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The Costs of Critical Habitat *or* Owl's Well That Ends Well

Jonathan Klick
JB Ruhl

Abstract: When the Fish and Wildlife Service designated land in four counties of Arizona as “critical habitat” necessary for the protection of the endangered cactus ferruginous pygmy-owl, property values dropped considerably. When the owl was later delisted, property values jumped back up. We use difference-in-difference and synthetic control designs to identify this effect with Zillow property value data. The results provide an estimate of the costs of this critical habitat designation, and they are considerable, contrary to the regulators’ position that critical habitat protection imposes no incremental costs beyond the original endangered species listing.

Introduction

The cactus ferruginous pygmy owl is a small, reddish brown owl with a cream-colored belly streaked with reddish brown colorings and a long tail (U.S. Forest Service 2000). By all accounts, it is adorable. Although abundant in Mexico, the population of pygmy owls in Arizona had become geographically separated from the Mexico population—making it impossible for the Arizona population to leverage the Mexico population for breeding—and dwindled to below 50 by the 1990s (U.S. Forest Service 2000). In 1997, the United States Fish and Wildlife Service (FWS) classified the Arizona owls as a “distinct population segment” (DPS) eligible for treatment as a species under the Endangered Species Act (ESA) and added the DPS to the list of endangered species protected under the ESA in 1997 (62 Fed. Reg. 10730 [1997]). The listing triggered several ESA regulatory and conservation programs designed to recover endangered species, including the designation of “critical habitat” for the owl in 1999 (64 Fed. Reg. 37419 [1999]). Years of litigation and lobbying ensued, including a 2001 federal court decision finding the economic impact analysis for the critical habitat designation was defective, leading the court to vacate the designation. The agency immediately began work to correct the analysis and in 2002 proposed a new designation along with a draft economic impact analysis; however, after further losses in court, the FWS delisted the species in 2006, which obviated the need to complete work on the critical habitat designation.

Using Zillow data, we study the effect of the critical habitat protections on home values in the four Arizona counties affected – Cochise, Maricopa, Pima, and Pinal. Using difference-in-difference and synthetic control methods, we find that designation of critical habitat lowered property values in these counties by 3-4 percent.

If property values fully capitalize the net effects of regulations (i.e., both the decrease in welfare due to infringements on land use as well as the increase in welfare due to people’s expected value of improved sustainability of the pygmy owl), our results suggest that the critical habitat designation for the pygmy owl was welfare reducing. At a minimum, our results provide some guidance regarding the economic cost of the owl’s critical habitat designation, which can inform the impact of the ESA critical habitat program generally. The current FWS position is that critical habitat designations entail no incremental costs beyond those already triggered by the original listing of the species as endangered. Our results imply that this position is in error.

Below, we provide a general description of the regulation of critical habitat, as well as the way it specifically played out with respect to the pygmy owl. We then discuss our data, empirical methods,

and results. We end with a discussion of how results such as ours should be incorporated into regulatory impact analyses in the ESA context.

Regulatory Background

The ESA was enacted in 1973 to provide a program for the conservation of species determined to be in danger of extinction or threatened with endangerment. When FWS designated a species as endangered or threatened pursuant to the criteria and procedures of section 4 of the ESA, several regulatory programs are triggered (Owen 2012). Section 9 of the statute (16 U.S.C. 1538) prohibits all persons and entities subject to federal jurisdiction from “taking” an endangered animal species (plant species receive less protection). The ESA defines take to include the obvious, such as hunting and killing, but also includes the term “harm” (16 U.S.C. 1532). The ESA does not define “harm” in statutory text, but the FWS has promulgated a regulation (50 C.F.R. 17.3) defining “harm” to include significant modification of the species’ habitat that leads to actual death or injury. Section 10 of the ESA (16 U.S.C. 1539) provides for a permitting process that allows take to occur provided certain conditions are met, including mitigation of the impact to the species (e.g., by restoring habitat elsewhere) (Wheeler and Rowberg 2010).

In addition to the take prohibition, Section 7 of the ESA (16 U.S.C. 1536) requires all federal agencies to consult with FWS and its sibling agency administering the statute for marine species, the National Marine Fisheries Service (NMFS), to ensure actions they carry out, fund, or authorize do not “jeopardize the continued existence” of the species or “result in destruction or adverse modification of habitat of such species which...is determined to be critical” (Plantinga et al. 2014; Ryan and Malman 2010). The category of “critical habitat” consists of areas FWS and NMFS determine are “essential to the conservation of the species” (16 U.S.C. 1532). Section 4 of the ESA (16 U.S.C. 1533) requires FWS and NMFS to designate critical habitat for species concurrently with their listing, or within one year if critical habitat is not at that time determinable (Cheever 2010). In practice, the agencies rarely meet these deadlines (Fish 2010). For example, the FWS designated critical habitat for the pygmy owl DPS in July 1999, two years after its listing as endangered (64 Fed. Reg. 37419 [1999]).

The relationship between a species’ habitat and its critical habitat has been a longstanding source of confusion. The U.S. Supreme Court recently held that to be critical habitat, an area must be located within the species’ habitat (Weyerhaeuser v U.S. Fish and Wildlife Service, 586 US ___ [2018]), but neither the ESA nor FWS regulations define “habitat.” The statute provides that critical habitat can include both occupied and unoccupied areas, if they are essential to the conservation of the species (16 U.S.C. 1532). Because critical habitat can include unoccupied areas, and the Supreme Court has ruled that all critical habitat must also be habitat, the ESA thus contemplates that unoccupied areas can be habitat. It remains unclear what features of unoccupied areas qualify it for being characterized as a species’ habitat, and thus also possibly its critical habitat. At the very least, areas previously occupied by the species into which the species ideally would return as it recovers seem eligible for designation as critical unoccupied habitat. Yet, the ESA mandates that critical habitat generally cannot be the entire geographic area that can be occupied by the species, whether presently occupied or not (16 U.S.C. 1532).

