SUSTAINABILITY

The Pinelands Development Credit Program: *Using Market Mechanisms to Achieve Preservation Goals*

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ABSTRACT The "Pine Barrens" are a UNESCO-designated biosphere reserve encompassing about 1.1 million acres in southern New Jersey. A state agency, the New Jersey Pinelands Commission, in conjunction with county and local governments, works to implement land management and environmental protection goals via a comprehensive management plan. The pinelands development credit (PDC) program is one tool aimed specifically at land preservation outcomes. The PDC program is a regional "transfer of development rights" market allowing landowners to sell their rights to further develop their property and enter their land into permanent protected status. Since the program's inception in 1982, over 55,000 acres of sensitive and rare ecosystem have been protected; the more than 1,200 transactions account for US$63 M of economic value. The PDC program is a clear illustration of the role that financial instruments and market mechanisms can play in achieving environmental protection outcomes. This case study offers an overview of the pinelands area, PDC program, and the transfer of development rights concept before examining the PDC program and its outcomes in greater detail. While the program has been hailed as a success, it will face challenges in the coming years, including a relatively inefficient process for converting PDCs into protected lands and the question of how the program can evolve once eligible lands become more scarce.

KEYWORDS planning, conservation, finance, markets, New Jersey, pinelands, preservation

Case Context

The New Jersey "Pine Barrens" are a UNESCO-designated biosphere reserve located in southern New Jersey (see map 1). Encompassing about 1.1 million acres, the area is managed jointly by the U.S. federal government, a state of New Jersey commission, seven county governments, and 56 municipal governments. Although it is a very old ecosystem, the pinelands as a protected area has existed only since the late 1970s with the passage of federal laws designating the Pinelands National Reserve and state laws outlining the Pinelands Protection Act and creating the New Jersey Pinelands Commission, or NJPC [1].

The primary mechanism for preserving and protecting the pinelands ecosystem is through zoning rules and review of development projects for compliance with environmental standards. The New Jersey Pinelands Commission, a state agency, has the power to set minimum environmental standards for all local zoning and development ordinances. All municipalities in the pinelands area are required to conform their local master plans and zoning ordinances to the regional plan set forth by the Pinelands Commission. Most construction and infrastructure development projects, as well as projects of any other type impacting the pinelands ecosystem or potentially impacting threatened and endangered species found in the pinelands ecosystem, must be reviewed for compliance with the Pinelands Comprehensive Management Plan (CMP) by the NJPC's professional staff of scientists, urban planners, and land management experts, as well as the 15-person Commission itself. The Commission's membership represents seven county governments, the interests of the federal government, and the interests of the state of New Jersey and its residents more broadly. Members of the

