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Closing the barn door: Construction and endangered species restrictions.

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DRAFT

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Abstract

This paper tests if the endangered species protection process accelerates construction by developers seeking to avoid potential restrictions. The case of the pygmy owl outside of Tucson, Arizona is used as a natural experiment. It is found that the protection process has accelerated development.

1 Introduction

Conflicts between private property rights and the conservation of species have fueled policy debate and costly legal battles across the United States. Since the takings of private land usually is in the form of future development restrictions, one important feature of these conflicts is the ability of private property owners to circumvent potential restrictions through preemptive construction. To understand the decision problem and regulation issues linked to this issue, a body of economic literature has arisen to model the developer's response to impending environmental regulations.

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Riddiough (1997) used stochastic option theory and simulation to argue that uncertainty about future takings imposes a substantial penalty on the value of land. Similarly, Innes (1997) demonstrated that uncompensated takings encourage earlier development. Innes, Polasky, and Tschirhart (1998) performed a survey of the takings and development literature and Innes (2000) proposed efficient compensation possibilities, such as negligence compensation. These models have implications policy for a wide range of situations, ranging from forests to farms, to ranches, to urban sprawl.

To date, little work has been done to test the main assertion of these models, that the threat of future development restrictions encourages development as landowners perform preemptive construction to avoid takings. One unpublished work (Lueck and Michael 2002) performed an empirical study of the response of logging companies to endangered species regulations. The study found that logging companies used preemptive harvests to evade endangered species regulations reducing the amount of endangered species habitat.

We perform an empirical test of this question through study of the response of urban growth to impending habitat restrictions. We use the habitat establishment and enforcement process for the cactus ferruginous pygmy owl outside of Tucson Arizona as a natural experiment to test for preemptive development in response to information on future restrictions revealed through the critical habitat hearings and enforcement and enforcement process.

2 Study Area

Tucson, Arizona, located with Pima County, is one of the fastest growing metropolitan areas in the county, representing a city defined by sprawl (Mulligan, Franklin, and Esparza 2002). According to the United States Census, Pima County currently has 843,746 residents, growing 26.5

percent over the last decade. City planners have complained that Tucson “has lost the war against sprawl” (Storm 2002) and that “urbanization eats away at ten square miles of the desert every year, destroying the habitat and lessening the natural beauty that brings people to the region” (Schliesman 2002). Several authors have taken advantage of Tucson’s characteristics to study real estate prices, land use, and habitat value (Osgood 2002; Colby and Wishart 2002; Mulligan, Franklin, and Esparza 2002; Shultz 2001; Cory and Willis 1985).

Most of the land surrounding the metropolitan area is natural desert, so urban growth often disturbs the habitats of native species. One particularly contentious example is that of the *glaucoideus* *brasilianum* cactus, also known as the cactus cactus ferruginous pygmy owl, or simply as the pygmy owl. The discovery of and federal actions leading to development restrictions due to the pygmy owl in Pima County provide the ideal natural experiment to study the impacts that this process has on development.

Although the pygmy owl was listed as endangered on December 12, 1994 (58 FR 7596), critical habitat was not established (62 FR 10730) at that time. Since the potential habitat of the owl covered several states, Arizona developers paid little attention to the listing. Evidence of the potential for the species to impact development did not surface until late 1997.

At the time, Amphitheater school district was preparing to break ground for the Ironwood Ridge High School on an undeveloped site northwest of Tucson. All of its permits had been approved except for one, concerning a footbridge over a dry arroyo. The bridge required approval from the Army Corps of Engineers who consulted with the U.S. Fish and Wildlife Service to determine if the development impacted endangered species. In November 1997, environmental lawsuits were filed and protests occurred at the school site, leading to the denial of the building permit and bringing the issue to the attention of the public. Critical habitat boundaries were drafted by the US Fish and Wildlife Service and presented to the public in hearings beginning on February 10, 1999

(Department of the Interior, Fish and Wildlife Service 1999b). The critical habitat was officially designated six months later, on August 11, 1999. The boundaries designated were unchanged from the draft boundaries presented during the hearings (Department of the Interior, Fish and Wildlife Service 1999a).