The consequence of this convoluted regulatory structure is that critical habitat is not necessarily (or usually) all of the habitat the destruction of which could lead to a violation of the Section 9 take prohibition—some or even most of this “take habitat” could be located outside the critical habitat zone (Owen 2012). Conversely, because critical habitat can include areas outside the geographic area

occupied by the species, it is not necessarily the case that destruction of critical habitat violates the take prohibition—if the species does not occupy the area, destruction of critical habitat in the area might not kill or injure individuals of the species (Owen 2012). In other words, “take habitat” is not coterminous with “critical habitat.”

The combined effect of the ESA’s Section 9 take prohibition and Section 7 no jeopardy/no adverse modification provisions has had profound impact on land and resources development in many parts of the nation, although its magnitude is debated (Malcolm and Li 2015, Ryan and Malman 2010). Considering the extent to which federal agencies fund and authorize actions by other public and private actors, the reach of Section 7 is expansive (Ryan and Malman 2010), and Section 9 applies everywhere in the nation to every public and private entity subject to federal jurisdiction (Parenteau 2010, Quarles and Lundquist 2010). While the vast majority of federal actions do not present jeopardy or adverse modification conditions (Owen, 2012), the consultation process for determining the impacts can be long and expensive (Ryan and Malman 2010). Even where neither jeopardy nor adverse modification is found to be a concern, the action could cause take of the species, for which Section 7 provides an authorization procedure that can result in project design modifications and habitat impact mitigation (Owen, 2012, Ryan and Malman 2010). Similarly, the Section 10 permitting process for projects that are not federal actions subject to Section 7 also can be protracted and costly, with similar project design and impact mitigation conditions imposed (Quarles and Lundquist 2010).

Pygmy owls are generalists in their food habits and can be found in areas below 4,000 feet in elevation containing one or more of riparian vegetation, Sonoran Desert scrub, and semidesert grasslands, all of which are abundant in southern Arizona (U.S. Forest Service, 2000). As a result, although few in number, the owl’s critical habitat designation spanned a large area of the region—over 700,000 acres. (64 Fed. Reg. 37419 [1999]). Through describing habitat features in the listing rule (62 Fed. Reg. 10730 [1997]) and a subsequent landowner survey protocols (63 Fed. Reg. 43362 [1998]. 65 Fed. Reg. 14999 [2000]), the FWS also effectively encompassed an even larger area to be “take habitat,” which as explained above required development projects to seek take authorization under Section 7 (for federal actions) or Section 10 (for all other projects) (Sinden 2004). Land development projects throughout the region thus began undergoing project permitting under Section 7 and Section 10 of the ESA, and Pima County began the process of developing a region-wide plan for ESA compliance to avoid inefficiencies of the project-by-project permitting approach (Pima County 2016). Although precise cost estimates are not available, ESA compliance on a project-by-project approach inevitably would have added to the costs of development in the form of consulting fees, project modifications to avoid take, and project delays (Quarles and Lundquist 2010).

Critical Habitat Impact Analysis

Although many other regulatory laws that require benefit-cost analysis of regulatory actions, the ESA prohibits FWS and NMFS from taking economic impacts into account when deciding whether a species should be listed—that decision must be based exclusively on scientific information on the species’ biological status and threats to its survival (16 U.S.C. 1533). The agencies also may not take economic impacts into account in Section 7 consultations regarding jeopardy and adverse modification (16 U.S.C. 1536). The take authorization procedures in Sections 7 do not allow FWS to take economic impact into account when deciding the conditions of authorization (16 U.S.C. 1536). Although the Section 10 permitting procedure for projects not covered by Section 7 allow consideration of the costs associated with mitigation, other costs and impacts of the permitting decision are not considered (16 U.S.C. 1539).

The one significant exception to the ESA's prohibition on benefit-cost analysis is that the statute not only allows, but expressly requires, an economic impact assessment in connection with the designation of critical habitat. Section 4 of the ESA (16 U.S.C. 1533) requires FWS to consider the economic impact and any other relevant impact of critical habitat designation and allows the agency to exclude areas that would biologically qualify for designation based on those impacts (Cheever 2010, Plantinga et al. 2014). Yet, for decades this requirement had little practical effect given how FWS interpreted the overall regulatory scheme. FWS steadfastly took the position that, except in the narrow circumstance when unoccupied habitat is designated critical habitat, designation of critical habitat has no economic impact, positive or negative, other than the administrative costs of designating the area and conducting adverse modification analyses in Section 7 consultations (Cheever 2010, Plantinga et al. 2014, Sinden, 2004).

The reasoning behind FWS's approach was somewhat convoluted, but not without some logic. The agency contended that designation of occupied habitat as critical habitat imposes no regulatory effect that is not already imposed through "baseline" regulatory impacts imposed by the Section 9 take prohibition and the Section 7 jeopardy prohibition (Cheever 2010, Plantinga et al. 2014, Sinden, 2004). In other words, the agency's theory was that any action that could lead to destruction or adverse modification of critical habitat would necessarily already have been regulated under Section 9 as take of the species, or under Section 7 as causing jeopardy to the species, or under both, and thus designating critical habitat for a species imposes no incremental regulatory impact above that baseline.

The result of the agency's baseline approach was that the critical habitat economic impact analyses were meaningless exercises in which the analysis estimated administrative costs of designation and consultations and omitted any consideration of economic impact to areas designated critical habitat and surrounding communities (Plantinga et al, 2014). Because the statute only allows analysis of economic impacts from the critical habitat designation, the agency refused to provide any assessment of the pre-existing baseline impacts from the take prohibition and jeopardy prohibition. In the final reports FWS issued, economic impacts thus were only quantified for conservation measures implemented specifically due to the designation of critical habitat (i.e., incremental impacts). Conservation measures implemented under the baseline (before critical habitat) scenario were described qualitatively within the reports, but economic impacts associated with these measures were not quantified (Plantinga et al, 2014; Byl 2018).