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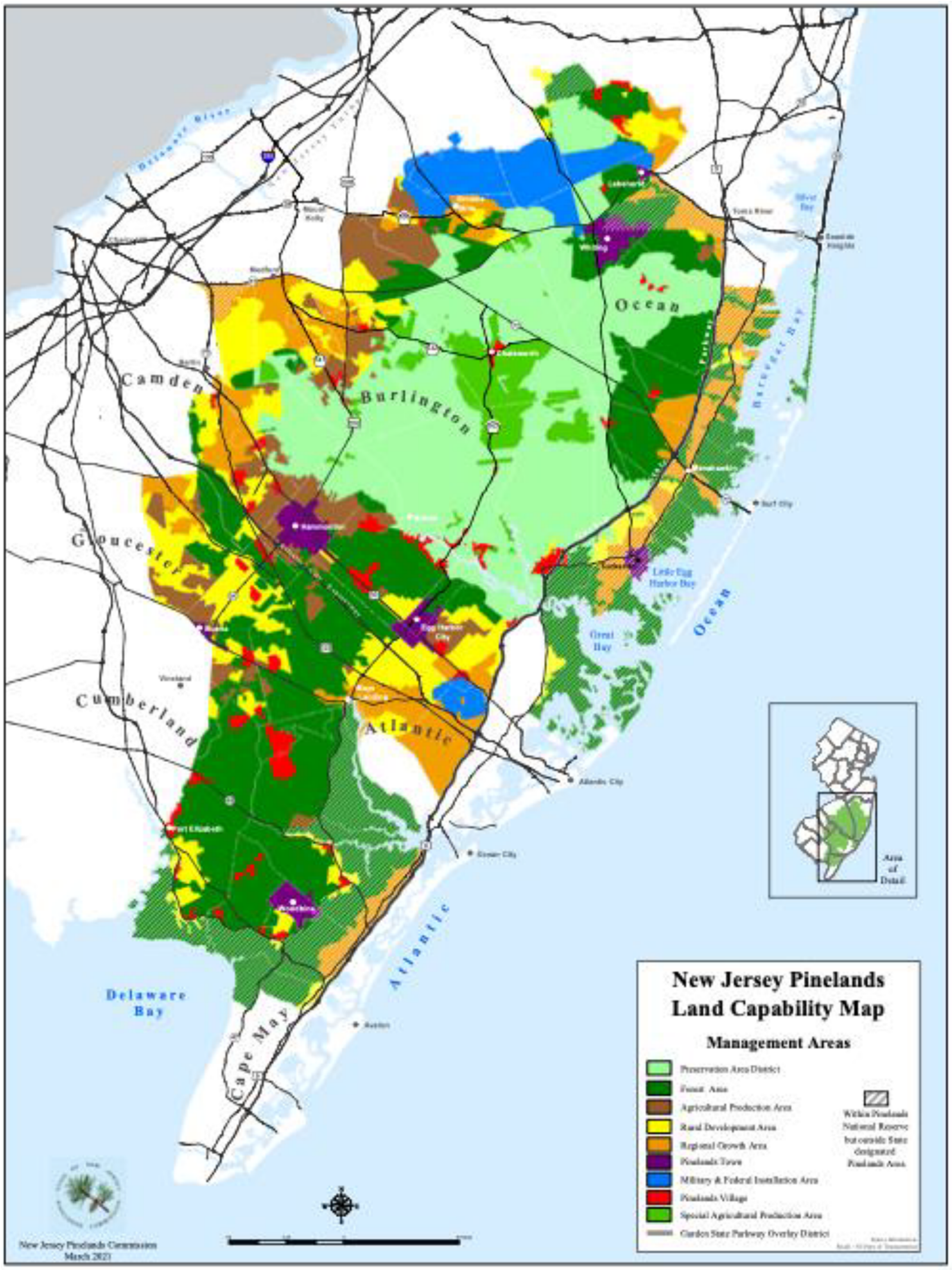
Commission are appointed by county governments, the U.S. Secretary of the Interior, and the New Jersey governor's office and serve as uncompensated volunteers. The NJPC also conducts extensive scientific, engineering, and historical research as well as offering opportunities for public education and outreach each year [2].

The pinelands ecosystem has been inhabited for thousands of years, first by indigenous peoples and next by subsequent waves of Euro-American settlers. The region is squeezed between greater Philadelphia and greater Atlantic City and subject to the development pressures of both regions as well as growth associated with communities in northern New Jersey and all along the New Jersey seashore. As these areas sprawled during the 1960s and 1970s, the state of New Jersey and its residents were faced with the decision to develop the pinelands area or carefully manage it, keeping the land closer to its natural state in order to preserve and protect the globally unique species, habitats, and aquifers found there. In fact, according to the U.S. Fish and Wildlife Service, the pinelands is home to "850 plants, 39 mammals, 299 birds, 59 reptiles and amphibians, and 91 fish" species including more than 90 species of plants and 44 species of animals that are listed as threatened, endangered, or otherwise of special concern to the state of New Jersey and/or the U.S. federal government through the Endangered Species Act [3]. The pinelands area also sits atop one of the largest aquifers on the U.S. east coast, the Kirkwood-Cohansey, which encompasses some 3,000 square miles [4].

After the decision was taken to protect the pinelands area and establish the NJPC, the question became how best to balance all of the activities going on in the region. Thousands of people already lived in the pinelands when it received its environmental designations, along with the farming, forestry, industrial, and commercial activities that supported many communities. For instance, Hammonton—celebrated as the "blueberry capital of the world"—is the epicenter of New Jersey's 57 million pounds-per-year of blueberry production [5], with all of the attendant sustainability challenges associated with commercial agriculture. Elsewhere in the pinelands, sand mining and forestry operations compete with housing developments, planned communities, and tourism operations. Even today, after 40 years of management by the NJPC, the pinelands are home to more than 700,000 people and tens of thousands of businesses [6].