It is difficult to identify the specific dates when developers became aware of impending restrictions, and when the bulk of the restrictions came into effect. It is true that developers' awareness probably began somewhat earlier during the protests involving Amphitheater School District. The critical habitat hearings date provided concrete evidence of impending restrictions along with the boundary geographic area that would be regulated. Since the federal register reports that habitat boundaries and restrictions were released to the public in the hearings beginning on February 10, 1999 (Department of the Interior, Fish and Wildlife Service 1999b), we choose that date as the time period when developers became aware of the impending restrictions. This choice means that the statistical analysis may understate the increase in development if developers did, in fact, have previous substantial knowledge of the restrictions. By choosing the hearings date as the time information is revealed as opposed to an earlier date, we are selecting a more conservative test of developers preempting restrictions.

Construction restrictions began at the end of the hearings. The establishment of critical habitat "prevents any action authorized, funded, or carried out is not likely to jeopardize the continued existence of a threatened or endangered species, or result in the destruction or adverse modification of critical habitat" (Department of the Interior, Fish and Wildlife Service 1999a). It directly restricts public construction, such as roads, schools, and other forms of infrastructure. It only impacts private land within the critical habitat if the land requires a federal permit, such as parcels containing an arroyo or riparian habitat.

Construction is prevented if a permit is not approved. Except for very rare cases, once per-

mits have been approved construction can occur even if there are additional habitat restrictions. Builders attempting to preempt restrictions would seek construction permit approvals prior to the establishment of restrictions. Therefore our study focuses on the timing of building permits.

Over time, additional restrictions were put in place. According to the Arizona Daily Star, on March 29, 2000 the U.S. Fish and Wildlife Service released “toughened owl survey guidelines” requiring developers or individuals who clear land within the pygmy owl habitat to conduct up to 6 surveys in a two year period. Those who clear land in pygmy owl habitat without authorization could be fined or imprisoned. The guidelines affected private, city, county, and state-owned land.

Many of private parcels within the habitat were exempt from federal restrictions. However, Pima County has been establishing restrictions of its own, including requiring private developers to perform a year of owl surveys. The enforcement has been severe enough for the Southern Arizona Home Builders (SAHBA) file suit in federal court on May 15 claiming that restrictions on the 130,000 acres of privately owned land in the habitat have resulted in millions of dollars of losses. They also challenged the endangered status of the owl. The process has lead to a great deal of uncertainty concerning future building restrictions, both in terms of new restrictions, and legal challenges of the restrictions currently in effect.

We choose the official designation of the critical habitat on August 11, 1999 in our statistical analysis as the date when restrictions were put in place (Department of the Interior, Fish and Wildlife Service 1999a). We select dates acknowledging that they are a simplification of reality, since the imposition of restrictions is an complex and ongoing process.

Current restrictions may be removed or challenged. For example, on December 4, 1999, Amphitheater cleared their Ironwood High Schools site for construction, and began building in February 2000. The high school has been completed and is in operation. Currently, the county is developing the multi-species Sonoran Desert Conservation plan, which would impose much more sever

restrictions on construction if it is successful. Thus, current restrictions may indicate much more severe future building limitations, which could in turn lead to additional preemptive construction. The uncertainty about future restrictions should be kept in mind when interpreting the estimation results.

3 Empirics

3.1 Data sources and integration

The Pima County Department of Transportation provided a Geographical Information Systems (GIS) database of georeferenced parcel polygons. This dataset included information from other county agencies, such as Planning and Zoning, and the County Assessors Office which provided ownership, real estate markets, and assessed values for all of the land in the county (342,857 parcels) as of the beginning of 1997. Each piece of land in the county was identified by location and parcel-id. The official critical habitat of the pygmy owl was also supplied as a GIS coverage by the county. A georeferenced parcel level dataset with the dates of all of the 58,644 construction permits awarded from January 1, 1997 through February 26, 2001 was provided by the County Planning and Zoning office as was a GIS coverage of the incorporated areas of the county.