Using the pygmy owl as an example, one can follow the agency's logic. When the owl was listed as an endangered species in 1997, the take prohibition and jeopardy prohibition immediately took effect. Take authorization was required under Section 7 (for federal actions) and Section 10 (for other actions) regardless of whether critical habitat was ever designated, and Section 7 consultations regarding the jeopardy prohibition would also have been required for all federal actions that could affect the species. When the agency designated critical habitat for the species in 1999, none of which was unoccupied habitat, all that was added to the regulatory mix was the additional requirement that Section 7 consultations also consider the adverse modification question. But—and this was the lynchpin of the agency's approach—because any adverse modification of the owl's critical habitat would also likely constitute either take, or jeopardy, or both, the baseline approach assumed no additional regulatory impact was imposed on land uses from adding the critical habitat. This left only the cost of designating the critical habitat and administering the subsequent adverse modification consultations as the additive impact of the designation. The FWS's initial draft economic impact analysis for the pygmy owl thus was characteristic of this baseline approach, claiming that there would be no economic impacts of any kind beyond costs to the agency and rejecting the findings of an independent study concluding that the

designation would result in significant losses of property values, tax revenues, development, and employment in the region (FWS 1999).

Soon after the critical habitat designation, however, a series of federal court opinions began to unravel the owl's status under the ESA (Cheever 2014, Fish 2010, Plantinga et al. 2014). A group of agricultural and other land use interests challenged the owl's listing and critical habitat designation. In May 2001 a federal appellate court with jurisdiction over Arizona overturned a critical habitat designation for a different species on the ground that the baseline approach was contrary to congressional intent (*New Mexico Cattle Growers Association v. U.S. Fish and Wildlife Service*, 248 F.3d 1277 [10th Cir. 2001]). The court reasoned that the baseline analysis approach, by assuming all impacts were already imposed by the take and jeopardy prohibitions, rendered the economic impact analysis meaningless and thus was contrary to the purpose Congress had in mind by requiring the analysis). The court ordered the agency to apply what it called a "co-extensive" analysis, under which the agency would assess the total impacts of ESA regulation in areas proposed for critical habitat designation, regardless of the regulatory source of those impacts (Cheever 2010, Fish 2010, Plantinga et al., 2014; Sinden, 2004). In other words, any economic burden that designating an area would cause must be counted in the economic analysis, even if the same burden is already imposed by listing the species and, therefore, would exist even if the area were not designated.

Bound by the appellate court's opinion, the federal trial court overseeing challenges to the pygmy owl's listing and critical habitat designation found the listing was proper but that the baseline approach to critical habitat impact analysis was impermissible (*NAHB v Norton*, 0903-PHX-SRB [D. Ariz 2001]) Indeed, FWS had seen this coming, and sought a voluntary remand of the critical habitat designation so that it could correct the economic analysis by using the co-extensive approach (Sinden, 2004). Although the court granted that request, it denied the request that the critical habitat designation remain in effect pending the production of the new impact analysis. The court vacated the critical habitat designation and ordered the agency to correct the impact analysis before critical habitat could be re-designated.

The agency re-proposed critical habitat areas in 2002, including most of the areas previously designated, and issued a draft of a new impact analysis conforming to the court's order (67 Fed. Reg. 71032 [2002]). Significantly—and in stark contrast to the original impact analysis using the baseline approach—the draft impact analysis projected "10-year costs resulting from the pygmy-owl's listing and critical habitat designation at \$108 million, with \$52 million of those costs resulting from critical habitat designation alone. The bulk of projected costs would be borne by the housing development and mining industries when they seek Federal dollars or permits to modify washes and streams and or discharge pollutants" (FWS, 2002).

Before the designation and impact analysis could be finalized, however, in 2003 the federal appellate court found that the listing of the species was based on unsupported science and overruled the trial court's decision upholding the listing of the owl (*National Association of Home Builders v. Norton*, 340 F.3d 835 [10th Cir. 2003], Sinden, 2004). The agency shifted its work to preparing a rule to delist the species, which the agency proposed in 2005 (70 Fed. Reg. 44547 [2005]) and finalized in 2006 (71 Fed. Reg. 19452 [2006]). Because critical habitat is designated only for listed species, the agency never published a final version of the new critical habitat designations, or of the impact analysis that would have quantified the impacts using the new co-extensive approach. Table 1 summarizes this regulatory history.

Table 1: Relevant Pygmy Owl Regulatory Timeline		
Date	Event	Reference
5/26/1992	Petition to list filed	58 Fed. Reg. 13045 [1992]
3/9/1993	FWS issues positive 90-day finding	58 Fed. Reg. 13045 [1993]
12/12/1994	FWS issues proposed listing of species	59 Fed. Reg. 63975 [1994]
3/10/1997	FWS issues final rule listing of owl as a distinct population segment (DPS) in Arizona	62 Fed. Reg. 10730 [1997]
12/30/1998	FWS issues proposed critical habitat (CH) rule	63 Fed. Reg. 71820 [1998]
4/15/1999	FWS releases draft CH economic analysis	64 Fed. Reg. 18596 [1999]
7/12/1999	CH designated	64 Fed. Reg. 37419 [1999]
1/2/2000	FWS finalizes take guidance/survey protocol	FWS (2000)
1/9/2001	NAHB files suit challenging listing and CH	NAHB v Norton, 0903-PHX-SRB [D. Ariz 2001]
9/21/2001	District Court upholds listing but vacates and remands CH	NAHB v Norton, 0903-PHX-SRB [D. Ariz 2001]
11/27/2002	FWS proposes new CH rule and issues draft economic analysis	67 Fed. Reg. 71032 [2002]
2/2003 – 6/2003	CH comment period extended several times but eventually work on the rule ceases due to lack of funding	68 Fed. Reg. 8730 [2003] 68 Fed. Reg. 22353 [2003]
8/19/2003	Appellate Court overrules District Court on validity of listing and remands to District Court	NAHB v. Norton, 340 F.3d 835 [10 th Cir. 2003]
6/25/2004	District Court remands listing rule to FWS	NAHB v Norton, 0903-PHX-SRB [D. Ariz 2004]
8/3/2005	FWS proposes delisting	70 Fed. Reg. 44547 [2005]
4/14/2006	FWS issues final delisting rule	71 Fed. Reg. 19452 [2006]

Potential Incremental Impacts of Critical Habitat Designation

The protection of critical habitat could have positive economic impacts through amenity values (Kroeger and Casey 2007) and provision of ecosystem services (Byl 2018), and negative impacts due to restrictions on use and development of land and resources (Brown and Shogrun 1998, Plantinga et al. 2014). Because critical habitat is designated concurrent with or (far more often) after the listing of a species (Fish 2010), however, it is difficult to measure its effects entirely in isolation of the other regulatory programs. In the rare instances when FWS has designated *unoccupied* habitat as critical habitat, the take and jeopardy prohibitions arguably would have little effect in those areas, in which case regulatory impacts could be attributable to the critical habitat designation (Byl 2018, Sinden 2004). Most cases involve designation of occupied areas already subject to the take prohibition and jeopardy prohibition.