Thus, one of the key goals of protecting the pinelands is to manage growth and environmentally disruptive types of economic activity. Through the CMP, nine land use designations were created for the pinelands region (map 1). Some designations, like "preservation" and "forest," have strict development restrictions in the interest of ecological protection. These designations also encompass thousands of acres of state and county parks, forests, and open space areas. Others, like the two types of agricultural designation, aim to continue the historical uses of an area for farming. Still others allow very modest development within the boundaries of towns and villages that existed prior to the implementation of the Pinelands Protection Act. Finally, on the margins of the pinelands area, are designated "regional growth areas" where the bulk of housing, economic, and commercial development is intended to take place [7]. The purpose of establishing these land use designations was to develop zoning tools for directing flows of growth and economic activity from Philadelphia, North Jersey, and greater Atlantic City away from ecologically sensitive places and toward areas where development might be less environmentally impactful. These zoning designations were imposed on existing property owners, in some instances significantly changing the calculus of their property value given the new types of development restrictions overlaid on their land.

One of the more innovative zoning tools associated with the region, relying on the land use designations just outlined, is the pinelands development credit program ("PDC" program). The PDC program is a regional "transfer of development rights" (TDR) system that allows landowners with preservation-, agricultural production-, and special agricultural production-designated property to sell their right to further develop their property while retaining ownership of the underlying land. These areas are known as "sending areas." Buyers of these development rights credits, located in designated "receiving areas" and particularly in the regional growth land use areas, are then allowed to increase the amount of residential development permitted on their lands. When PDCs are purchased, the "sending" area enters into a program of permanent land protection through deed restrictions. In this way, the PDC program takes development pressure off of lands in the core pinelands area and redirects it toward the outer margins while also adding additional acreage to the



Map 1. New Jersey Pinelands land use designations [8].

rolls of permanently protected land in the pinelands ecosystem.

Case Methodology

In this case study, we examine the PDC program in greater detail in order to illustrate the roles that market mechanisms can play in achieving land preservation and ecological protection goals. We've examined annual reports, sales data, and other documentation produced by and about the PDC program over the period 1982–2020. All of the sources we've examined are publicly available through the PDC Bank's website, and citations for specific sources are included as appropriate. We also conducted an interview with the executive director of the PDC Bank and an employee of the NJPC who works with the PDC program. Organizationally, in this article, we first offer an overview of the TDR concept and then examine the PDC program and its impacts. Next, we consider some limitations of the PDC program and explore questions about the program's future.

CASE EXAMINATION

TDR: From Concept to Reality

The "TDR" concept first emerged in the United States during the 1960s as a tool for historic preservation; TDR programs have since been applied to a range of challenges from environmental protection to affordable housing [9, 10]. The goal of a TDR is to reduce or prevent development in some places by concentrating development (or potential development) in other areas [11]. TDR markets have two sides: The places or parcels that are intended to be preserved by the TDR are called sending sites, while receiving areas are places considered appropriate for growth. The owners of sending sites have the option to take an easement on their land in return for a marketable commodity in the right to develop their property [12]. These owners can sell these TDRs to developers in receiving areas. Receiving areas are already zoned for development but are allowed additional developments or density when the developer buys TDRs [11]. TDR programs are considered zoning techniques that aim to protect the environment while also controlling urban growth. Often, though not always, TDR programs protect resources that are hard to measure purely by quantitative metrics, like historic landmarks, urban growth, or affordable housing [11].

TDR programs generally serve three functions for stakeholders: (1) redistributing development rights, (2) offsetting property rights restrictions, and (3) leveraging private dollars for resource protection [9, 13]. First, by redistributing development rights, TDRs support the spatial goals of communities while avoiding the policy and market imperfections that are sometimes brought by planning and zoning rules. For example, urban areas can experience high land prices due to positive externalities such as tax breaks or availability of transit, while rural areas may face negative externalities from agricultural operations and development restrictions [9]. Second, by offsetting property rights restrictions, TDRs still allow for the right to develop—just in a different location. Thus, TDRs are helpful to avoid using downzoning, where governments undergo rezoning to allow less development potential, as a strategy to implement environmental protection goals. Downzoning may restrict a property owner's ability to use land and may decrease property values, which often leads to political and legal challenges. But a TDR can offset these property rights impacts and provide an avenue for compensating property owners whose rights have been diminished in pursuit of a broader social or environmental goal [9].