The comprehensive parcel level datasets used for this study differ from other commonly used types of data, such as Multiple Listing Service home sales. These differences offer some advantages and disadvantages that impact model choice and interpretations of results. The dataset is comprehensive, including properties with homes, apartments, empty land, public land, office buildings, reservations, and military bases. This provides a much broader set of observations to a regression than datasets that target a single use type, such as Multiple Listing Service (MLS) information on house sales. Use of the complete set of parcels avoids the selection bias can occur when analyzing

a single land use, but comes with its own problems. MLS data describing houses sold through realtors, a relatively homogenous land use type, is not especially useful for investigating investment choices on vacant or public land. However, it does provide a wide array of variables explicitly describing the house sold, such as the number of fireplaces and cooling system. Comprehensive parcel datasets are too heterogenous across use and have too many data points to be able to develop a standard database of use specific information. The parcel level database is used in this study because it provides the complete record of parcels in all uses and all legal development in the county in individual, non-aggregated form. It represents a trade off between breadth of observations and number of explanatory variables.

Endangered species regulations are complex. For the pygmy owl case, environmentalists, developers, and school board personnel each argue different interpretations of the law. Courts are currently determining which interpretation is valid, a process that may continue indefinitely. Since critical habitat and housing restrictions are not entirely established due to ongoing court battles, we study how people react to their interpretation of potential restrictions based on the timing of the habitat process as opposed to modeling the actual restrictions put in place.

The unit of observation was an individual parcel. The full cash value of the land without improvements was assigned to the Assessed variable, which was scaled to hundred thousand dollar units. We integrated these datasets using the location and parcel-id information to develop the regression database. Parcels inside of the pygmy owl critical habitat were identified, and a dummy variable (Habitat) was set for those parcels. There were 12,267 parcels in the critical habitat. In addition, a dummy variable (Halfmile) was set for all parcels outside of the critical habitat, but within one half mile of the boundary. To represent the land within city limits, the Incorporated dummy variable was created with a value of one for all parcels that fell within incorporated areas of the county. The coverages of parcels and real estate markets were geographically linked and