Legal scholars have argued that the legal theory underlying the FWS baseline approach, which assumed critical habitat in occupied areas has no incremental effect, does not necessarily follow from the statutory text (Owen 2014, Sinden 2014). There is no legal reason why destruction of some critical habitat could rise to the level of adverse modification before posing jeopardy to the entire species. Nevertheless, FWS had never made such a finding (Owen 2014).

Even if not legally compelled, however, there are practical reasons why designation of critical habitat in occupied habitat may have incremental economic effects above the pre-existing regulatory baseline. The three regulatory programs—take prohibition, jeopardy prohibition, and adverse modification prohibition—each have distinct features that result in different land development risk impacts (Owen 2012, Quarles and Lundquist 2010). When these differences are accounted for, the addition of a critical habitat designation for a listed species looks much less benign than the FWS’s former baseline impact approach assumed.

The take prohibition applies to public and private actors, on public and private lands where the species’ habitat is found, regardless of any connection to federal agency action (Parenteau 2010). Take, as defined through the regulatory definition of harm, is also a low threshold compared to jeopardy and adverse modification (Owen 2012, Quarles and Lundquist 2010). Take could occur where even a minor impact to habitat leads to injury to just a single individual of the species, whereas jeopardy and adverse modification are found only based on species-wide impacts (Quarles and Lundquist 2010, Ryan and Malman 2010). Yet, proof of take requires demonstration of proximate cause and foreseeability, which can be difficult for the agency to prove when development occurs in areas with arguably “suitable” habitat that is not shown to be occupied (Glen and Douglas 2001, Parenteau 2010, Quarles and Lundquist 2010).

The jeopardy prohibition also potentially applies wherever the species’ habitat is found, but only to projects carried out, funded, or authorized by a federal agency (Ryan and Malman 2010). Such projects can occur on public or private land, and often the trigger is a federal permit needed for a private development. The Section 7 consultation process can be costly and protracted, and the action agency (e.g., agency proposing to issue a permit) and consulting agency (FWS or NMFS) exchange scientific information and impact assessments (Ryan and Malman 2010). Very few consultations result in a finding of jeopardy (Owen 2012), however, so the threat is more from the process delay than any substantive impacts. Nevertheless, it is not uncommon for a project to undergo some design modifications to reduce the chance of a jeopardy finding.

The adverse modification prohibition, like the jeopardy prohibition, applies only to projects with a federal agency connection (Ryan and Malman 2010). Unlike the take and jeopardy prohibitions, however, adverse modification can only be found to occur in the species’ critical habitat. While this reduces the area within which the adverse modification prohibition could impose any regulatory impact, the key distinction is that areas of critical habitat are identified in published maps (Cheever 2010). Whether a parcel is or is not within critical habitat—and thus is essential to the conservation of the species—is entirely unambiguous and known to all. Although Owen (2012) documented that FWS rarely has found adverse modification without also finding jeopardy, adverse modification is regarded as easier to prove with scientific reliability (Sinden 2004).

The sum total of these effects is that critical habitat is more visible to the regulatory, market, and public eyes, and adds yet one more regulatory hoop to ESA compliance in designated areas. This can lead to more complex section 7 consultations, more active litigation over projects in critical habitat areas, hesitation to invest in development projects, and potential stigma effects on land values given the uncertainty surrounding critical habitat effects (Kroeger and Casey 2014; Plantinga et al 2014; Ray 2010).

Given these potential effects, controversy over critical habitat impact analysis methods and the legal and practical impacts of critical habitat designations continued long after the pygmy owl chapter on the

matter closed. In conflict with the federal appellate court's 2001 decision invalidating the baseline approach, in 2004 another federal appellate court found that the co-extensive approach was not consistent with the statutory purpose and ordered the agency to use a baseline approach, but to not assume away incremental impacts (*Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service*, 248 F.3d 1277 [10th Cir. 2001], Owen 2012; Plantinga 2014). In an attempt to bring clarity to the critical habitat impact analysis program and acknowledge the possibility of incremental impacts, in 2013 FWS adopted a new regulation that essentially codified the court's order (78 Fed. Reg. 53058 [2013]). The new "incremental" approach does not assume away the possibility of incremental impacts attributable to critical habitat, but requires that only the probable impacts on federal actions (e.g., issuing a permit) for which the designation is the "but for" cause can be counted. Yet the agency provided no guidance on how to determine that "but for" condition, other than to compare the protections provided by the critical habitat designation (the world with the particular designation) to the combined effects of all conservation-related protections for the species and its habitat in the absence of the designation of critical habitat (the world without designation, i.e., the baseline condition including listing). This suggests the need for retrospective empirical analyses of experienced incremental impacts (Plantinga et al. 2014).

Previous Empirical Studies

Plantinga et al. (2014) and Langpap et al. (2018) summarize the limited body of empirical studies on the economic impact of critical habitat designations. Plantinga et al (2014) examined critical habitat impact analyses FWS and NMFS prepared using the "but for" incremental analysis eventually adopted in the 2013 regulation, concluding that most quantify only the costs associated with additional or expanded consultations to consider adverse modification. They also summarize several empirical studies of critical habitat impacts that had been conducted at the time. Zabel and Peterson (2006) found that critical habitat designations in California had significant negative effects on building permit applications. In a second study (Zabel and Peterson, 2011) they found that critical habitat designations have positive effects on housing prices within designated areas, likely due to restricted housing supply.