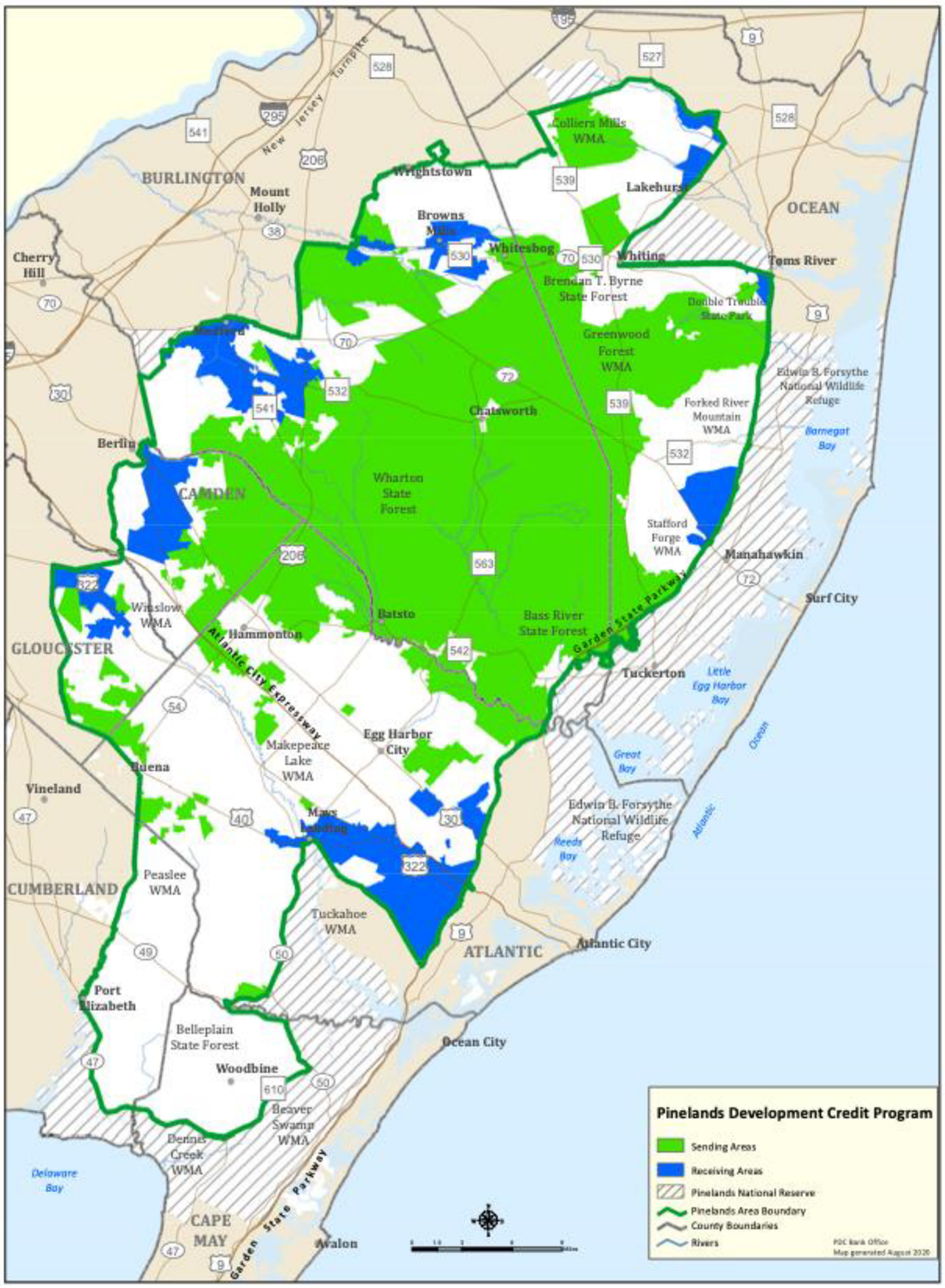
A TDR system can also serve as a tool to create more resilient communities by preserving environmentally sensitive land. For example, the City of Miami is using TDR in its Arch Creek Basin as tool in community adaptation to climate change. This area is primarily residential and is largely located within a Special Flood Hazard Area. The program offers to convert these areas to a large-scale slough park through voluntary relocation, even allowing preselling and low-income options when eligible [14]. TDRs also leverage private funds for resource area protection as public funding can often be lacking. By enabling development rights to be transferred between landowners and developers on the private market, TDRs can provide protection for environmental and agricultural areas without imposing taxes or incurring debt on the community [9].