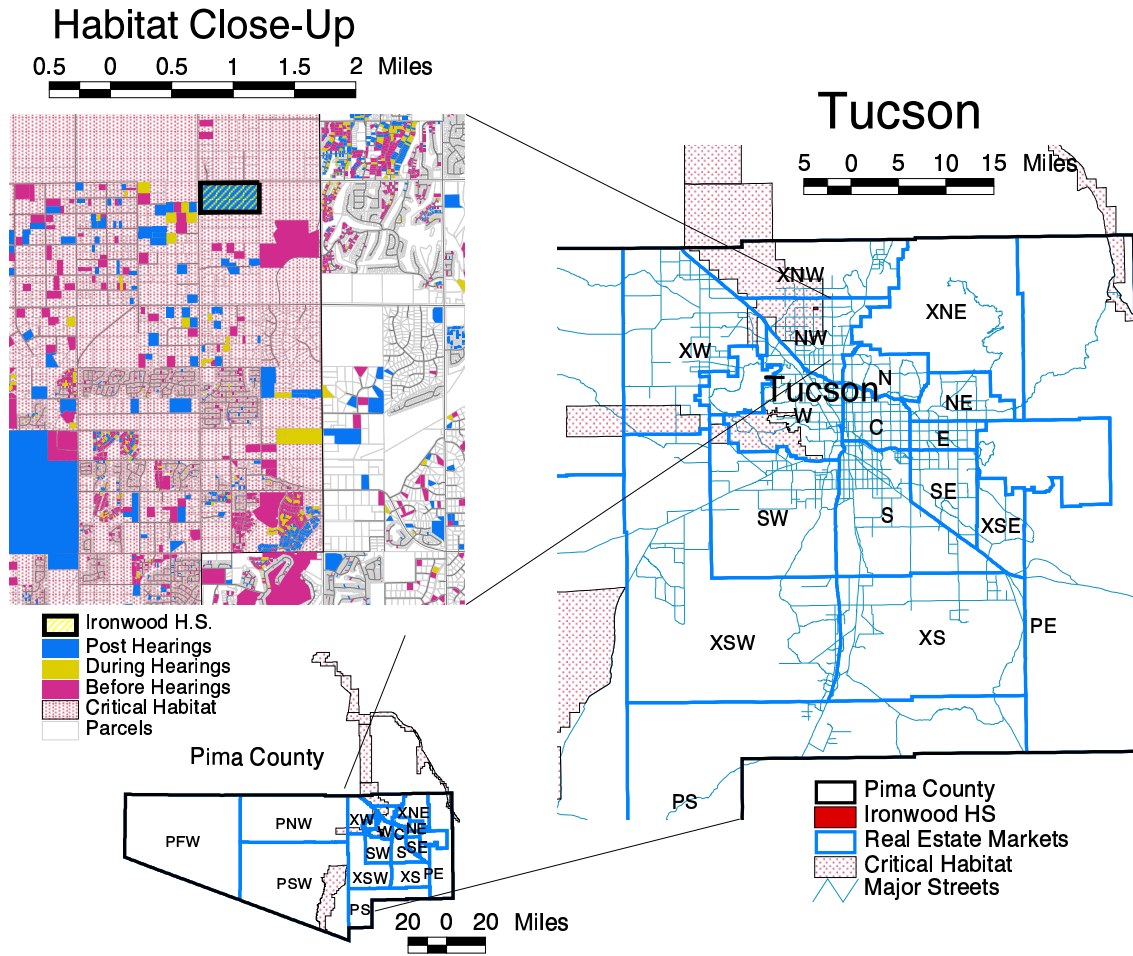


Figure 1: Habitat and Construction

dummy variables were set for the regions (E, N, NE, NW, PE, PFW, PNW, PS, PSW, S, SE, SW, W, XNE, XSW, XW, and NO MARKET for land falling outside of the market areas). The central (downtown Tucson) region was not included to prevent overspecification.

The first construction permit awarded for a lot was linked to the parcel database, as well as the date of the permit. Parcels were grouped according to when (and if) construction occurred, with a dummy variable set for each phase. All construction permits awarded before the hearings for critical habitat (before February 10, 1999) were in the “Pre-Hearings” group, which represented 23,677 parcels and a time period of 316 days. Permits awarded in the 453 days after the hearings

had started but before the critical habitat was officially established (August 11, 1999) were classified into the “During Hearings” group of 6,489 parcels. The 15,577 parcels with construction permits in the 561 days in the dataset after habitat specification were categorized into the “Not Built” group. All parcels that did not have construction during the time period were assigned to the “Not Built” category of 297,035 parcels. The study period covered a total of 1,512 days. Figure 1 illustrates the real estate market regions as well as the habitat boundaries. It shows three levels of detail, ranging from all of Pima County, to the Tucson area, to the habitat surrounding the Ironwood High School. Parcel level construction timing is depicted only in for the finest level of detail, as the parcel coverages represent too much information to be visible in the larger scales.

3.2 Analysis

The landowner was assumed to be the decision-maker with the parcel as the decision unit. The null hypothesis was that information about the future enforcement of a critical habitat does not impact current construction on land within areas that are expected to have future restrictions.

Because of the large dataset (342,857 parcels), the data processing and estimation was time consuming. It is acknowledged that there were inconsistencies in the statistical approach used. It is presented as merely a preliminary regression for discussion purposes until we complete a more appropriate analyses.

A multinomial logit was performed to compare the probability of construction in each phase against the time before the pygmy owl hearings. The probability of the construction occurring on parcel i during phase j (with a total of $m = 4$ phases) is represented in equation 1 below.

$$P_{ij} = \frac{\exp(\beta_j' \mathbf{x}_i)}{\sum_{k=1}^{k=m} \exp(\beta_k' \mathbf{x}_i)} \quad (1)$$

The parcel specific vector \mathbf{x} consists of an intercept term, Assessed, the assessed value of the lot ignoring construction or improvements, Incorporated, the dummy variable for if the parcel is within city limits, Halfmile, if the parcel is outside of but within a half mile of the habitat, and dummy variables for the real estate market region that the parcel is within.

To test the null hypothesis, parcels within the critical habitat were compared with all others in Pima county through the exogenous Habitat dummy variable. A positive and significant value for the Habitat variable for any phase indicates that being within the habitat significantly increases the probability of construction within that phase. A rejection of the null hypothesis would be the recovery of a positive and significant parameter for the Habitat variable during the Hearings phase when the location of the future critical habitat was revealed. This would show that land within the critical habitat had an increased probability of construction relative to the rest of Pima county when compared with the period before habitat information was revealed, indicating that landowners are building early to avoid future potential restrictions.

3.3 Discussion of Results

Results are presented in Tables 1 through 3. Table 1 presents the recovered vector of parameters β_2 that represent the phase after hearings on the critical habitat were opened, but before the habitat became official and any restrictions were put in place. Recall that these are in comparison to the first phase, before the hearings began. Relative to the first phase, construction was more likely for parcels with lower assessed land values. Lying inside of city limits or being within a half mile of the critical habitat did not significantly impact the probability of construction in this phase. Construction was significantly more likely in the south east and extreme southeast market areas. It has been argued that the pygmy owl listing has impacted Tucson development patterns by shifting development into the southeast area (Wilson 2002). Our results support that argument. Other

market areas did not show significant differences from the first phase.

Habitat, the experiment variable, is highly significant and positive, rejecting the null hypothesis and showing that the probability of construction during the hearings phase was significantly higher for parcels inside of the critical habitat when compared to the initial phase and the rest of Pima county. Therefore the information revealed during the habitat hearings was linked to increased construction within the critical habitat. Note that the proposed critical habitat was identical in extent to the critical habitat actually enforced.

The estimated β for construction that occurred in the phase following critical habitat designation is shown in table 2. The results for this option are similar to those of the previous option. The Assessed value, Habitat, South East, and Extreme Southeast variables are significant and of the same sign as for the hearings phase. The positive and significant Habitat parameter is about half the magnitude as during the hearings phase indicating less of a push for building within the critical habitat in the post hearing phase. Interestingly, the positive sign of the parameter reveals that the designation of the habitat did not dampen construction within the habitat when compared to the prehearings phase.

Table 3 represents the parameters for the probability of not building during the study period. The signs of parameters are somewhat confusing compared to the other tables of results since it represents the probability of not building. Parameters with negative signs indicate a higher probability of building in the first three phases. Most of the variables are significant. This is the only option with a significant intercept. The parameter for the intercept is relatively large and positive, reflecting the fact that the majority of parcels in Pima county did not have construction during the study period. The market area dummies reflect the growth patterns of the county over the years of the study. The negative and significant sign for the Habitat variable shows that the critical habitat area had relatively more construction than the rest of Pima county.

Parameter	Std	Pvalue	Ave X	Variable
-0.591	0.510	0.247	1.000	Intercept
-0.050	0.017	0.003	17.143	Assessed
0.676	0.172	0.000	0.036	Habitat
-0.168	0.124	0.173	0.207	Incorporated
0.202	0.173	0.243	0.031	Halfmile
-0.125	0.607	0.837	0.071	E
-0.219	0.493	0.657	0.065	N
0.086	0.470	0.855	0.058	NE
-0.561	0.495	0.257	0.114	NW
0.487	1.162	0.675	0.006	PE
-1.197	3.033	0.693	0.010	PFW
-0.655	3.678	0.859	0.002	PNW
0.531	0.658	0.420	0.012	PS
0.508	5.569	0.927	0.003	PSW
-0.535	0.495	0.280	0.093	S
1.350	0.472	0.004	0.054	SE
0.323	0.490	0.509	0.067	SW
0.135	0.453	0.765	0.086	W
-1.020	1.123	0.364	0.004	XNE
-0.054	0.527	0.918	0.037	XNW
0.808	0.548	0.140	0.035	XS
0.815	0.664	0.220	0.007	XSE
1.110	0.560	0.047	0.061	XSW
-0.418	0.492	0.395	0.037	XW
0.011	1.364	0.994	0.005	NO MARKET

Table 1: Period 2. During Hearings

Parameter	Std	Pvalue	Ave X	Variable
0.241	0.315	0.445	1.000	Intercept
-0.040	0.011	0.000	17.143	Assessed
0.329	0.121	0.007	0.036	Habitat
-0.068	0.078	0.387	0.207	Incorporated
-0.163	0.122	0.180	0.031	Halfmile
0.148	0.343	0.666	0.071	E
-0.323	0.303	0.286	0.065	N
0.009	0.287	0.975	0.058	NE
-0.473	0.304	0.119	0.114	NW
0.472	0.679	0.487	0.006	PE
-0.544	1.418	0.701	0.010	PFW
-1.435	3.499	0.682	0.002	PNW
0.361	0.402	0.368	0.012	PS
0.781	2.880	0.786	0.003	PSW
-0.399	0.297	0.179	0.093	S
0.664	0.294	0.024	0.054	SE
0.414	0.297	0.163	0.067	SW
0.050	0.276	0.856	0.086	W
-1.137	0.764	0.137	0.004	XNE
-0.105	0.329	0.749	0.037	XNW
0.458	0.339	0.177	0.035	XS
1.370	0.354	0.000	0.007	XSE
0.529	0.359	0.141	0.061	XSW
-0.372	0.302	0.218	0.037	XW
0.199	0.752	0.791	0.005	NO MARKET

Table 2: Period 3. Post Critical Habitat Designation

Parameter	Std	Pvalue	Ave X	Variable
4.453	0.053	0.000	1.000	Intercept
-0.033	0.003	0.000	17.143	Assessed
-0.070	0.039	0.074	0.036	Habitat
-0.199	0.021	0.000	0.207	Incorporated
-0.253	0.036	0.000	0.031	Halfmile
-0.519	0.047	0.000	0.071	E
-1.731	0.050	0.000	0.065	N
-1.556	0.044	0.000	0.058	NE
-1.946	0.049	0.000	0.114	NW
-0.444	0.117	0.000	0.006	PE
-0.190	0.145	0.191	0.010	PFW
-0.652	0.287	0.023	0.002	PNW
-1.150	0.078	0.000	0.012	PS
1.034	0.297	0.000	0.003	PSW
-1.443	0.044	0.000	0.093	S
-1.338	0.048	0.000	0.054	SE
-1.309	0.047	0.000	0.067	SW
-1.485	0.038	0.000	0.086	W
-1.721	0.124	0.000	0.004	XNE
-2.047	0.063	0.000	0.037	XNW
-1.055	0.061	0.000	0.035	XS
-1.252	0.092	0.000	0.007	XSE
-0.454	0.060	0.000	0.061	XSW
-2.392	0.052	0.000	0.037	XW
-0.722	0.133	0.000	0.005	NO MARKET