Other studies reach a diverse set of results. Using a general equilibrium analysis for several critical habitat designations in Western states, Quigley and Swoboda (2007) found that designations increase prices and rents of lands outside of the designation area. Auffhammer et al. (2020) studied market values of vacant land parcels in and near two critical habitat designations in California, finding large and statistically significant decreases in values. Kroeger and Casey (2006) used a willingness to pay analysis to conclude that critical habitat designation for the Canada lynx had significant net positive effects. Nelson et al. (2014) compared land use changes and conservation activities in areas with and without critical habitat designation, finding no significant differences but reaching no conclusions about opportunity costs imposed by critical habitat.

Only one previous retrospective study has been conducted on the effects of pygmy owl critical habitat designation. Using a matching estimator, List et al. (2006) found that higher rates of development occurred within critical habitat area following the *proposed* designation in 1998, and that undeveloped land values fell in those areas after the proposal. They estimate that as a result of this preemptive strategy by developers, many parcels within the critical habitat area were developed a year sooner than parcels outside the area. This is similar to Lueck (2003), who found that forest plots were more likely to be harvested and were harvested at an earlier age in North Carolina to avoid land use regulations meant to protect endangered red-cockaded woodpeckers.

The story of the pygmy owl ESA experience provides a unique opportunity to assess the impacts of critical habitat designations. This is because, as a result of regulatory and litigation events discussed above, the ESA turned “on” and then turned “off” in the rapidly developing Tucson area within the span of nine years, but critical habitat did so in only part of the area affected by ESA regulation and was in effect for only part of the period. Indeed, the pygmy owl presents the only such instance in which a species found in a developing urban region has had its ESA listing and critical habitat profiles switched on and off so abruptly. Within that time frame, the owl’s critical habitat designation was delayed for two years after the listing, lasted in effect for just over two years, and then was soon after re-proposed but never finalized before the delisting. This allows us retrospectively to study whether the addition of the adverse modification prohibition to a subset of the larger area already subject to take and jeopardy prohibitions made any difference.

If the logic behind FWS’s baseline approach used in the 1999 impact analysis for the owl were valid, there would be no discernible incremental economic impact from the introduction of the critical habitat designation two years after the species was listed. Similar areas within and outside the critical habitat should look the same. If there were discernible impacts—a possibility the agency’s current incremental analysis approach contemplates—they should have been eliminated under one of two scenarios. In one, the incremental impacts would disappear once the federal trial court vacated the critical habitat designation in 2001. The other scenario is that the agency’s commitment at that time to correct the analysis and re-propose critical habitat, and its actions doing so in 2002, perpetuated at least some of the incremental effects until the species was delisted and the prospects of a critical habitat designation were thereby fully eliminated.

Data, Methods, and Results

The property value analyses use the Zillow Home Value Index, which represents the median home value in a given geographic region. Zillow uses machine learning tools to generate continuous estimates of properties in the US, adjusting for both property specific attributes and location specific trends. Relative to the Case Shiller repeat-sale index, Zillow’s estimates are available for many more (and more precise) locations. Also, while the Case Shiller Index relies on just those homes that are sold (and sold more than once at that), the Zillow index includes all properties in the area. A detailed presentation of the Zillow methodology is available at <https://www.zillow.com/research/revisions-zhvi-methodology-6064/>.

For our analysis, we use Zillow’s index capturing the median value of all properties at the county level. We use monthly data beginning with the pygmy owl listing in March 1997, to ensure the effects of the listing are already baked into the baseline, through the end of 2006. We stop analysis then to avoid including the housing collapse (which hit Arizona and, in particular, Maricopa County especially hard). We examine data from Arizona and its border states, California, Colorado, Nevada, New Mexico, and Utah.

Table 2 provides the mean value of the index, the starting and ending value of the index for the sample period, and the standard deviation of the index for each of the Arizona counties affected by the critical habitat listing (Cochise, Pima, Pinal, and Maricopa). For comparison purposes, we also provide these figures for each of the states.

Table 2:				
Property Index Summary Statistics				

	Mean	March 1997	December 2006	Standard Deviation
Counties Affected by Critical Habitat Designation				
Cochise	110,234	81,800	170,200	28,163
Pima	146,610	105,500	232,800	41,261
Pinal	138,989	87,000	230,300	44,678
Maricopa	166,371	113,800	275,100	53,399
States				
Arizona	130,423	87,673	221,285	53,776
AZ (excl CH counties)	124,954	82,329	218,700	56,269
California	275,423	155,845	435,886	167,226
Colorado	199,950	130,312	281,712	116,870
Nevada	213,768	144,425	335,050	81,376
New Mexico	146,414	131,644	190,167	52,653
Utah	172,876	146,912	222,241	67,391
Note: Zillow Home Value Index for all homes at the monthly frequency. State data represent the average of the underlying county data.				

Using the Zillow Home Value Index data, we first examined a basic difference-in-difference specification to isolate the effect of the designation of critical habitat in Cochise, Pima, Pinal, and Maricopa counties in Arizona. As comparison counties, we included all other Arizona counties, as well as the counties from all of Arizona's border states. Because there are obvious scale differences in the property values across counties, we examine the natural logarithm of the Zillow index. We include county and period fixed effects. However, as seen in Table 2, there are clearly trend differences across the counties, so we also provide specifications that allow for county-specific linear trends. We cluster our standard errors by county.

Table 3:		
Formally Designated Counties		
(Standard Errors Clustered by County)		
Pygmy Owl Critical Habitat Designation	-0.03* (0.02)	-0.03*** (0.01)
County Fixed Effects	Yes	Yes
Period Fixed Effects	Yes	Yes
County-Specific Trends	None	Linear
Outcome variable is ln (Zillow Index) at the county level and monthly frequency covering period March 1997 – December 2006. All counties from Arizona, California, Colorado, New Mexico, Nevada, and Utah included. Arizona counties affected by Pygmy Owl Listing and Critical Habitat Designation are Cochise, Pima, Pinal, and Maricopa. Critical Habitat designation covers period July 1999 – September 2001.		
***p < 0.01 (against a two-tailed test of a hypothesized 0 effect)		
**p < 0.05 (against a two-tailed test of a hypothesized 0 effect)		
*p < 0.10 (against a two-tailed test of a hypothesized 0 effect)		

The specifications present a consistent story. We observe a 3 percent decline in property values. This effect is statistically significant at the 10 percent level in the no trends specification and at the 1 percent level in the county-specific trends specification.