The last few decades have seen a shift toward voluntary, market-based strategies through the use of public–private partnerships and incentives [15]. This trend follows the increasing shift away from publicly funded, bureaucratic approaches to planning and more toward incentive-driven, entrepreneurial placemaking [9]. To allow for such an environment, these governments are responsible for providing carefully planned zoning and properly connected infrastructure [16]. TDR programs are becoming more attractive in the current land use policy environment, as they require comparatively fewer regulatory tools and comprehensive plans. Furthermore, from a legal perspective, TDRs are a means to mitigate or compensate for regulatory takings [17]. If sending area land meets the criteria for taking and TDR is seen as compensation, the program must provide just compensation for the taken property. Likewise, if the TDR is seen as an economically viable use of the impacted property, TDR may release the local government's liability for a taking [9, 17]. Local and county governments must actually create the market for TDRs, allowing for parties to trade development rights. Depending on the size and scope of the TDR, these programs can be managed at the county or municipal level. All programs usually require short-term start-up investments and long-term administration costs and considerable coordination among different components of government. To meet these demands, third-party groups such as nonprofits and consultants are sometimes involved in the actual management and administration of TDR programs [18].

Ideally, the use of TDRs will result in development rights being transferred from rural areas into urban settings, where the infrastructure, employment, shopping, and public services needed to accommodate additional development already exist [11]. Therefore, for a TDR program to work efficiently, a community must have separated working landscapes and planned development areas. This allows for clear sending and receiving areas in the TDR process. TDRs normally struggle in rural areas that lack developmental pressure, with this technique rarely being used in such circumstances [16].

The PDC Program

The PDC program largely follows the contours of a typical TDR program. The NJPC allocates PDCs to landowners in the Preservation Area District, Agricultural Production areas, and Special Agricultural Production Areas. These areas are established in the Pinelands CMP as allowing little-to-no development, as in either residential or commercial development. The CMP outlines permitted uses for each of these areas, but the overall goal within these



Map 2. Pinelands development credit sending and receiving areas [18, no page].

areas is to preserve the land as either wilderness or active farmland. Within the PDC program, these areas are known as "sending areas" (map 2). Property owners can determine whether they are eligible for PDCs by applying to the NJPC for a Letter of Interpretation, which establishes basic facts about the property including: landscape attributes (wetland or nonwetland), title, structures on the property (and their uses), notable activity on the property (such as agricultural or commercial activity), any desire on the part of the landowners to reserve the right to build a house on the property in the future, and any easements or deed restrictions that may affect the property. Using this information, NJPC staff then determine how many PDCs a property owner is entitled to claim. If inclined, property owners can then sell their PDCs once allocated to anyone they'd like to.

Each individual credit transfers the right to build four homes. Credits can be bought and sold in quarter-credit increments, with each quarter-credit representing the right to build a single home. PDC transactions are arranged independently between buyers and sellers. However, the transactions are recorded and finalized by the PDC Bank. The PDC Bank is the statutorily designated processing agency for the PDC program. The PDC Bank maintains the details of recent transactions, including publicly accessible information about prices and volumes of credits transacted. The Bank maintains lists of PDC holders and can connect those looking to sell their credits to potential buyers. The PDC Bank also maintains the physical certificates, similar to physical bond or stock certificates, associated with each property, and ensures these are transferred correctly upon any transaction. The PDC Bank has the ability to purchase PDCs directly and has the option of either "retiring" them and removing them from the marketplace or maintaining holdings until sometime in the future. Historically, this "public sale" power has been used only in limited circumstances and typically in association with injections of capital from the State of New Jersey. Finally, the Bank works with the NJPC when credits are redeemed in order to ensure that corresponding amounts of land are entered into permanent protected status.

One innovation associated with the PDC program, discussed further below, is that land with PDCs allocated to it can be sold and bought with the PDCs still attached to it or PDCs can be "severed" from the underlying land and sold separately. For PDCs to be severed and sold, a deed restriction must be recorded first for the underlying land, committing the property to some level of environmental protection in perpetuity because the owner has severed their rights to further develop the property. Once the restriction is filed and recorded, the PDCs are considered severed from the land. The landowner selling the credits still retains the title to the land and is allowed to continue using it in accordance with the CMP, uses that typically center on passive recreation activities like hiking, hunting, or fishing. The deed restriction must be recorded in such a way as to also bind future owners of the land to the same uses.