Table 3: Period 4. No Construction During Study Period

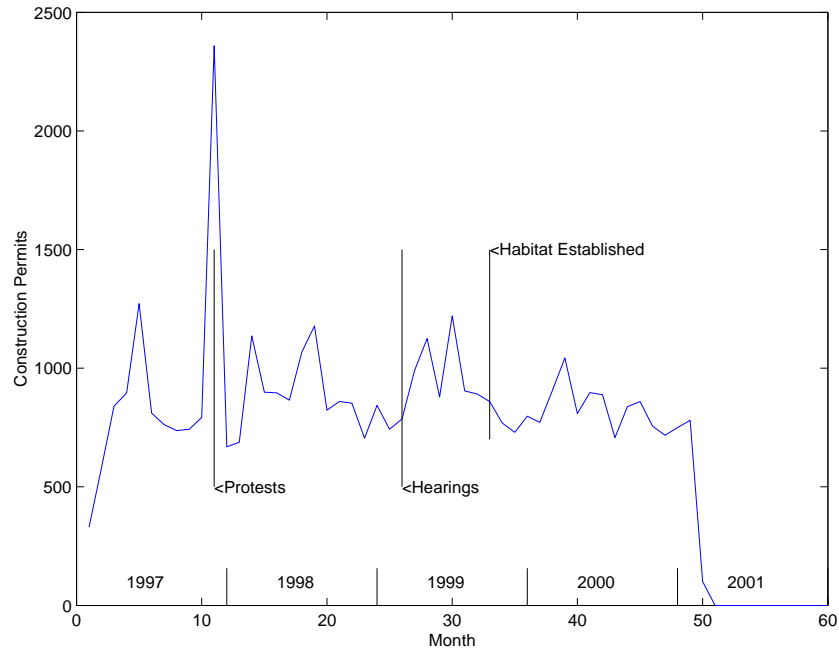


Figure 2: Construction Permits by Month in Pima County

The empirical results can be further understood by looking at figures 2 and 3. Figure 2 presents the number of construction permits awarded each month during the study period. Potentially interesting dates are marked on the graph. December 1997 is marked on the graph to represent when environmental protests occurred and the Amphitheater school district was denied the permit. The large construction spike seen on this date was due to a large subdivision project that was awarded construction permits for each of its lots (outside of the critical habitat) on a single day. These permits were probably unrelated to the pygmy owl issue.

The months of the release of the critical habitat in public hearings and the final announcement of critical habitat are marked on the figure. Note that an inspection of the plot does not reveal atypical behavior occurring for building permits between those two events.

Figure 3 depicts the number of construction permits awarded by month for properties within the critical habitat. Again, lines are drawn for the months when the pygmy owl became an public

issue, when critical habitat hearings were opened, and when the critical habitat became established. This figure presents a dramatically different picture than the one for all of the permits within Pima County. Following the protests and denial of the building permits for the school, the number of construction permits within the habitat appear to increase slowly. Since it is difficult to put a specific date on when the pygmy owl issue first became public, it should be remembered that the position of the “Protests” line is only a rough guide. For this reason, the “Protests” date was not used in the regression, but instead the date of the opening of hearings and public announcement of the habitat location was used to represent the revelation of new information.

Following the date of the hearings, a dramatic jump in construction permits can be seen, which drop again once the habitat is officially established. Recall that these features do not occur on the plot of the rest of the county. Therefore inspection of the timing of construction permits within the habitat supports the regression results in showing that there was substantial construction that occurred in response to the endangered species process in order to develop before restrictions were put in place.

It is interesting to note that construction permits within the habitat did not decrease to the 1997 levels, even though the critical habitat had been established and construction restrictions were put in place. This could either be due to an increase construction resulting from continued growth of Tucson or a continued attempt by developers to preempt additional expected restrictions. Evidence for the latter argument comes both from the county wide figure and the regression results. The county wide figure does not show an overall increase for the post critical habitat phase. The regression, which controlled for regional growth, nevertheless found a positive and significant parameter for the habitat dummy variable in the post critical habitat phase. Therefore uncertainty over the future of building restrictions within the critical habitat may have led developers to expend additional resources in circumventing building restrictions, a reaction that outweighed the

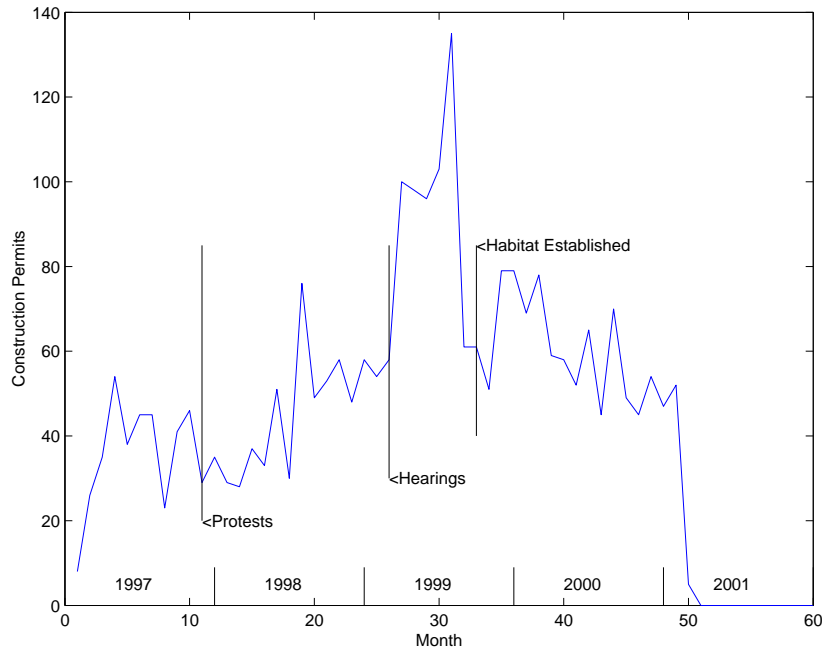


Figure 3: Construction Permits by Month in Critical Habitat

preservation benefits of the establishment of the critical habitat. Additional work is necessary to make a conclusive statement concerning this possibility.

4 Conclusion

There is a well established theoretical literature arguing that private entities will perform preemptive development to avoid possible future restrictions due to endangered species legislation. We have tested this assertion using the process leading to the establishment of critical habitat for the cactus ferruginous pygmy owl and its impact on construction in the area surrounding Tucson, Arizona.

Preliminary results indicated that developers did preempt many of the impending construction restrictions. In fact, uncertainty in the status of current restrictions may be increasing the rate of construction within the critical habitat for those developers who are still permitted to build.

This paper only represents a preliminary investigation. A more developed statistical model must be applied, such as a nested binomial logit regression. In this regression the initial choice would be to build or not in the first phase. For the parcels that did not build, the second choice would be to build in the second phase, and so on.

If spatial error processes exist, they can cause inefficiency and bias in discrete choice regressions. Future regressions should be adjusted in order to account for this possibility. Because the dataset is so large, many computationally expensive spatial autocorrelation estimation techniques are not feasible. The large dataset does however lend itself to sampling methods which could be implemented to remove spatial error interdependence (Nelson and Hellerstein 1997).

Acknowledging that additional work must be done, the basic econometric conclusions of the paper are that developers do build early in response to impending building restrictions, or uncertainty concerning possible restrictions. The uncertainty associated with agency actions and court battles may increase short term development within critical habitat. It is possible that the timing of the endangered species regulation process may lead to more habitat damage than would occur if the process had not occurred.

Policy makers could improve the situation through several options. They could accelerate the enforcement process and increase the restrictions within the habitat. An alternate solution would be to provide compensation to property owners. Policies that lower the level of uncertainty in the final development, restrictions may reduce preemptive development. This may have a significant impact for the pygmy owl critical habitat which has shown increased development after restrictions have been put in place by those who are still allowed to build. As it currently stands, the endangered species protection process provides perverse incentives for developers.

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