Recent work has drawn into question the normal approach to statistical inference in the difference-in-difference context. Cameron, Gelbach, and Miller’s (2008) wild cluster bootstrap allows for non-parametric inference. Comparing our test statistic of -2.77 for our critical habitat designation effect in the county-specific trend specification to the empirical distribution of test statistics from their approach, we continue to find that our effect is statistically significant. Specifically, in the symmetric two-tailed case, the wild cluster bootstrap gives a critical value associated with a 5 percent type 1 error of 2.37. When symmetry is not imposed, the critical values are -1.85 and 2.53.

Because we have a fairly large number of clusters (i.e., counties), perhaps the concern addressed by the wild cluster bootstrap is not large. However, Conley and Taber (2011) raise a concern when the number of treated clusters is small and MacKinnon and Webb (2018) extend this intuition. MacKinnon and Webb indicate that the few treated clusters case can lead to severe over-rejection and the wild cluster bootstrap does not remedy the problem. Instead, they propose a randomization inference approach where, essentially, the treatment is randomly assigned to non-treatment units and the associated test statistic is collected. After doing this repeatedly, the empirical distribution of these placebo test statistics is used to set critical values for the actual analysis. Doing this, we find that our test statistics of -2.77 is smaller than all but 4.4 percent of the placebo test statistics. Thus, it appears as though our finding is unlikely to have arisen by chance alone.

In Table 4 below, we further examine the effect of critical habitat designation on property prices by also including the effect on properties in counties mentioned by FWS as potentially providing habitat for the pygmy owl but not included in the critical habitat designation. These counties are Yuma, Santa Cruz, Graham, Greenlee,¹ and Gila.² While the properties in these additional counties are not at risk of having regulatory restrictions placed on them as a result of the critical habitat designation, each was named in the FWS “take habitat” survey protocol for landowners (FWS, 1998), meaning that both the take prohibition and jeopardy prohibition, but not the adverse modification prohibition, could attach to areas in those counties.

Table 4:	
Formally Designated Counties & Counties Under Guidance	
(Standard Errors Clustered by County)	
Pygmy Owl Critical Habitat Designation	-0.03*** (0.01)
Pygmy Owl Survey Protocol Guidance	-0.01 (0.05)
County Fixed Effects	Yes
Period Fixed Effects	Yes
County-Specific Trends	Linear
Outcome variable is ln (Zillow Index) at the county level and monthly frequency covering period March 1997 – December 2006. All counties from Arizona, California, Colorado, New Mexico, Nevada,	

¹ Greenlee County is not covered in the Zillow data.

² See <https://www.fws.gov/southwest/es/Documents/R2ES/pygowl2.pdf> .

and Utah included. Arizona counties affected by Pygmy Owl Listing and Critical Habitat Designation are Cochise, Pima, Pinal, and Maricopa. Critical Habitat designation covers period July 1999 – September 2001. Arizona counties affected by Pygmy Owl Survey Protocol Guidance are Gila, Graham, Santa Cruz and Yuma. Critical Habitat designation covers period July 1999 – September 2001.

***p < 0.01 (against a two-tailed test of a hypothesized 0 effect)

**p < 0.05 (against a two-tailed test of a hypothesized 0 effect)

*p < 0.10 (against a two-tailed test of a hypothesized 0 effect)

Interestingly, these additional counties do not exhibit a comparable decline in property values during the critical habitat designation period.

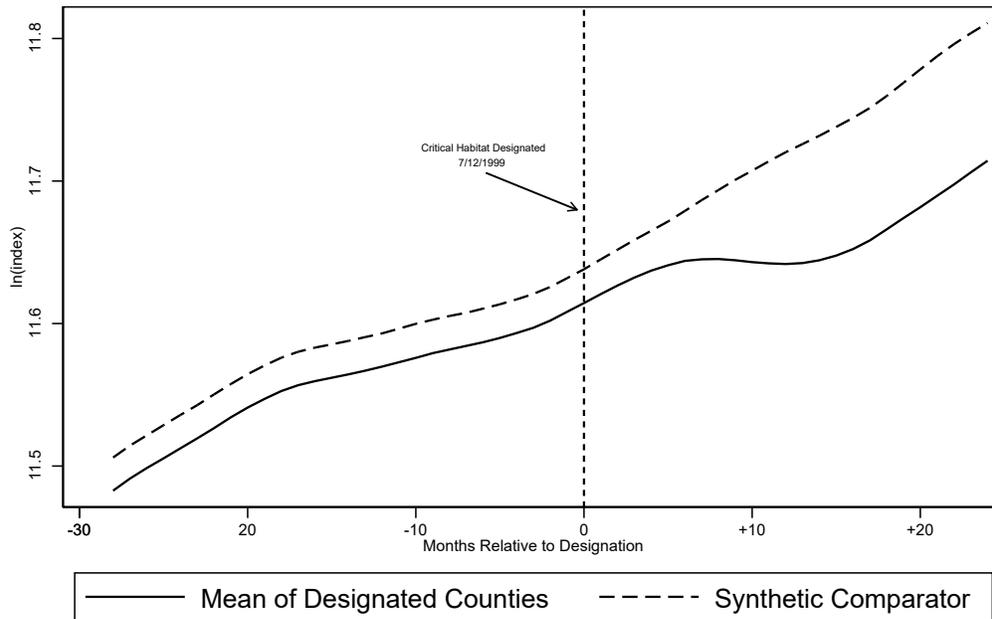
While the difference-in-difference analyses are suggestive that the critical habitat designation led to a decline in property values, it may be useful to attempt to examine a more compelling research design. To better isolate the counterfactual of what would have happened to property values in Cochise, Pima, Pinal, and Maricopa counties, we implemented the synthetic control approach of Abadie, Diamond, and Hainmueller (2010). Essentially, we create a portfolio county that provides the best match for the average Zillow index for the four Arizona counties in the period from the beginning of our sample (April 1996) until the month before the critical habitat is designated in July 1999.

The Abadie et. al. algorithm chose non-zero positive weights for the counties presented in Table 5 (all other counties received zero weight).

Table 5:	
Weights for Synthetic Control	
County	Weight
Alamosa County, CO	0.073
Grand County, CO	0.061
Imperial County, CA	0.019
Mohave County, AZ	0.207
Navajo County, AZ	0.071
Otero County, CO	0.042
Placer County, CA	0.022
San Benito County, CA	0.101
Santa Fe County, NM	0.049
Shasta County, CA	0.035
Summit County, UT	0.010
Teller County, CO	0.155
Yavapai County, AZ	0.101
Yuma County, AZ	0.056

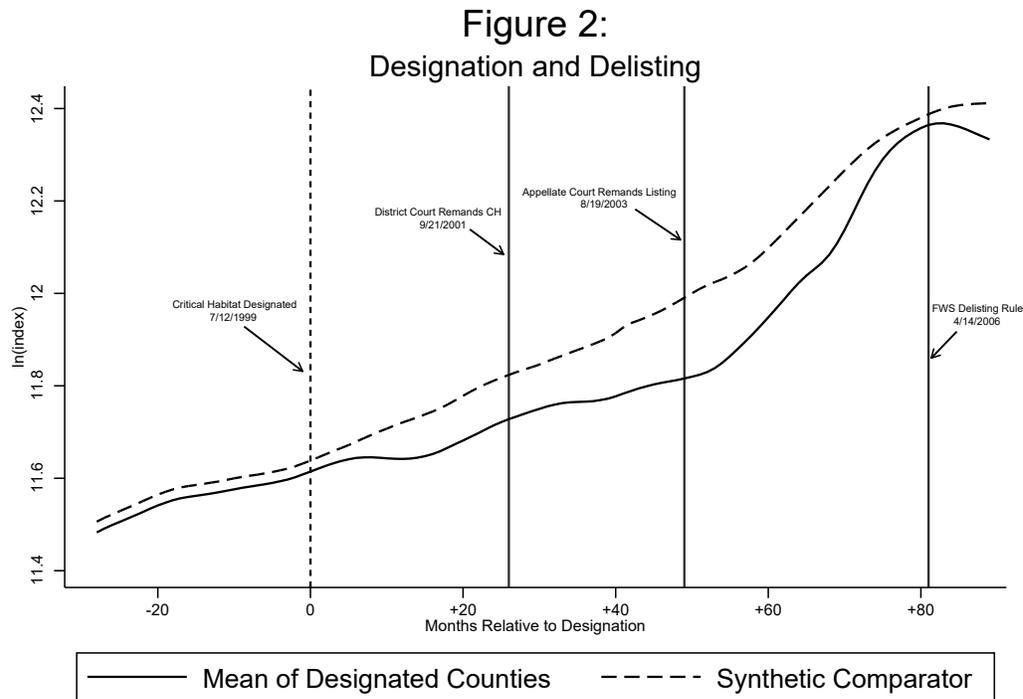
Figure 1 below provides the results of the synthetic control exercise.

Figure 1:
Effect of Critical Habitat Designation on Property Values



Although the affected counties and the synthetic comparator match up well even past the designation of the critical habitat, there is a departure between the two a few months later. The lag in effect could be attributable to the time it took for FWS consultations under section 7 of the ESA to fully integrate the adverse modification assessment required in critical habitat areas and impose conditions on affected land use projects, such as the habitat avoidance conditions reported by Sinden (2004), at which point the property market could incorporate that experience into prices. Assessing the statistical significance of this gap can be done by comparing the ratio of the root mean squared prediction error in the post intervention period relative to the pre-period for the treatment group with the distribution of the similar ratio for the placebo test of running the synthetic control for all non-treated counties during the same time period. This comparison suggests that the critical habitat designation effect stands at the 95th percentile of this placebo distribution.

If we re-run this exercise examining a longer window to examine how long these depressed property values endure, Figure 2 reveals an interesting dynamic. Specifically, the property values in the affected counties remain depressed relative to the synthetic comparator until FWS delisted the pygmy owl in April 2006. This suggests the second scenario we outlined above took effect—i.e., following the two-year experience with the designation in place, the market and public perceptions that led to the fall in prices persisted even after critical habitat was vacated as long as FWS continued to pursue re-designation of critical habitat. Following the court decisions invalidating the listing, the proposed delisting of the species effectively ended the prospect of any effects from a critical habitat designation, by which time the effects on prices was no longer detected.



Effect by County

FWS did not designate equal areas as critical habitat across the four counties.³ The largest designation of private land occurred in Pinal County with 71,634 acres (432,606 acres overall), followed by Pima County with 61,830 private acres (260,883 acres overall), and Cochise County at 2,461 private acres (4,832 acres overall). Maricopa County's designation was trivial at 68 private acres (33,391 acres overall). This suggests that very little of our overall effect can be driven by Maricopa County if the critical habitat designation is causing the price decline we observe. In Table 6, we run our difference-in-difference regression separately for each county.

Table 6: Effect of Critical Habitat Designation on Housing Values by County (Standard Errors Clustered by County)					
	All Designated Counties	Pinal County	Pima County	Cochise County	Maricopa County
Pygmy Owl Critical Habitat Designation	-0.03*** (0.01)	-0.04*** (0.01)	-0.04*** (0.01)	-0.04*** (0.01)	-0.01 (0.01)
County Fixed Effects	Yes	Yes	Yes	Yes	Yes
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes
County- Specific Trends	Linear	Linear	Linear	Linear	Linear

³ See Federal Register, volume 64, Number 132 (July 12, 1999), p. 37424, Table 1.

Outcome variable is ln(Zillow Index) at the county level and monthly frequency covering period March 1997 – December 2006. All counties from Arizona, California, Colorado, New Mexico, Nevada, and Utah included. Arizona counties affected by Pygmy Owl Listing and Critical Habitat Designation are Cochise, Pima, Pinal, and Maricopa. Critical Habitat designation covers period July 1999 – September 2001.

***p < 0.01 (against a two-tailed test of a hypothesized 0 effect)

**p < 0.05 (against a two-tailed test of a hypothesized 0 effect)

*p < 0.10 (against a two-tailed test of a hypothesized 0 effect)

While our estimated effect is statistically significant for Pinal, Pima, and Cochise counties, the effect size is substantially smaller and is not statistically significant for Maricopa County, where very little private land was designated for critical habitat (68 acres). While it might be surprising that the effect sizes for the other three counties are comparable despite there being variation in how much private land was designated in the counties, calibrating expected effect sizes is a little difficult in those instances. For example, although Cochise County (2,461 acres) had less private land designated than Pinal County (71,634 acres) and Pima County (61,830), most of Cochise County’s landmass is not privately owned⁴ and its population is clustered in much smaller areas than that of the other counties.⁵

Alternative Test

To further examine how the critical habitat designation affected the property market in Arizona, we use monthly employment data from the Quarterly Census of Employment and Wages⁶ to examine how these regulatory decisions affected land use. The critical habitat designation arguably made it more difficult to build new housing and commercial developments. Our outcome variable is the log of total private employment in the construction sector by county by month. To account for other background forces affecting employment, we control for the log of total employment. We include county level fixed effects, period fixed effects, and county-specific linear trends, as above. Likewise, to be consistent with the property value analyses, we examine the period March 1997 through December 2006.

Table 7:					
Private Construction Employment Effects in Formally Designated Counties					
(Standard Errors Clustered by County)					
	All	Pinal	Pima	Cochise	Maricopa
Pygmy Owl Critical Habitat Designation	-0.041*** (0.013)	-0.053*** (0.014)	-0.030*** (0.008)	-0.064*** (0.008)	-0.017** (0.008)
Ln(Total Private Employment)	0.429*** (0.101)	0.427*** (0.101)	0.424*** (0.101)	0.424*** (0.101)	0.424*** (0.10)
County Fixed Effects	Yes	Yes	Yes	Yes	Yes
Period Fixed Effects	Yes	Yes	Yes	Yes	Yes
County-Specific Trends	Linear	Linear	Linear	Linear	Linear
Outcome variable is ln(Private Employment in Construction) at the county level and monthly frequency covering period March 1997 – December 2006. Data come from the Quarterly Census of Employment and Wages. All counties from Arizona, California, Colorado, New Mexico, Nevada, and					

⁴ <https://www.cochise.az.gov/about> suggests that 40 percent of the land is privately owned.

⁵ https://www.ers.usda.gov/webdocs/DataFiles/53180/25557_AZ.pdf?v=0

⁶ <https://www.bls.gov/cew/downloadable-data-files.htm>

Utah included. Arizona counties affected by Pygmy Owl Listing and Critical Habitat Designation are Cochise, Pima, Pinal, and Maricopa. Critical Habitat designation covers period July 1999 – September 2001.

*** $p < 0.01$ (against a two-tailed test of a hypothesized 0 effect)

** $p < 0.05$ (against a two-tailed test of a hypothesized 0 effect)

* $p < 0.10$ (against a two-tailed test of a hypothesized 0 effect)

These results suggest that there is a statistically significant reduction in construction employment on the order of 4 percent during the period when the four Arizona counties were affected by the critical habitat designation. This decline is not driven by a market-wide employment decline. As we observed with the housing price analyses, the effects in the three counties with more land designated as critical habitat are larger than the observed effect in Maricopa County, where very little land was designated as critical habitat. These findings reinforce the causal interpretation of our housing value findings.

Implications

Malani (2007) and Klick and Parchomovsky (2017) suggest that property values might capitalize in the welfare effects of laws and regulations and provide at least a rough estimate of the social value of regulatory amenities. While much hinges on one's belief about the completeness of such capitalization, our estimates at least provide some guidance regarding the costs of the FWS designation of critical habitat for the pygmy owl. Credible cost estimates, as described above, have been in short supply in this regulatory setting.

It is notable that the costs we have identified suggest that the FWS's former baseline approach for critical habitat impact analyses underestimated the economic effects. The FWS position that the adverse modification prohibition that is triggered by critical habitat designation imposes no incremental costs depended on a formalistic evaluation of legal requirements of the three ESA regulatory programs. Even assuming the adverse modification prohibition does not add to the regulatory baseline imposed by the take prohibition and jeopardy prohibition, markets respond to more than legal formalities. The explicit mapping of critical habitat areas and the weighty "essential to the conservation of the species" standard for critical habitat expose development in designated lands to heightened risk of being deemed to cause take of the species and to closer monitoring by the agency and advocacy groups. The addition of the adverse modification assessment step to Section 7 consultations exposes those developments that require federal agency funding or approval to more extensive review and an additional decision point over which advocacy groups can litigate. The combined effect of these factors registered in property values in the case of the pygmy owl. It is plausible that they have similar effects in other markets. Yet the baseline approach FWS used ignored any such effects—indeed it shut off any examination of them whatsoever.

Our findings thus suggest that the Tenth Circuit appellate court's instincts in questioning the former baseline approach were on target. But the court's alternative of co-extensive analysis mashes together all three regulatory programs, meaning that it counts in the critical habitat impact analysis costs of ESA regulation that will exist regardless of the decision made regarding critical habitat. The 2013 rule in which FWS and NMFS outlined their incremental analysis approach removes the hard assumptions of the baseline approach—i.e., that critical habitat adds no regulatory burdens and imposes only administrative costs—but provides no guidance as to how to conduct the incremental effects analysis other than to compare the world with and without the critical habitat designation. Our findings suggest

that those two worlds can look very much different, and that careful attention to incremental impacts analysis is needed.

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