Participation in the PDC program is largely voluntary, though some municipalities may require the purchase and redemption of PDCs as a condition of zoning approval for a given project. However, there are many reasons why a developer would choose to purchase and redeem PDCs for a project. Although in theory anyone can purchase PDCs, from a conservation perspective, PDCs are ideally sold to buyers in CMP-designated "receiving areas" in the regional growth area land use designation. These are areas of considerable existing development and deemed capable of accommodating regional growth influences while also protecting the environment and character of the pinelands. There are regional growth areas designated in 22 municipalities in the pinelands area, and in these municipalities, zoning regulations are such that housing and development projects that incorporate the purchase of PDCs are allowed to construct up to 50% more housing than would otherwise be permitted. For many building projects, this means that a developer could also sell 50% more housing units than they otherwise would be allowed to. Municipalities designate residential, commercial, and industrial zones within a regional growth area. Many residential zones have assigned base density and a maximum permitted bonus density; if a developer wishes to build at maximum permitted bonus density, then PDCs are required. When a developer "redeems" PDCs as part of a project, the PDCs are officially removed from the marketplace. Thus, it is actually in the interests of land preservation goals to see additional development on the margins of the pinelands area because this results in lands elsewhere becoming permanently protected.

Based on our analysis of all available sales data running back to the inceptions of the program in 1982, there have been more than 1,200 transactions within the program, representing 6,977 construction rights (figure 1). In

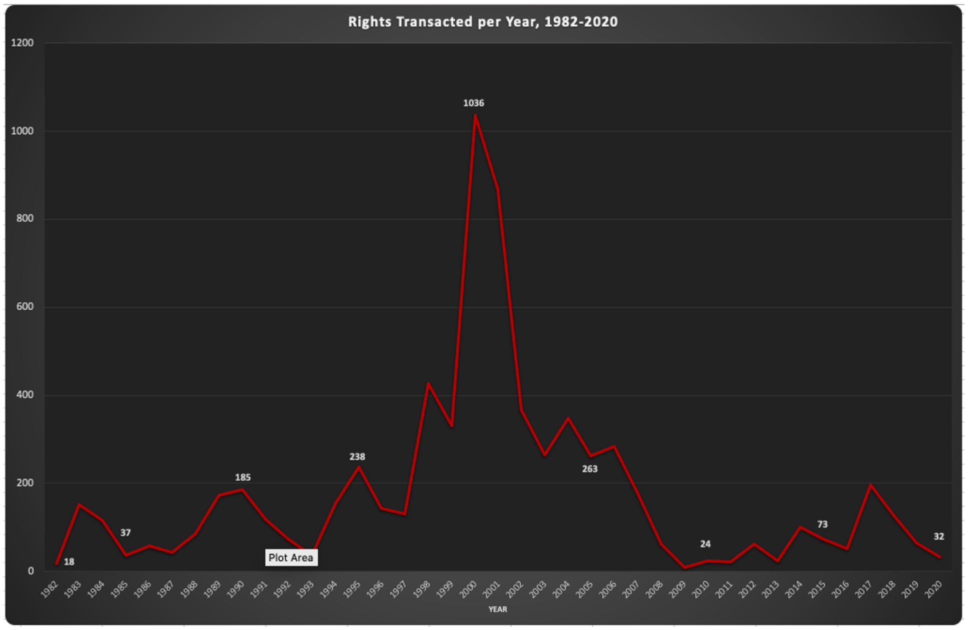


Figure 1. Rights transacted per year, 1982–2020.

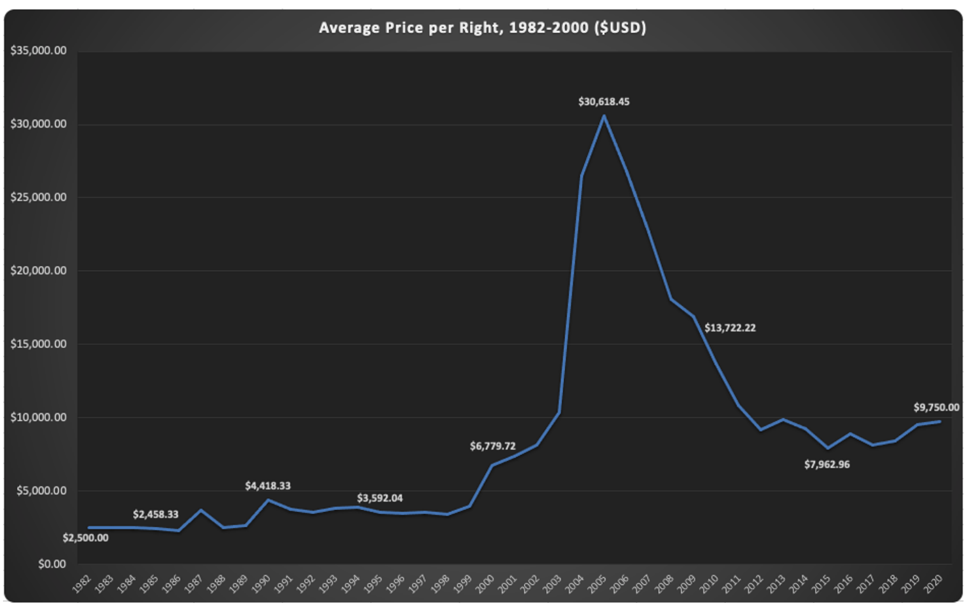
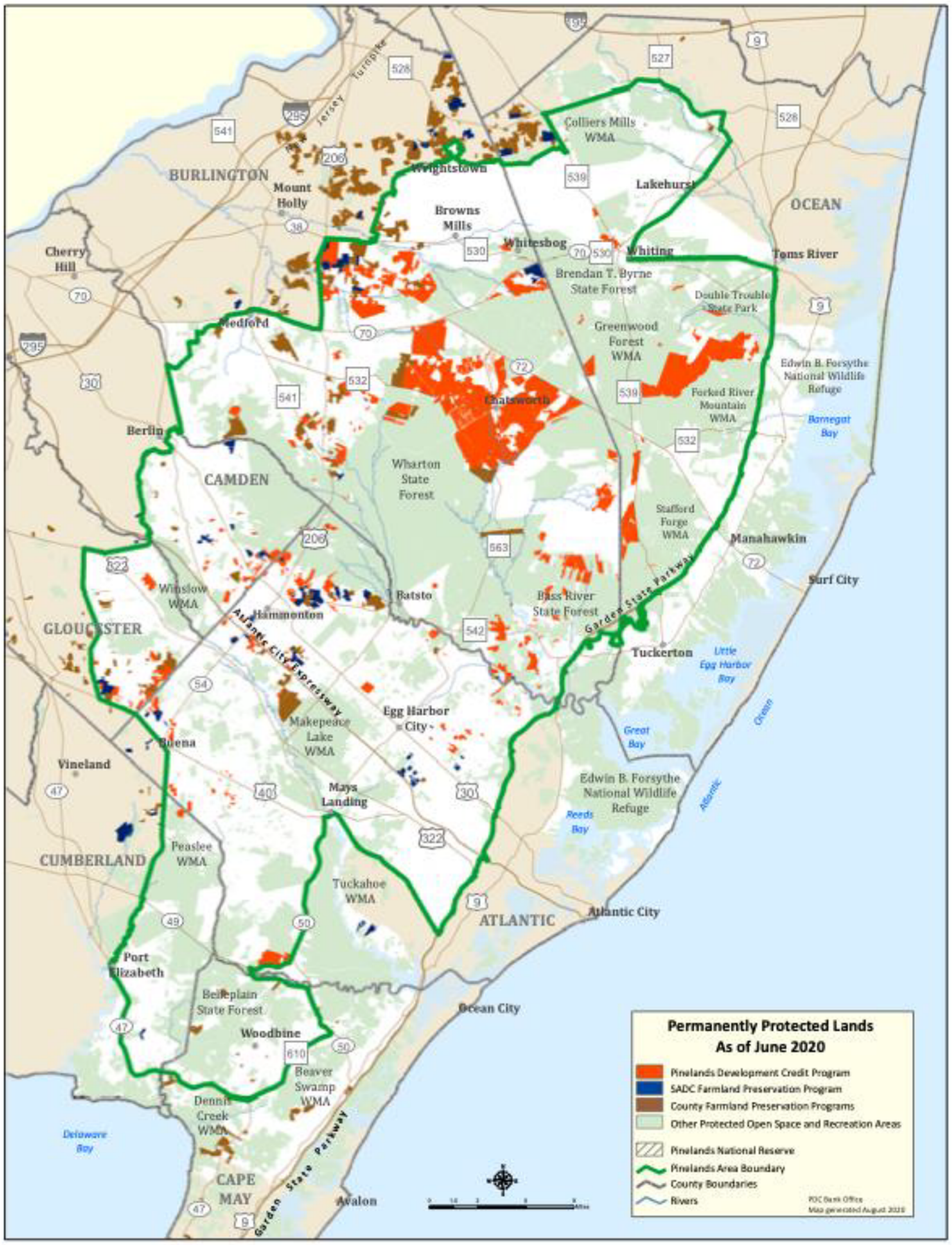


Figure 2. Average price per right, per year, 1982–2020.

practical terms, that means that nearly 7,000 new housing units that would have otherwise been built in preservation- or agriculture-designated areas were successfully relocated to one of the regional growth areas on the margins of the pinelands area. These transactions have totaled more than US$63 M in economic value, including the handful of purchases and sales made by the PDC bank itself. In the years we studied, 1982–2020, there were on average about 31 transactions per year, and the average price for a right was about US$8,700 (figure 2). However, these averages mask considerable variation and volatility within the PDC market from year to year. Unsurprisingly, the contours of the PDC market follow the ebbs and flows of the broader economy—transactions, and prices, rise during periods of economic growth, and stagnate or even fall during economic downturns. While we examine some of the ongoing challenges with the marketplace for PDCs in the final section of this article,



Map 3. Permanently protected lands in the pinelands area. Note that the map depicts areas preserved through the PDC program as well as other programs [19].

we emphasize here the land preservation successes of the program: during the years of the PDC program, 55,391 acres of the pinelands area have entered into permanent protection because of rights being severed and redeemed [18, see also map 3].

Discussion and Analysis: Where Does the PDC Program Go From Here?

The PDC program has helped achieve the NJPC's land preservation goals and also serves as an illustration of the ways in which market mechanisms can contribute directly to environmental protection. But there are challenges and limitations to the program that are also worth considering.

First is the apparent difficulty in "converting" PDCs into protected land. Remember that in its essence, the PDC program represents the creation of a financial derivative and a market for that derivative: PDCs (the derivative) can be transacted entirely separate from the land itself (the underlying asset). Land with PDCs allocated to it can be sold and bought with the PDCs still attached to it, or PDCs can be "severed" from the underlying land and sold separately. Derivatives are not in themselves problematic, but it is important to understand that PDC "derivatives" and underlying markets for land in the pinelands area will operate differently from one another. There's no guarantee that PDC transactions will translate into protected lands, in contrast to the way that a simple purchase of land by a preservation group (e.g., The Nature Conservancy) would.

This fact is most clear when we examine the distinctions between PDCs allocated, severed, and redeemed, or what we call the "conversion rate." According to data supplied in the PDC Bank's 2020 Annual Report, over the lifetime of the PDC program, more than 2,979 PDCs have been allocated to landowners since 1982 [19]. But only 1,581 (53.1%) of those credits have been "severed" and entered into the marketplace to be utilized in development projects. Perhaps of even greater concern, just 982.5 PDCs have actually been redeemed, representing 62.1% of severed credits and just 33% of all PDCs that have been allocated. In other words, only 33% of all PDCs allocated have been converted into protected land.

These figures improve when we consider the purchase activity of the PDC Bank itself. On occasion during its history, the PDC Bank has purchased PDCs from sellers, at market prices. These so-called public sales, in contrast to the core "private sale" mechanism outlined in this article, have the sole purpose of "retiring" PDCs from the marketplace and entering additional land into permanent protected status without any associated development project receiving the credits. When we include the PDCs that have been purchased and retired via public sales, the ratio of redeemed PDCs increases to 41.4% of all PDCs allocated and 78% of all PDCs that have been severed. This suggests—similar to many commercial and retail banks—that the PDC Bank can play an outsized role in supporting the marketplace for its products.

Second, there are inherent physical limits built into any TDR program, and the PDC program is no exception. Land in the pinelands area—the "underlying asset" in the PDC program—is limited in two ways. First, there will be a point in time where no new PDCs can be allocated to "sending" areas (a cap on supply). