife" agency since the early 20th century. Table 2 shows only one state (Pennsylvania) does not unify (inland) fish with game.

[43] As Cannamela and Warrren (1999) and others noted this system of enforcement often led to violent and counterproductive confrontations.

Clustering also occurs in environmental agencies where forestry and parks are commonly merged, but health and water quality tend not to be (see the bottom rows of Table 2).

The process by which transformation from autonomous to hierarchical agencies is informed by our model as well. For example, commentators argued that a departmental hierarchy that controlled "…all conservation activities, not only of wild life, but also of state forests, (and) parks" would provide efficient and coordinated administration (Connery 1935). Examples of the potential gains from coordination are abundant. For example, Missouri established an integrated Conservation Department in 1937, by merging forestry with wildlife and fishery. Commentators wrote that integration was essential because: "There was no way forest wildlife could be brought back without control of wildlfire."[44] Moreover, vegetation from forests moderate stream temperatures and provide shade for fish in streams; however deer and other wildlife also damage productive timber so complementary relationships run in both directions. Deer populations also interact with humans in other negative ways (e.g., Lyme Disease, vehicle collisions, crop damage) that generate potential gains from coordination with health and highway departments, for example. More recently, in the 2000s, hunting and fishing organizations opposed a reorganization of Missouri's wildlife agency with the state's Department of Environmental Quality, perhaps because of the added uncertainty of how license revenues would be spent in the larger hierarchy.

Figure 5

The emergence of hierarchical agencies coincides with changes in agency funding. Table 2 shows that by the 1970s most agencies were now divisions of hierarchical agencies. In 2010, just 18 (of 50) were autonomous. Figure 5 shows how the share of revenue from user-based sources (i.e., hunting and fishing licenses and federal taxes on related equipment) have fallen as a share of all wildlife agency/division expenditures. Until 1970, these used-based sources provided

[44] See http://mdc.mo.gov/sites/default/files/resources/2010/05/5418_3349.pdf, pg. 203, pg. 206.

well over 90 percent of expenditures; by 2010 these sources provided around 75 percent of the budgets. These change is consistent with our model of agency organization which implies that hierarchical agencies will shaped by non hunter-angler interests and thus use funds from outside this group as well.

B. Description of the State Level Data

The empirical variables are organized in the following categories: the dependent variables, contracting cost and land-habitat variables, agency organization variables, wildlife demand variables, and controls. Tables 4 and 5 shows the variables used in the cross section estimation and their summary statistics. Further details of the data collection process are described in the appendix. The 1990 and 2000 data are compiled from several sources (see Appendix) including the Wildlife Conservation Fund of America (WCFA), the U.S. Wildlife Service (USFWS), the U.S. Bureau of the Census, the Economic Research Service of the U.S. Department of Agriculture (ERS), the Wildlife Management Institute (WMI), the International Association of Wildlife Agencies (IAFWA), and individual state wildlife agency websites.

The dependent variables are the wildlife agency's annual budget (*BUDGET*); it's revenues from license sales (*LICENSE REVENUES*); its revenues from non-user based general funds (*GENERAL FUNDS*), and the percentage of an agency's budget allocated towards non-game (*NON-GAME*). The budget and revenue source data come from regular *Surveys of State Wildlife Agency Revenue* conducted by the WCFA. The budget calculations include all revenue derived from license fees, general funds, donations, federal sources, and other miscellaneous in-state sources. To maintain consistency across agencies with different jurisdiction and hierarchal organizations, the budget calculations exclude any revenue that is derived from peripheral sources such as state parks, forests, and commercial fisheries. *NON-GAME* indicates the expenditures used to fund non-game programs as a percentage of the agency's total budget. The non-game expenditure data comes from regular surveys conducted by the IAFWA entitled *State Wildlife Diversity Program Funding*.

Table 4, Table 5

We use three variables to account for differences in private and public wildlife habitat and for landowner contracting costs. The variable we use to measure the extent of open access land holdings is the percentage of federally owned open access land (*PUBLIC LAND*) in each state.[45] The percent of urban land (*URBAN LAND*) is also used to control for the amount of potential wildlife habitat. The variable (*FARM SIZE*) is the average size (in acres) of farms in each state and this is our proxy for landowner contracting costs. The agency organization variable is *AUTONOMOUS*. *AUTONOMOUS* equals one if the wildlife agency is free-standing (see panel A in figure 2).

We measure differences in demand for game and non-game with several variables from a national survey of outdoor recreation that is conducted twice a decade.[46] Demand for game is separated into categories for residents and nonresidents and for hunters and anglers. Resident demand for game is measured by the total number of state residents that hunted (*HUNTERS*) or fished (*ANGLERS*) in any U.S. state. Nonresident demand for game is measured by the total number of nonresidents that hunted (*NONRESIDENT HUNTERS*) or fished (*NONRESIDENT ANGLERS*) in each state. Non-game demand is measured by the total number of days that state residents spent watching wildlife (*WILDLIFE WATCHING*). We also control for the overall size of the state budget (*TOTAL STATE BUDGET*) in all equations. In our estimates of non-game budget allocation we also control for other institutional features of non-game management and discuss those variables below.

[45] Federally owned open access land includes Forest Service (USFS) and Bureau of Land Management (BLM) landholdings but excludes Park Service (USPS) and Bureau of Indian Affairs (BIA) land holdings. Unlike USPS and BIA land, wildlife recreational access on USFS and BLM land is generally unrestricted.
[46] The data used to measure this demand come from the *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* (various years) conducted by the U.S. Fish and Wildlife Service. The survey has been conducted since 1955 and is one of the most comprehensive continuing outdoor recreation surveys available.

C. Cross Section Estimates of Agency Budgets

We estimate the size of a wildlife agency (its budget) using pooled data for 2000 and 1990. We use the following empirical specification, where for any state *i* the complete model is

(7) $B_{it}^* = X_{it}\beta_{it} + \theta_{t=2000} + \varepsilon_{it}$ $i = 1, \ldots 50,\ t = 2000$ and 1990.

where B_{it}^* is the budget of the agency in state *i* during time period *t*, X_{it} is a matrix of independent variables including a unit vector for the constant term, β_{it} is column vector of unknown coefficients, $\theta_{t=2000}$ is a year 2000 dummy, and ε_{it} is a column vector of error terms.

The results of six different OLS specifications are presented in Table 6. Specifications 1-2 use the pooled data, specifications 3-4 use 2000 data, and specifications 5-6 use 1990 data. In general, the results presented in Table 4 are consistent with the predictions of the model.

Table 6

The coefficients on the contracting cost variable and wildlife habitat variables have the predicted signs. For 2000, the estimated coefficients indicate that a ten percentage point increase in *PUBLIC LAND* is correlated with about a \$6-\$7 million increase in agency budgets. These estimates are consistent with the prediction that more federally owned land under open access policy decreases the costs of agency management relative to private landowner management. For 2000 the coefficients on *FARM SIZE* indicate that an increase of average farm size by 100 acres is correlated with about a \$5-10 million decrease in agency budgets. Taken together the coefficient estimates on *PUBLIC LAND, FARM SIZE,* and *URBAN LAND* suggest that increases overall habitat, the proportion of habitat held by public agencies and private contracting costs will increase the demand for agency wildlife management.[47] The estimated coefficients for *AUTONOMOUS* are either positive or negative, depending on the specification, but they

[47] The negative effect of *URBAN LAND* is consistent with the prediction that a decrease in land for wildlife habitat (*L* in our model) decrease agency budgets. However, increases in *URBAN LAND* could also lead to an increase in private contracting costs thereby causing an increase in budgets. Our estimates show that the habitat effect dominates the contracting cost effect.

all have relatively large standard errors. Taken together we find no evidence that autonomous agencies different budgets during this period.[48] We examine this issue more carefully with panel data below.

We expect that increases in the wildlife demand variables to should increase the size of agency budgets and this is generally the finding with the exception of *RESIDENT HUNTERS* which has negative coefficients though statistically insignificant. The reason for this seemingly contradictory effect is that increases in resident hunters decreases the amount of funding from state general funds as we explain below. Note that many of these demand variables are highly correlated with each other and this helps explain why the standard errors are relatively large.

We also control for other general state-wide effects with *TOTAL STATE BUDGET*, *POPULATION*, and per-capita income (*INCOME*). These results indicate that general increases in overall state budgets, population, and income tend to not have direct effects on the size of wildlife agencies. These findings offer indirect support for our model where the demand for the agency is based on contracting costs rather than overall demand for public goods or wealth redistribution through government spending.

We estimated many other specifications, using different variables, samples or methods, but do not present them here. Some of the important findings are discussed here, but none appreciably change the findings discussed above. For example, we included a variable that measures variation in farm size and found this variable to have a positive effect on budgets sizes that was generally only marginally statistically significant. Because more variation will increase contracting costs, this finding is consistent with our theory but we do not include the variance

[48] For 1990 narrow agency budgets are from 2 to 11 million dollars lower; for 2000 the reduction is from 19 to 31 million dollars.

measure in our main specifications because it is crudely constructed and because it is highly correlated with *FARM SIZE*.[49]

Estimates of the Budget Composition

The discussion of the change in funding sources (see Figure 5) above warrants more analysis. To further examine wildlife agency budgets we also separately estimate important components of the agency budget: the revenues from the sale of licenses for hunting, fishing, and trapping (*LICENSES*) and revenues from state general funds not based on wildlife use (*GENERAL FUNDS*). The results of six different specifications are presented in Table 7 – three for each of the two dependent variables. The results presented in Table 7 are generally consistent with the predictions, but also give additional insights.

Table 7

As Table 7 shows, contracting costs and habitat sometimes have differential effects on license revenues and general funds revenues. FARM SIZE in particular has no effect on license revenues but it has a negative effect on general funds. This result suggests that general taxpayers rather than hunters tend to finance the extra administration, regulatory, and enforcement expenses that wildlife agencies incur in states where private contracting costs are high. Increases in *PUBLIC LAND* lead to more revenues from all sources, and increases *URBAN LAND* leads to a reduction in revenues from all sources. Finally, *AREA* has a large positive effect on general funds but not on license revenues suggesting that costs of managing extra habitat are borne by general taxpayers. *AUTONOMOUS* has no strong effect on the budget components in this cross section.

[49] Because it can reasonably argued that there might be diminishing returns to habitat, we also estimated specifications with *AREA* and $AREA^2$ where we found the *AREA* still had a positive effect and $AREA^2$ had a negative effect (though small and not statistically significant). Because Alaska and Hawaii are such unusual states in terms of habitat, species, and landownership we also estimated the same specifications in Table 6 excluding them from the data. In doing so we found similar effects generally but a larger effect on AREA. We also estimated specification using various combinations of specific wildlife demand variables. In addition, we replaced contemporary wildlife demand variables with lagged variables to control for possible reverse causation and found that using lags had little effect on our main results.

The estimated coefficients on the wildlife demand variables indicate some subtleties in agency funding. The prediction of a positive effect is found for *ANGLERS* but for *HUNTERS* the estimates show a seemingly contradictory negative effect on general funds and general appropriations. A possible explanation for these rather strong negative effects is that increases in resident hunters indicate a more completely captured and narrowly focused agency that does not cater to the general public. The coefficient estimates for *NONRESIDENT HUNTERS* and *NONRESIDENT ANGLERS* are positive for license revenues, but only nonresident angler coefficients are positive for the general funds measures.

Again we also control for other general state-wide demand effects using *TOTAL STATE BUDGET, POPULATION*, and *INCOME* variables. We also find that the effects of these variables are small and generally statistically insignificant. This finding indicates that the separate components of wildlife agency size are not strongly linked to any overall size of the state governments or with income and population increase and this supports our contracting cost-based model of agency demand.[50] As above we estimated other specifications, using different variables, samples or methods. In general the results do not change although some of the estimates are sensitive to the inclusion or exclusion of the observations from Alaska and Hawaii.

D. Estimates of Budget Allocation Between Game and Non-game Management

We modify the budget model in order to examine the allocation of resources between the management of game and non-game species.[51] The game side of the wildlife agency is the same as above, though we now use subscripts *G* and *N* to distinguish game and nongame. Now the agency also must choose non-game management (w_N). The costs of wildlife management in this type of agency are $C = C(w_G, w_N)$ as we noted in our discussion of cost complementarity. Since

[50] The positive coefficient on *YEAR 2000*, however, provides some evidence of a time trend in general funding.
[51] The division between non-game and game users is strong according to some wildlife management professionals. Ledford (1998) reports that "there is a very real us versus them mentality among some wildlifers with game species interests and others with non-game interests".

non-game wildlife output (W_N) is a public good we assume that the state will effectively manage non-game wildlife across all land within the state.[52] The objective function becomes

$$\max_{w_A, w_N} V = \rho_G W_G(w_G)h_A + \rho_N W_N(w_N)L - C(w_G, w_N). \quad (8)$$

with the same land constraint as (2). The first term is the revenue from game management and the second term is the (shadow) revenue from non-game management. Given the optimal choices -- w_G^*, w_N^* -- the two separate revenue components, for the game and nongame programs respectively, are

$$\begin{aligned} G^* &= C_G(w_G^*)h_A \\ N^* &= C_N(w_N^*)L \end{aligned} \quad (9)$$

Now the agency budget is $B^* = G^* + N^*$ and the percent of the agency budget devoted to non-game is $A^* = (N^*/B^*)100$.[53]

A number of predictions emerge. Increases in demand (increases in ρ_A, ρ_N) will increase both budgets and the effect on the share devoted to non-game will depend on the relative size of such an increase. Increases the share of public land (l_A/L) will increase game management but not affect non-game management so A^* will decrease. Increases in land owner parcel size will decrease the game budget but have no effect on non-game management, so A^* will increase. These predictions are summarized as

Prediction 6. A autonomous agency will allocate a smaller share of its budget to non-game management compared to a hierarchical agency ($A^* < A^B$).

Prediction 7. An increase in the average size of private land holdings (l_A/n) will increase the non-game share of the agency budget (A^*).

Prediction 8A. An increase in game wildlife demand (ρ_G) will decrease the non-game share of the agency budget (A^*).

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[52] This simple assumption rules out private non-game management. It would be possible to develop a habitat loss function as with game management.

[53] In 2000 we find that the state average $A = 5\%$.

Prediction 8B. An increase in nonuse-based wildlife demand (ρ_N) will increase the non-game share of the agency budget (A^*).

Data are limited for nongame expenditures, so we estimate the budget allocation of an agency with pooled data and for a given year using the following empirical specification, where for any state *i* the complete model is

$$A_i^* = X_{it}\beta_{it} + \theta_{t=1995} + \varepsilon_{it} \quad , \; i = 1,\ldots,50 \;\; t = 1995 \text{ and } 1990. \tag{10}$$

where A_{it}^* is the fraction of the budget allocated to non-game management (defined above) of the agency in state *i*, X_{it} is a matrix of exogenous variables including a constant, β_{it} is column vector of unknown coefficients, $\theta_{t=1995}$ is a year 1995 dummy, and ε_{it} is a column vector of error terms. We estimate (10) with the cross section data for 49 states in 1995 and 50 states in 1990.[54] . The results of six different specifications of (10) are presented in Table 8, with two pooled, two for 1995 and two for 1990.

Table 8

The estimated coefficients for *FARM SIZE* are positive as expected and imply that increases in private contracting costs are correlated with increases in the percentage of agency budgets allocated towards non-game. These results support the notion that an increase in contracting costs among private landowners leads to a greater relative demand for state agency provision of non-game management, which is a public good.[55]

With the exception of *AREA*, which is negatively correlated with non-game management, the habitat variables have mixed effects and are not generally statistically significant. Here *PUBLIC LAND* is predicted to have an ambiguous effect because as this type of land increases there is more demand for both game and non-game management by the agencies and hence no

[54] There are no data available for California for 1995.

[55] The coefficients on *FARM SIZE* suggest that non-game allocations will increase 0.2 to 0.4 percentage points in response to an increase of 100 acres in average farm size.

clear prediction about the share of the budget allocated to non-game. Similarly, and increase in *URBAN LAND* decreases habitat for both game and non-game so the effect is also ambiguous. . The estimates for *AREA*, however, are negative, indicating that a state with ten thousand more square miles (6.4 million acres) would allocate from 0.1-0.2 percentage points less of the budget to non-game management. For *AREA* the game demand effect overwhelms the non-game demand effect.

The estimated coefficients on the agency organization variables generally support our predictions that autonomous agencies will allocate a smaller share of their budgets to non-game management. The coefficient estimates on *AUTONOMOUS* are negative in all specifications and statistically significant; they indicate that an autonomous agency will allocate about 2-4 percentage points less of its budget to non-game than will a hierarchical agency. This effect is large in magnitude considering that the mean non-game allocation across states was only 4.1 percent and 4.9 percent in 1990 and 1995 respectively.

The 1995 estimated coefficients on the wildlife demand variables are generally consistent with the predictions but the 1990 coefficients are not. The 1995 estimate for *HUNTERS* are negative indicating an increase in hunters reduced the budget allocation to non-game management. The 1995 coefficient on *WILDLIFE WATCHING* is positive, as predicted, suggesting that wildlife watchers influence how much an agency allocates to non-game. The 1990 coefficients on these variables, however, are all insignificant. This may suggest that early non-game programs were less responsive to constituent forces.

Again we control for other general state-wide effects: a) the coefficient estimates for INCOME are small and insignificant, rejecting the view that richer populations place more value on such amenities as non-game species; and b) the estimates for POPULATION are not stable, changing sign even while remaining statistically significant. We also control for other legal and regulatory forces that can affect budget allocations towards non-game, in particular the impact of federal Endangered Species Act (ESA) policies and state tax return contribution systems.

Because federal endangered species law and regulations can encourage states to implement non-game management programs it is important to control for the cross state variation in this policy. An ideal variable to control for would be some measure of the total costs incurred by states as a result of federal ESA listings. If states are trying to avoid or limit federal control, non-game allocations should increase positively with the costs incurred as a result of listing. We use the total amount spent by state agencies and the USFWS through Section 6 of the ESA *(ESA SECTION 6 FUNDS*)[56] and find coefficient estimates that are positive and statistically significant in all specifications.[57] We estimated other specifications, using slightly different variables. None of these alternatives change the findings discussed above. For example, using the number of federal endangered species (instead of ESA section 6 funds) had a similar effect.

E. Estimates of the Effect of Organization on Budgets using Panel Data

We now use panel data to estimate the effects of agency organization on agency budgets. We have built a state-level annual panel data set of agency organization and founding dates spanning 1860 to 2010 and are in the process of adding other variables to the panel. We constructed the panel on organization on a state-by-state basis, primarily by visiting the websites of state historical archives departments but also by reading accounts of agency organization from other sources. We are presently creating a detailed appendix of this process.

Other annual variables come from a variety of sources, and span different time periods. For the period spanning 1952 to 2008, we have collected annual data on the expenditures each state makes on fish and game along with annual data on total state revenues and expenditures on,

[56] Through Section 6, states can receive federal funding "to assist in the development of programs for the conservation of endangered and threatened species or to assist in monitoring the status of candidate species." This a grant program that requires that state agencies submit a proposal to the U.S. Fish and Wildlife Service and offer matching funds (16 U.S.C. §§ 6).

[57] These results suggest that states agencies may be trying to avoid federal control by increasing spending when the risk of listed species is high or that agency constituents are more effective in lobbying for the well-being of endangered and threatened species than other non-game. We also control for whether or not a state has a non-game tax check off fund (*TAX CHECKOFF*) however, the coefficient estimates are statistically insignificant; implying that the presence of a state voluntary contribution mechanism has little systematic impact on the budget allocation.

and revenue from, related assets such as parks, forests, and public health. These data come from various U.S. Census surveys of state government finances. For the period spanning roughly 1925 to 2008, we have also collected data on revenues from fishing and hunting licenses and on federal appropriations from Pittman-Robertson and Dingell-Johnson. These data come from the U.S. Fish and Wildlife Service. However, the license data spanning 1925 to 1940 are incomplete because those data primarily omit fishing license revenue and focus on hunting license revenue. For a period spanning 1929-2010, we have also collected annual data on state populations and per-capita incomes, from the U.S. Bureau of Economic Analysis.

In addition to the annual state-level panel, we have thus far collected other variables for more sporadic time periods. From the Agricultural Census reports (downloaded from Haines, Fishback, Rhode. 2010), we have data on total land in farms, average farm size by state, and the total number of farms exceeding 1000 acres. We have these variables for decadal periods during 1870-1930, and approximately every five years since 1930, with a few gaps. We also have data on state populations for each decade, from 1860 to 1930. To this we add data on state's total area, acres owned by the federal government, and acres owned by each state as parks. Federal (open access) landholdings are relatively time invariant since the 1930s, and we presently only have data for 1944, 1970, 1980, 1990, 2000, and 2010 for this variable. We have data on acreage in state parks for about every five years from 1970 to 2010. This variable is also relatively time invariant, but there are some within state changes over time. The data on federal and state parks come from tables in U.S. statistical abstract reports of the U.S. Census Bureau, and, in some cases, from reports of the land holding agencies.

Using these data, we estimate two sets of regressions denoted by equations (11) and (12). In both cases, the dependent variable is the log of fish and game expenditures (either as an autonomous agency or a division within a hierarchy).

$$\ln B_{it} = \theta_t + \lambda AUTONOMOUS_{it} + \delta X_{it} + \gamma Z_i + \varepsilon_{it} \qquad (11)$$

(12) $$\ln B_{it} = \alpha_i + \theta_t + \lambda AUTONOMOUS_{it} + \delta X_{it} + \varepsilon_{it}$$

The notation *i* refers to the 48 states (excluding Alaska and Hawaii) and the notation *t* refers to each year, spanning roughly 1950 to 2008. The notation X_{it} refers to time variant controls (e.g., population, per-capita income, and total state revenues) and the notation Z_t refers to time invariant variables such as state total acreage, and variables we treat as time invariant such as total federal acreage. The notation θ_t refers to the year fixed effects, which we include for each the 58 years to control for trends in fish and wildlife demand and other time-related factors.

Equation (12) differs from equation (11) because (12) allows each state to have its own intercept, by including state fixed effects. Hence, the key coefficient λ in (12) measures relationships between organizational structure and budgets based on within state variation over time (e.g., organizational changes within a state rather than organizational differences across states). By contrast, the coefficients λ in (11) measures the relationship between organization and state budgets based on both cross-state and within state time variation. Equation (12) is a better design for identifying the causal effects of organization on budgets, because unobservable time invariant differences across states (e.g., mix of wildlife species endemic to an area) are absorbed by the state fixed effects. We show the pooled regressions of equation (10), however, to demonstrate relationships between time-invariant variables (and relatively time invariant variables) and state budgets. *AUTONOMOUS* again indicates the type of organization. In the estimates below not only use this simple autonomous - hierarchical indicator but we also use indicators that denote the type hierarchy; that is, whether or not wildlife is in a hierarchy with parks, forest, agriculture, and so on. This allows us to examine how specific organization regimes affect outcomes.

Table 9 shows OLS pooled estimates of equation (11). All errors are clustered by state, to account for possible serial correlation within states over time (Bertrand et al. 2003). To force the federal land and farm variables into years for which we lack data from those variables, we inpute missing values by imposing linear growth between data points. Column 1 and 4 omit the farm size variables. In columns 2 and 4 we include average farm size to proxy landowner contracting costs. In columns 3 and 5 we include the number of farms larger than 1000 acres to proxy landowner contracting costs. In columns 1-3, we include an indicator for whether or not the agency is autonomous. In columns 4-6, we control for more details about agency organization, by including indicators for the combinations of agency organizations described above. All specifications control for state revenue, population, and per capita income. Because the coefficients and dependent variables are logged, they have elasticity interpretations.

Table 9

The estimates from table 9 show that more acreage in a state is associated with larger budgets, but this relationship is driven primarily by federal acreage. As our basic model of agency size implied, more open access federal land will increase the size of an agency. In terms of the landowner contracting costs variables, average farm size is negatively related to budgets. A 10 percent increase in average farm size across states is associated with a 2.83 percent decline in state budgets (and perhaps an increase in private wildlife management as we theorize).

Comparing the organization variables shows that larger budgets are associated with autonomous agencies. The column 2 coefficient indicates that being autonomous is associated with an approximately ($e^{0.164}$ -1) 17.8 percent larger budgets. The columns 4-6 coefficients, however, show that the relationships between hierarchy and budgets depend on which agencies are merged together into a single cabinet. Wildlife departments that are merge with forestry and environmental quality departments have smaller budgets when compared to wildlife departments that are autonomous or part of cabinets with parks, marine fisheries, and agriculture.[58] A key difference is that parks and marine fisheries generate significant revenues from user funds whereas forestry and environmental quality departments do not. Hence, the revenue from wildlife

[58] We do not take much stock in the wildlife & agriculture coefficient because this is estimated from only a few states that combined wildlife with agriculture.

agencies may be more at risk from appropriation by forestry and environmental quality departments. This difference may explain why wildlife agencies combined with these services may have smaller budgets.

Table 10 shows fixed effects estimates of equation (11). Comparing the results across Tables 9 and 10, we note the following patterns. First, in both sets of estimates there is evidence that higher landowner contracting costs are associated with smaller wildlife budgets. In Table 10 agency budgets decrease by 0.08 percent with a one percent increase in the number of large farms. By contrast, budgets in the pooled regression results respond negatively to changes in average farm size, rather than responding to the number of large farms. The fact that budgets are not negatively related to farm size in the panel with fixed effects is interesting. This may be because shifts in farm size within a state over time measure two forces that have opposing effects on wildlife budgets. On one hand, decline average farms sizes is a proxy for declining habitat (via urban subdivision) that should have the effect of shrinking wildlife demand and hence budgets. On the other hand, declining average farms sizes should raise landowner contracting costs, thereby raising demand for public wildlife management. By contrast, changes in the number of large farms within a state over time may better isolate changes in contracting costs without being confounded by changes in habitat.

Table 10

Second, table 10 shows that specific changes in hierarchy are strongly related to changes in agency budgets within states over time. As was the case in the pooled estimates of table 9, we find evidence here that the combination of wildlife agencies with forestry reduces expenditures on fish and wildlife. Unlike table 9, however, we also find evidence in table 10 that the combination of wildlife with parks raises expenditures on fish and wildlife by up to ($e^{0.191}$ -1) 21 percent. Whereas tables 9 and 10 are similar in that both reveal a negative relationship between budgets and the combination of wildlife with environmental quality, in table 10 the relationships are not statistically significant.

In terms of the control variables, larger state revenues and per capita incomes are associated with larger expenditures on fish and wildlife. State populations have no significant association with fish and wildlife expenditures, perhaps because the larger demand induced by larger populations is offset by habitat loss associated with more people. To summarize the results, there are strong indications that agency hierarchy affects expenditures and also indications that landowner contracting costs do as well. .

V. CONCLUSION

In this paper we examined the determinants of the organization and behavior of public bureaucracy by studying state the evolution of state wildlife agencies from their inception in colonial game law to their manifestation as modern hierarchical environmental agencies. To our knowledge this is the first such empirical analysis of this fundamental component of modern governments. Our study examines the tradeoffs and evolution of public administration of landscape scale environmental resources.

The economic history shows that state environmental governance institutions evolved in response to imperfect incentives, first arising from the high costs of controlling a landscape scale asset. From this beginning the governance path -- from game laws to piece-rate wardens to fledgling agencies and then to autonomous and finally hierarchical agencies – shows the tradeoffs inherent in imperfect organizations. For wildlife, states passed laws to prevent overexploitation which result from high contracting costs. From here the public administration and manage of wildlife begins with unspecialized enforcers of laws. Lacking a specialized agency, the incentives to enforce were too weak so the agency emerges as a specialized law enforcer. Fledgling agencies generated their own revenues to fund enforcement by developing a system of licensing for the harvest of wildlife. This in turn led many state governments to ‘steal’ this wildlife revenue by diverting it other a variety of other state actions, often distant from wildlife and environmental issues. Establishing autonomous agencies limited this revenue grab but not until the Pittman Robertson act did agencies receive protection from other state agencies. These autonomous agencies thrived until the past few decades when the growing number of complementary assets (due to rising population density, growing number of deer, and emerging interest in 'environmentalism') led to the creation of hierarchical agencies that coordinated activities of wildlife and related asset management. In turn, the funding for these hierarchical agencies has relied less on user-based revenues and more on state general funds..

The economics of bureaucracy has been dominated by theoretical models and case studies of federal agencies. Our study using a long panel of state data illuminates the rationale for environmental agencies and explains their size and structure as well has how their behavior is influenced by their organization. Though the data we use are admittedly imperfect, the analysis here nonetheless shows that public bureaucracy is shaped by a combination of contracting costs, organizational structure, and demand from users. Further analysis of all types of state agencies would undoubtedly expand our understanding of these important organizations.

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Table 1: Evolution of State Wildlife Management, 1700-2000

Year	Game Laws Adopted	Specialized Wildlife Law Enforcement Position	State Game Commission Created	Resident License System Adopted	Non-resident License System Adopted	Funding
1700	3 (25% of colonies)	local authorities responsible for enforcement of game laws	0	0	0	none
1750	10 (76.9% of colonies)	local authorities (Massachusetts creates local deer wardens in 1739)	0	0	0	none
1800	13 (81.3% of states)	local authorities	0	0	0	none
1850	18 (58.15% of states)	primarily local authorities (2 more states create local wardens --NH fish wardens 1809, ME moose wardens 1852)	0	0	0	none
1900	48 (98% of states and territories)	31 states (63% of total) develop warden positions at local and/or state level (compensation is often unspecified, but varies across states between salaries and piece-rate)	17 (34.7%) Massachusetts establishes first commission 1865, International Association of Fish, Wildlife, and Conservation Commissioners formed 1902	5 (10%) Michigan and North Dakota were the first in 1895	9 (18.4%) New Jersey was the first in 1873	limited (states allocated meager funds from general budget as they began to collect license fees)
1950	50 (100% of states and territories)	50 (100%) have game wardens	46 (92%)	44 (89.8%)	?	Pittman-Robertson Act of 1937 forces states to give full license fee to game agencies
2000	50 (100% of states)		50 (100%)	50 (100%)	50 (100%)	funding sources vary, but all agencies are funded by license fees, federal monies, tax check-offs, dedicated taxes, and other special programs

Sources: Palmer (1912), Lueck (1989, 1998), and Belanger (1988). Each cell indicates the number (%) of states with the various wildlife management regimes.

Table 2: Evolution of State Environmental and Resource Agencies, 1860-2010, excluding Alaska and Hawaii

	1860	1870	1880	1890	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
States with Board, Commission, or Agency																
Agriculture	5	8	23	33	40	44	47	47	47	47	47	47	48	48	48	48
Health	1	4	24	38	42	47	48	48	48	48	48	48	48	48	48	48
Inland fish	0	12	31	34	41	46	46	47	48	48	48	48	48	48	48	48
Wildlife (includes warden)	0	0	4	11	30	40	46	47	48	48	48	48	48	48	48	48
Saltwater fish	1	7	14	15	18	18	19	19	20	20	21	21	21	21	21	21
Forests	0	0	1	7	13	28	37	45	46	48	48	48	48	48	48	48
Parks	0	0	0	1	4	10	19	31	44	44	47	48	48	48	48	48
Water quality	0	0	0	0	0	0	0	4	6	22	34	47	48	48	48	48
Air quality	0	0	0	0	0	0	0	0	0	0	7	44	48	48	48	48
Oil & Gas	0	0	0	0	0	1	4	9	18							
Wildlife Agency is in a hierarchy with:																
Inland fish	0	0	4	8	26	36	43	45	47	47	47	47	47	47	47	47
Saltwater fish	0	0	3	4	5	7	11	11	11	12	13	14	18	18	19	19
Forests	0	0	0	0	3	5	7	12	21	18	17	21	23	19	21	20
Parks	0	0	0	0	0	0	4	10	18	15	15	22	27	28	29	28
Agriculture	0	0	0	0	1	0	5	3	2	1	1	1	2	1	1	1
Water quality	0	0	0	0	0	0	0	1	2	4	3	9	12	12	10	10
Air quality	0	0	0	0	0	0	0	0	0	0	0	6	9	10	9	9
Health	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Oil & Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wildlife is an autonomous agency (except for inland and saltwater fish)																
Number (% of total)	na	na	4(100)	11(100	27(90)	35(88)	38(83)	33(70)	26(54)	30(63)	31(65)	23(48)	19(40)	18(38)	17(35)	18(38)
Environmental agency combinations																
Forestry & parks	0	0	0	0	0	3	10	20	26	27	25	25	26	24	23	24
Forestry & agriculture	0	0	0	0	2	3	4	3	2	1	2	3	5	8	8	9
Health and water quality	0	0	0	0	0	0	0	2	3	13	23	26	15	11	5	4
Health and air quality	0	0	0	0	0	0	0	0	0	0	6	26	15	11	5	4
Water quality & some natural resource	0	0	0	0	0	0	0	1	2	4	5	10	18	16	17	16
Air quality & some natural resource	0	0	0	0	0	0	0	0	0	0	0	8	18	16	17	16
Oil-gas &																

Notes: (1) Mississippi was the last state to create a wildlife agency, doing so in 1932. (2) The last state to create an agricultural agency was Maryland, doing so in 1972. (3) Nevada was the last state to create a forestry agency, doing so in 1945. The last state to create a parks agency was North Dakota, in 1965. (4) Four states created water quality boards and commissions during the 1920s: Connecticut, Illinois, Pennsylvania, and Wisconsin (with Pennsylvania first in 1923). (5) The seven states that created air quality agencies during the 1950s were: Florida, Louisiana, Maryland, New York, Oregon, Pennsylvania, and Rhode Island. (6) Pennsylvania is the only state with separate agencies for wildlife and inland fish. (7) As of 2010, Rhode Island was the only state that combined wildlife administration with the administration of agriculture. (8) In a few cases, commissions, boards, and agencies were temporarily abolished and then reinstated. (9) It is not uncommon for certain resources to move back and forth from autonomous to hierarchy administration over time. (10) In a few cases, a common secretary or board oversees two autonomous administrative agencies. We consider these agencies to be autonomous, rather than combined, for purposes of coding.

Table 3
Economic Forces under Different Organizational Regimes

	Open Access	*Laws with Wardens*	*Primitive Agencies*	*Autonomous PR Agencies*	*Modern Hierarchical Agency*
Overuse of the resource	Yes	Yes	Reduced	No	No
Power of incentives for management	Low	Low	Higher	Higher	Lower than autonomous
Coordination with other asset users	None	Low	Low	Low	Higher

Table 4: Variable Definitions and Summary Statistics (2000)

Variable Name	Definition	Minimum	Maximum	Mean	Standard Deviation
Dependent Variables					
BUDGET	Total budget ($1000)	$5,900	$2,227,000	$52,700	$ 42,000
LICENSE REVENUES	Revenues from license sales ($1000)	$218	$67,900	$22,600	$16,100
GENERAL FUNDS	Funds from state treasury: earmarked & general appropriations. ($1000)	$1,700	$128,000	$17.,900	$26.,000
NON-GAME	1997 non-game spending as a percentage of 1996 total budget	0.28%	21.69%	4.94%	4.94%
Contracting Costs & Habitat					
AREA	Total land & water area (sq. miles)	1,544	663,267	75,879	97,068
PUBLIC LAND	Percent of total land that is federally owned open access land	0.34%	82.87%	15.30%	21.01%
URBAN LAND	Percent land area classified as urban	0.17%	37.5%	6.9%	8.9%
FARM SIZE	Average size of farms (in acres) (2002)	71	3,651	627	864
Agency Organization					
AUTONOMOUS	=1 if the agency is autonomous, = 0 if hierarchical.	0	1	0.50	0.50
Wildlife Demand Variables					
HUNTERS	The number of state residents who hunted in any state	500	1.13 M	260,110	225,123
ANGLERS	The number of state residents who fished in any state	89,000	2,389,000	680,960	560,469
NONRESIDENT HUNTERS	The number of non-resident hunters	0	142,000	49,800	36,992
NONRESIDENT ANGLERS	The number of non-resident anglers	41,000	1.05 M	192,140	160,693
WILDLIFE WATCHING	The total number of residents actively engaged in wildlife watching	126,000	5,490,000	1,320,000	1,100,000
Control Variables					
POPULATION	Total state population	480,907	32,666,550	5,395,508	5,937,650
INCOME	Per-capita income in dollars	$21,017	$41,392	$28,261	$4,409
TOTAL STATE BUDGET	Total budget of state in dollars($,1000,000)	$1,937	$109,635	$17,727	$19,052
ESA SECTION 6 FUNDS	The total dollars spent by states under the ESA Section 6 (1997)	$0.00	$549,025	$93,605	$105,085
TAX CHECKOFF	=1 if the state has a tax checkoff for non-game, otherwise = 0 (1997)	0.00	1.00	0.71	0.45

Sources: See Appendix

Table5: Variable Definitions and Summary Statistics (1990)

Variable Name	Definition	Minimum	Maximum	Mean	Standard Deviation
Dependent Variables					
BUDGET	Total budget ($1000)	$4,350	$1.410	$37,700	$ 28,700
LICENSE REVENUES	Revenues from license sales ($1000)	$165,942	59,400	18,700	14,000
GENERAL FUNDS	Funds from state treasury: earmarked and general ($1000) appropriations.	$208,185	$68.8 M	$9.6 M	$15.5 M
NON-GAME	1992 non-game spending as a percentage of 1990 total budget	0.34%	29.23%	4.13%	5.34%
Contracting Costs & Habitat					
AREA	Total land and water area (sq. miles)	1,544	663,267	75,879	97,068
PUBLIC LAND	Percent of total land that is federally owned open access land	0.19%	81.74%	15.29%	21.32%
URBAN LAND	Percent of land area assigned as urban	0.13%	32.12%	5.78%	7.51%
FARM SIZE	Average size of farm (in acres) (1992)	76	5,173	726	1,069
Agency Organization					
AUTONOMOUS	=1 if the agency is autonomous; = 0 if hierarchical.	0.00	1.00	0.54	0.50
Wildlife Demand Variables					
HUNTERS	Number of state residents who hunted in any state	17,000	1,020,000	281,220	230,000
ANGLERS	Number of state residents who fished in any state	83,000	2.7 M	704,300	605,299
NONRESIDENT HUNTERS	Number of non-resident hunters	3,000	155,000	41,300	31,412
NONRESIDENT ANGLERS	Number of non-resident anglers	17,000	865,000	201,660	146,303
WILDLIFE WATCHING	Number of residents actively engaged in wildlife watching	190,000	6.5 M	1.52 M	1.37 M
Control Variables					
POPULATION	Total population	453,588	29.7 M	4.96 M	5.46 M
INCOME	Per-capita income	$16,032	$31,674	$22,610	$3,386
TOTAL STATE BUDGET	Total budget of state in dollars ($,1000,000)	1,344,000	78,867,000	11,446,000	13,949,000
ESA SECTION 6 FUNDS	Expenditures by states under ESA Section 6 (1992)	$0.00	$824,484	$164,620	$28,476
TAX CHECKOFF	=1 if state has a tax checkoff for non-game, otherwise = 0 (1992)	0.00	1.00	0.60	0.49

Sources: See Appendix.

Table 6: Estimates of State Wildlife Agency Budgets
Dependent variable = total budget

INDEPENDENT VARIABLES	(1) Pooled	(2) Pooled	(3) 2000	(4) 2000	(5) 1990	(6) 1990
CONSTANT	21,213,432	13,111,282	34,670,890	44,119,871	5,926,840	11,203,554
Contracting Costs & Habitat						
PUBLIC LAND	544,868 (2.21)**	697,606 (3.11)**	594,738 (2.30)**	676,649 (2.85)**	370,998 (1.68)	539,942 (2.70)**
AREA	73.43 (2.55)**	74.80 (3.18)**	37.18 (1.41)	51.12 (2.04)*	84.52 (3.13)**	88.91 (3.91)**
URBAN LAND	-1,372,453 (2.46)**	-1,010,765 (1.93)*	-1,215,268 (1.93)*	-628,555 (1.16)	-1,131,641 (2.46)**	-496,291 (1.07)
FARM SIZE	-9,227 (2.79)**	-6,956 (2.53)**	-10,068 (2.75)**	-4,593 (1.53)	-6,422 (2.50)**	-5,837 (2.50)**
Agency Organization						
AUTONOMOUS	183,343 (0.02)	-3,874,532 (0.47)	3,169,265 (0.29)	-3,187,234 (0.35)	-2,041,363 (0.25)	1,204,647 (0.17)
Wildlife Demand						
HUNTERS	-------	-31.16 (1.20)	-------	-53.26 (1.75)*	-------	-38.67 (1.18)
ANGLERS	-------	18.69 (0.85)	-------	44.50 (1.82)*	-------	28.27 (1.140
NON-RESIDENT HUNTERS	-------	120.36 (1.72)	-------	53.24 (0.53)	-------	175.22 (2.80)**
NON-RESIDENT ANGLERS	-------	47.07 (1.82)*	-------	35.65 (1.22)	-------	22.77 (1.02)
WILDLIFE WATCHING	-------	19.84 (1.78)*	-------	27.74 (2.05)**	-------	23.92 (1.80)*
Controls						
TOTAL STATE BUDGET	-138.85 (0.88)	-300.03 (1.91)*	135.33 (0.10)	439.41 (0.41)	-379.73 (0.22)	1,342 (1.31)
POPULATION	4.59 (7.95)**	-0.45 (0.18)	4.43 (1.13)	-3.72 (1.01)	3.88 (1.68)	-7.90 (1.83)*
INCOME	597.87 (0.57)	245.75 (0.27)	282.23 (0.23)	-694.50 (0.68)	829.47 (0.74)	-261.50 (0.22)
YEAR 2000 (=1 if year is 2000)	1,857,186 (0.65)	7,819,844 (1.74)	-------	-------	-------	-------
Adjusted R^2	0.67	0.76	0.69	0.82	0.66	0.78
F-Statistic	20.45	26.23	21.27	26.60	23.13	36.99
Observations	100	100	50	50	50	50

Notes: The standard errors used to calculate the t-statistics in Columns 1-2 are clustered by state. The standard errors used to calculate the t-statistics in Columns 3-6 are calculated using White's correction for heteroskedasticity *Significant at the 10% level for a two-tailed test. **Significant at the 5% level for a two-tailed t-test.

Table 7: Estimates of the Components of Wildlife Agency Budgets

INDEPENDENT VARIABLES	Y = LICENSE REVENUE			Y = GENERAL FUNDS		
	Pooled	**2000**	**1990**	**Pooled**	**2000**	**1990**
CONSTANT	-9,531,956	-8,633,653	-478,325	22,515,630	46,123,388	44,502,679
Contracting Costs & Habitat						
PUBLIC LAND	286,911	237,907	262,069	184,966	204,825	334,939
	(2.94)**	(2.24)**	(3.24)**	(1.57)	(1.57)	(2.09)**
AREA	2.04	9.41	-4.75	58.66	37.70	24.94
	(0.13)	(0.57)	(0.33)	(4.51)**	(2.94)**	(1.37)
URBAN LAND	-364,322	-299,320	-172,540	-549,093	-310,890	-574,320
	(1.76)*	(1.28)	(0.87)	(1.60)	(0.82)	(1.21)
FARM SIZE	-166,72	821.65	-595.84	-5,296	-3,814	-4,658
	(0.14)	(0.60)	(0.61)	(2.98)**	(1.54)	(2.04)**
Agency Organization						
AUTONOMOUS	-3,124,279	-1,626,826	-416,939	-3,151,859	-5,530,477	-1,932,487
	(1.22)	(0.48)	(0.21)	(0.44)	(0.69)	(0.23)
Wildlife Demand						
HUNTERS	22.94	20.27	6.38	-66.82	-83.41	-108.95
	(1.60)	(1.47)	(0.41)	(3.78)**	(4.43)**	(2.98)**
ANGLERS	1.17	9.60	13.71	15.02	29.86	23.71
	(0.13)	(0.86)	(1.49)	(0.96)	(1.66)	(0.74)
NON-RESIDENT HUNTERS	141.14	83.46	182.69	-4.64	4.19	8.43
	(2.15)**	(1.37)	(3.28)**	(0.07)	(0.06)	(0.11)
NON-RESIDENT ANGLERS	7.61	2.98	2.23	39.51	32.88	49.08
	(0.70)	(0.25)	(0.27)	(2.23)**	(1.55)	(2.03)**
WILDLIFE WATCHERS	8.08	8.09	8.03	8.60	16.36	20.82
	(2.37)**	(1.79)*	(1.81)*	(1.00)	(1.46)	(1.44)
Controls						
TOTAL STATE BUDGET	-48.37	339.42	835.88	-182.36	147.27	-275.34
	(0.70)	(0.62)	(1.77)*	(1.68)	(0.21)	(0.26)
POPULATION	-0.51	-2.00	-3.98	0.54	-1.33	-0.80
	(0.56)	(1.11)	(2.34)**	(0.31)	(0.47)	(0.13)
INCOME	367.04	389.79	42.72	-238.07	-1020	-1,239
	(0.83)	(0.77)	(0.08)	(0.46)	(1.41)	(1.19)
YEAR 2000	-2,817,595	-------	-------	8,255,326	-------	-------
(=1 if year is 2000)	(0.85)			(1.64)		
Adjusted R^2	0.79	0.80	0.84	0.61	0.72	0.71
F-Statistic	39.23	34.14	23.48	18.08	22.66	9.89
Observations	100	50	50	100	50	50

Notes: The standard errors used to calculate the t-statistics in Columns 1 and 4 are clustered by state. The standard errors used to calculate the t-statistics in Columns 2-3 and 5-6 are calculated using White's correction for heteroskedasticity *Significant at the 10% level for a two-tailed test. **Significant at the 5% level for a two-tailed t-test.

Table 8: Estimates of the Percent of Budgets Spent on Non-game Management

INDEPENDENT VARIABLES	(1) Pooled	(2) Pooled	(3) 1995	(4) 1995	(5) 1990	(6) 1990
CONSTANT	-0.583	-3.532	5.954	7.250	-6.196	-13.08
Contracting Costs & Habitat						
AREA	-0.00001	-9.80e-06	-0.00001	-7.09E-06	-0.00002	-0.00001
	(2.31)**	(1.79)*	(1.82)*	(1.30)	(2.08)*	(1.44)
PUBLIC LAND	0.008	-0.062	0.034	-0.61	-0.0151	-0.117
	(0.21)	(1.48)	(0.84)	(1.29)	(0.26)	(1.64)
URBAN LAND	-0.006	-0.061	0.06	-0.15	-0.105	-0.122
	(0.08)	(0.77)	(0.54)	(1.58)	(0.56)	(0.68)
FARM SIZE	0.003	0.003	0.002	0.002	0.003	0.004
	(3.56)**	(3.72)**	(2.60)**	(2.93)**	(3.45)**	(3.48)*
Agency Organization						
AUTONOMOUS	-2.40	-3.04	-2.55	-3.55	-2.368	-3.181
	(2.48)**	(3.25)**	(1.62)	(2.45)**	(2.37)**	(2.71)**
Wildlife Demand						
RESIDENT HUNTERS	-------	-2.14e-06	-------	-0.00002	-------	0.0002
		[illegible]		[illegible]		[illegible]
RESIDENT ANGLERS	-------	-2.17e-06	-------	-1.61E-06	-------	-8.78e-06
		(0.41)		(0.39)		(1.07)
<u>NONRESIDENT HUNTERS</u>	-------	3.42e-06	-------	-0.000012	-------	8.59e-07
		(0.35)		(0.95)		(0.05)
NONRESIDENT ANGLERS	-------	6.14	-------	6.95E-06	-------	7.88e-06
		(1.63)		(1.42)		(1.13)
WILDLIFE WATCHERS	-------	8.38e-07	-------	8.53E-06	-------	-3.84e-06
		(0.41)		(3.44)**		(1.02)
Controls						
POPULATION	2.65e-07	1.78e-07	3.42e-07	-7.88E-07	2.24e-07	1.33e-06
	(1.62)	(0.43)	(1.60)	(1.80)*	(0.92)	(1.07)
INCOME	0.0002	0.0003	-0.000001	0.00002	0.0005	0.0008
	(1.16)	(1.68)	(0.05)	(0.12)	(1.09)	(1.64)
BUDGET FROM ESA SECTION 6 FUNDS	-------	0.00001	-------	0.00024	-------	0.000012
		(2.45)**		(2.86)**		(2.42)**
TAX CHECKOFF	-------	-0.99	-------	-1.065	-------	-0.935
		(1.23)		(1.03)		(0.80)
YEAR 1995 (=1 if year is 1995)	0.358	1.11	-------	-------	-------	-------
	(0.35)	(1.04)				
Adjusted R^2	0.297	0.409	0.257	0.581	0.368	0.553
F-Statistic	3.41	5.88	2.12	11.18	2.62	2.13
Observations	99	99	49	49	50	50

Notes: The standard errors used to calculate the t-statistics in Columns 1 -2 are clustered by state. The standard errors used to calculate the t-statistics in Columns 3-6 are calculated using White's correction for heteroskedasticity *Significant at the 10% level for a two-tailed test. **Significant at the 5% level for a two-tailed t-test. All of the variables used for the 1995 specification are from 1995 except for URBAN LAND (2000), BUDGET FROM ESA (1997), and TAX CHECKOFF (1997).

Table 9: Pooled OLS Estimates of Agency Expenditures on Wildlife, 1951-2008

	(1)	(2)	(3)	(4)	(5)	(6)
Land Variables (logged)						
TOTAL ACREAGE	0.313***	0.277	0.198	0.269***	0.288	0.208
	(0.045)	(0.273)	(0.298)	(0.056)	(0.255)	(0.270)
FEDERAL ACREAGE	0.141**	0.112*			0.143**	0.112*
	(0.058)	(0.065)			(0.054)	(0.057)
FARM ACREAGE		0.007	-0.137		-0.029	-0.205
		(0.147)	(0.175)		(0.152)	(0.186)
AVERAGE FARM SIZE		-0.283***			-0.300***	
		(0.070)			(0.065)	
NO. FARMS > 1000 ACRES			0.065			0.071
			(0.082)			(0.079)
Agency Organization						
AUTONOMOUS	0.236**	0.164*	0.139			
	(0.098)	(0.094)	(0.096)			
WILDLIFE & FORESTS				-0.199*	-0.268***	-0.222***
				(0.105)	(0.088)	(0.080)
WILDLIFE & PARKS				0.048	0.132	0.138
				(0.116)	(0.101)	(0.095)
WILDLIFE & ENV QUALITY				-0.242*	-0.215*	-0.204
				(0.127)	(0.111)	(0.123)
WILDLIFE & AGRIC				-0.186	-0.050	-0.214
				(0.258)	(0.175)	(0.241)
WILDLIFE & MARINE				0.029	-0.014	-0.093
				(0.108)	(0.109)	(0.110)
Controls (all logged)						
TOTAL STATE REVENUE	0.674***	0.594***	0.522**	0.852***	0.757***	0.681***
	(0.227)	(0.200)	(0.214)	(0.226)	(0.195)	(0.211)
STATE POPULATION	-0.199	-0.254	-0.003	-0.361*	-0.393**	-0.117
	(0.204)	(0.198)	(0.196)	(0.203)	(0.194)	(0.191)
STATE PER CAPITA INCOME	0.321	0.808***	0.301	0.266	0.826***	0.247
	(0.316)	(0.286)	(0.313)	(0.306)	(0.277)	(0.326)
CONSTANT	-6.154**	-8.726***	-4.349	-4.907	-8.587***	-3.419
	(3.012)	(2.771)	(3.283)	(3.027)	(2.616)	(3.309)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effects	No	No	No	No	No	No
Observations	2783	2735	2735	2783	2735	2735
Adjusted R-squared	0.759	0.804	0.784	0.762	0.816	0.795

Notes: * p<0.1, ** p<0.05, *** p<0.01. All standard errors are clustered at the state level. The panel is slightly imbalanced, because data for a few state year observations is missing.

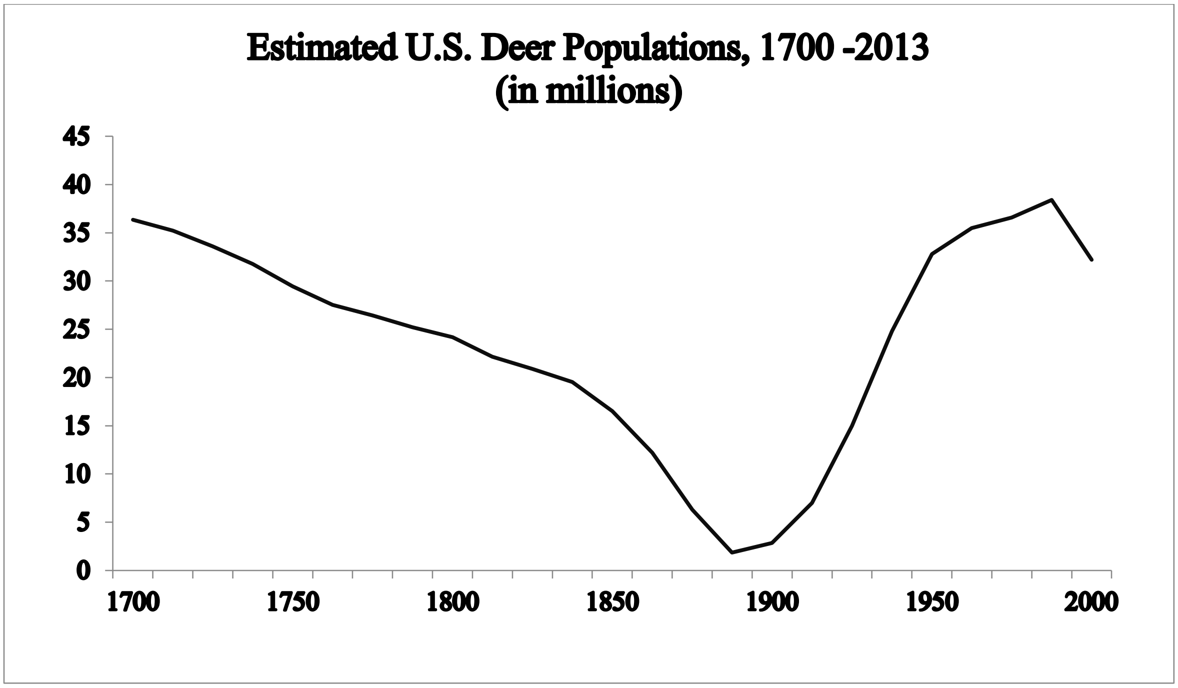
Table 10: Fixed Effects Panel Estimates of Agency Expenditures on Wildlife, 1951-2008

	(1)	(2)	(3)	(4)	(5)	(6)
Land Variables (logged)						
FARM ACREAGE		0.141	0.308**		0.067	0.221
		(0.157)	(0.128)		(0.159)	(0.135)
AVERAGE FARM SIZE		0.229			0.202	
		(0.194)			(0.190)	
NO. FARMS > 1000 ACRES			-0.104**			-0.084**
			(0.041)			(0.040)
Agency Organization						
AUTONOMOUS	-0.052	-0.058	-0.048			
	(0.066)	(0.065)	(0.064)			
WILDLIFE & FORESTS				-0.175***	-0.156***	-0.147**
				(0.055)	(0.054)	(0.057)
WILDLIFE & PARKS				0.191***	0.173***	0.153***
				(0.060)	(0.060)	(0.057)
WILDLIFE & ENV QUALITY				-0.067	-0.036	-0.019
				(0.067)	(0.076)	(0.070)
WILDLIFE & AGRIC				0.411***	0.416***	0.420***
				(0.082)	(0.080)	(0.077)
WILDLIFE & MARINE				-0.058	-0.065	-0.063
				(0.094)	(0.092)	(0.092)
Controls (all logged)						
TOTAL STATE REVENUE	0.242	0.310*	0.389**	0.352**	0.379**	0.430**
	(0.171)	(0.177)	(0.165)	(0.168)	(0.175)	(0.169)
STATE POPULATION	0.211	0.263	-0.001	0.164	0.233	0.024
	(0.152)	(0.171)	(0.136)	(0.153)	(0.168)	(0.150)
STATE PER CAPITA INCOME	0.712**	0.728**	0.728**	0.611*	0.609**	0.637**
	(0.321)	(0.292)	(0.293)	(0.309)	(0.278)	(0.278)
CONSTANT	-4.064	-9.495**	-7.614*	-4.021	-7.608*	-6.434*
	(4.071)	(4.462)	(4.075)	(3.808)	(3.927)	(3.791)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2783	2735	2735	2783	2735	2735
Adj. R-squared (within)	0.776	0.778	0.780	0.784	0.785	0.785

Notes: * p<0.1, ** p<0.05, *** p<0.01. All standard errors are clustered at the state level. The panel is slightly imbalanced, because data for a few state year observations is missing.

Appendix: Data Sources

Variable Name	Source
BUDGET	WCFA, 2000, *1996, and 1990 Surveys of State Wildlife Agency Revenue*.
NON-GAME	IAFWA, *State Wildlife Diversity Program Funding: 1998 and 1992 Surveys*. Data from Nevada, Maine, and Illinois was modified after phone conversations with non-game biologists at each department.
HUNTERS	USFWS, 2000, *1996, and 1990 National Surveys of Fishing, Hunting, and Wildlife Associated Recreations* (Survey).
ANGLERS	Same as above
NONRESIDENT HUNTERS	Same as above
NONRESIDENT ANGLERS	Same as above
WILDLIFE WATCHING	Same as above
INCOME	US Bureau of Economic Analysis
PUBLIC LAND	General Services Administration, Government wide Real Property Policy, *Comparison of Federally Owned Land with Total Acreage of State* and USPS, *Land Resources Division, Listing of Acreage by State*
FARM SIZE	USDA, National Agricultural Statistics Service, 2002, *1997, and 1992 Censuses of Agriculture*
URBAN LAND	Same as above
GENERAL FUNDS SHARE	WCFA, 2000, *1996, and 1990 Surveys of State Wildlife Agency Revenue*.
AUTONOMOUS AGENCY	WMI, *Organization, Authority and Programs of State Wildlife Agencies*, 1997 and 1987 and individual websites of state wildlife agencies.
POPULATION	US Census of Population
AREA	General Services Administration, Government wide Real Property Policy, *Comparison of Federally Owned Land with Total Acreage of State*
ESA SECTION 6 FUNDS	IAFWA, *State Wildlife Diversity Program Funding: 1998 and 1992 Surveys*.
TAX CHECKOFF	IAFWA, *State Wildlife Diversity Program Funding: 1998 and 1992 Surveys*.



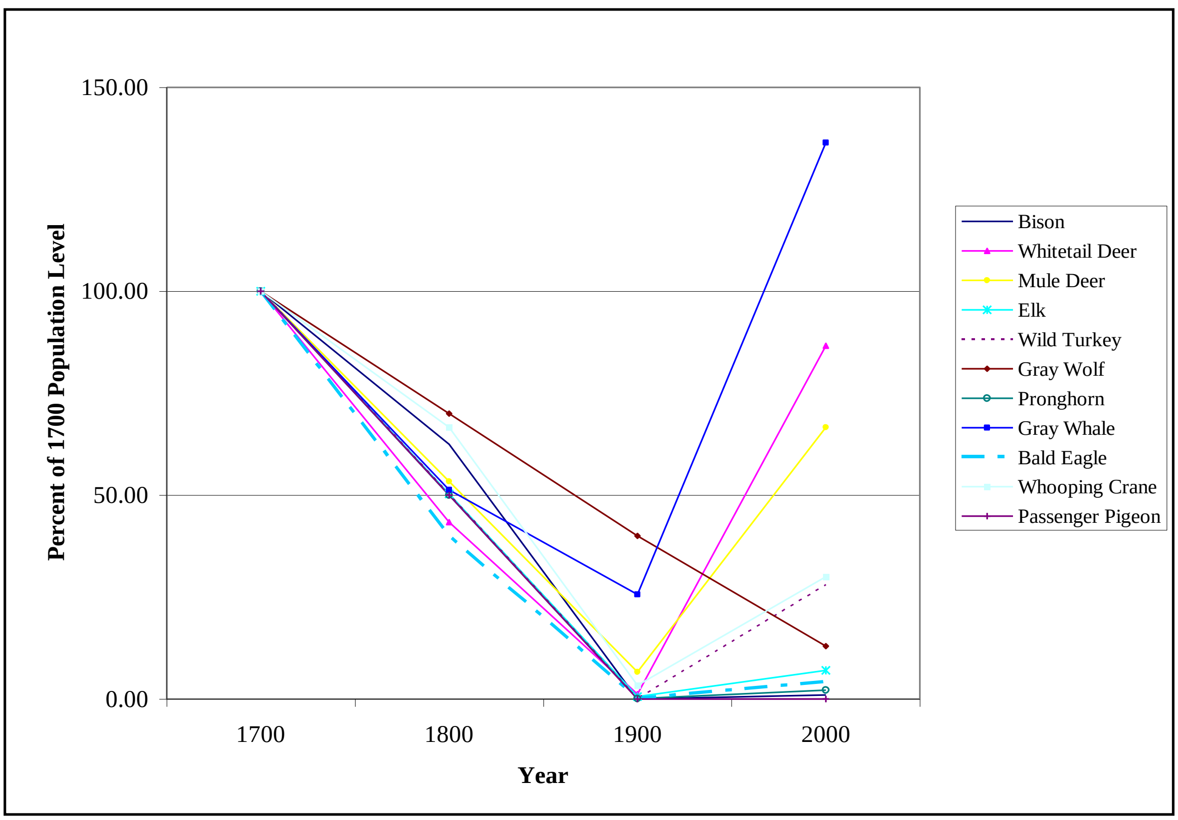
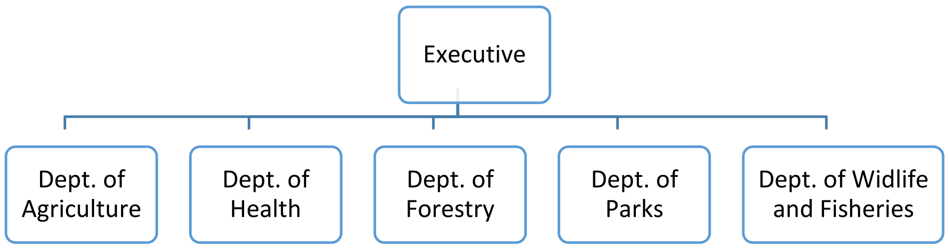


Figure 1: Time paths of wildlife populations: a) deer; b) other wildlife.

A. Autonomous state agencies: Common in early to mid-1900s



B. Hierarchical agencies: Becoming common in last 50 years

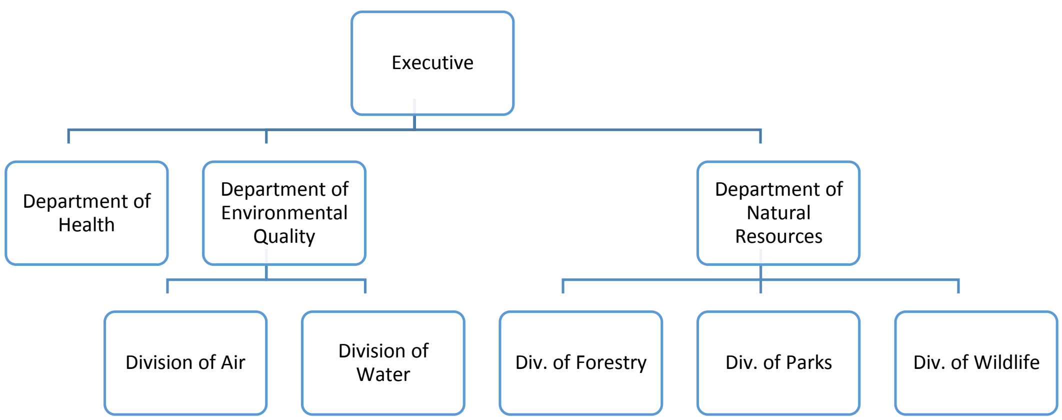


Figure 2: Dominant Structures of State Environmental Agency Organization

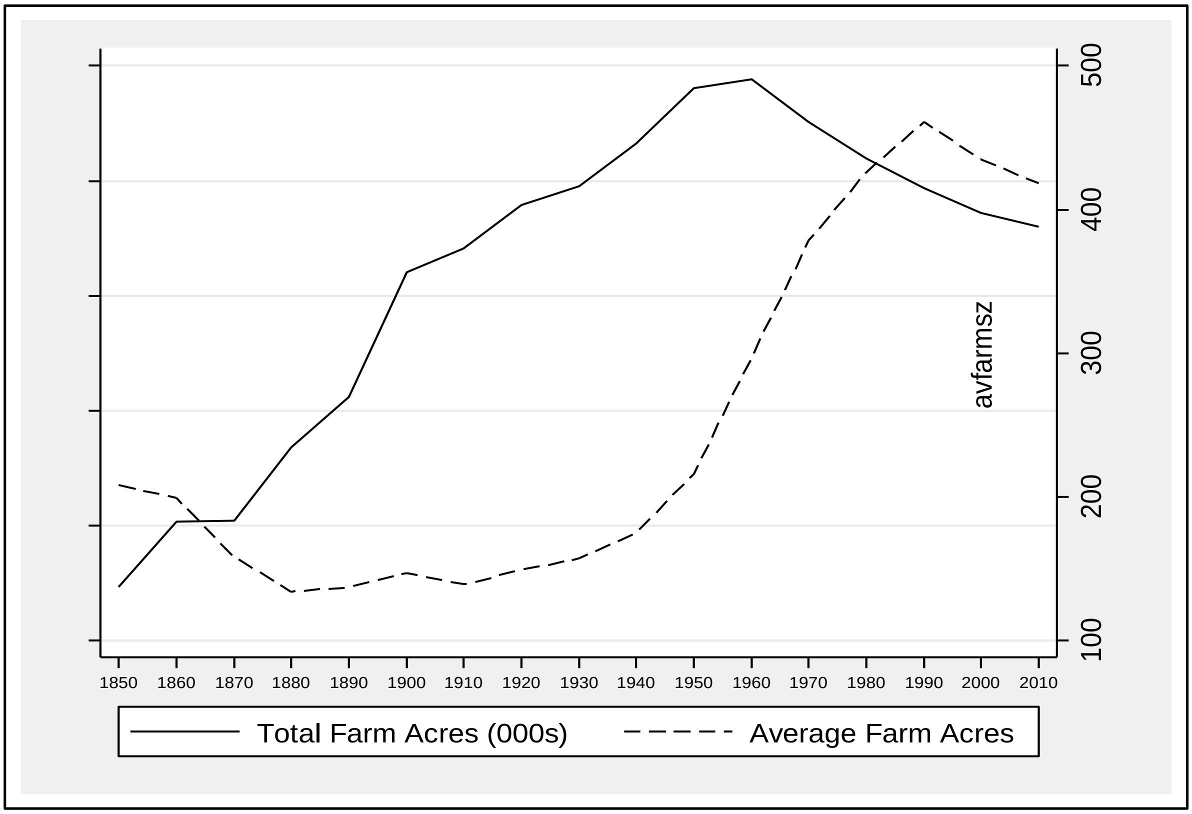


Figure 3: Agricultural Land, 1850-2010.
Source: Statistical abstracts of the U.S. and National Census of Agriculture for various years.

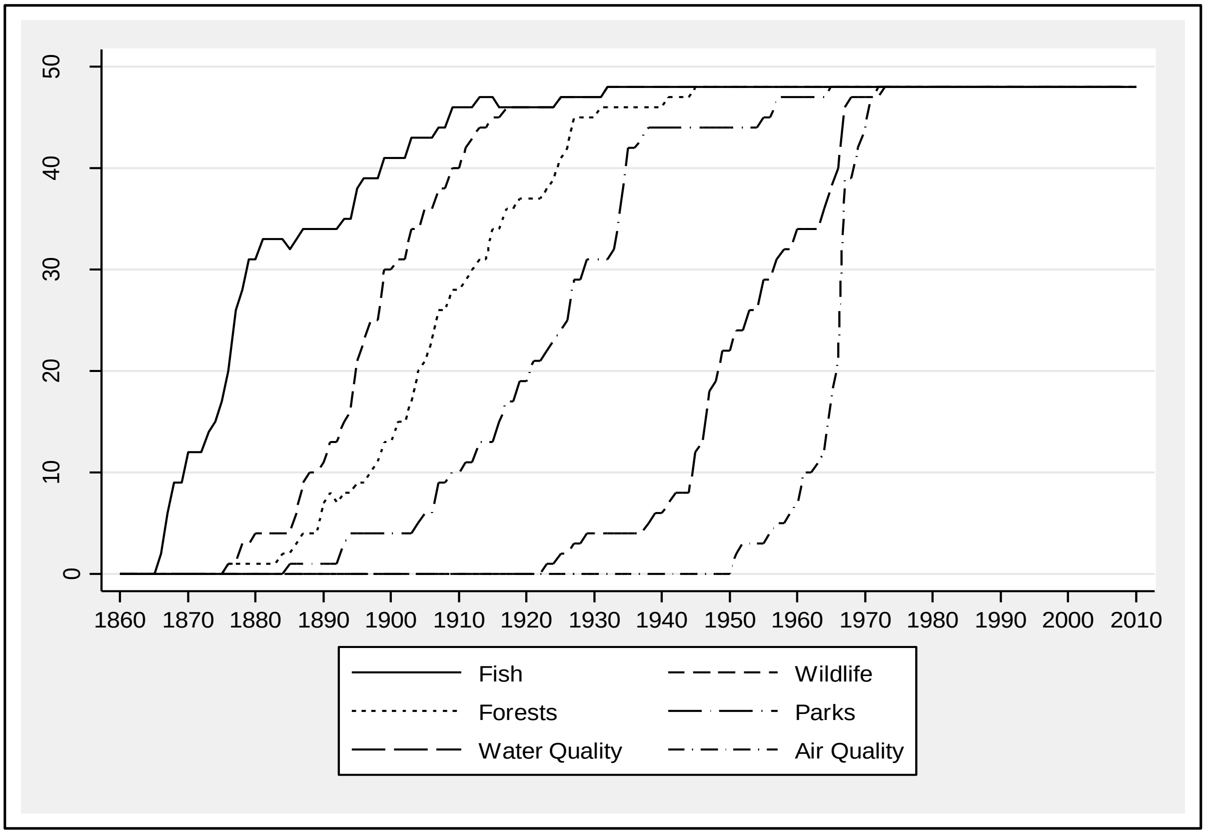


Figure 4: Emergence of Environmental Agencies, 1860-2010.
Source: Authors' compilation based various sources. See appendix.

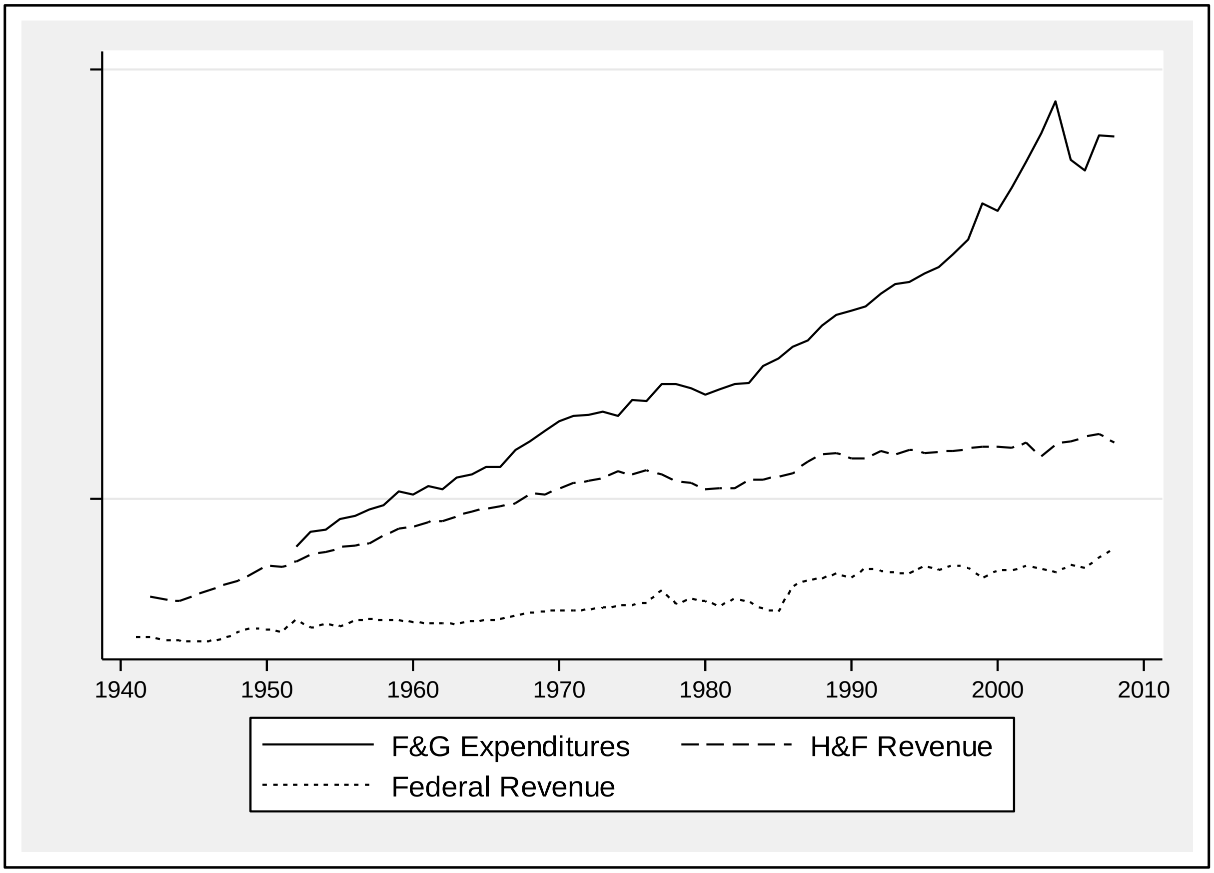


Figure 5: Wildlife Agency Expenditures and Revenue Sources, 1940-2010.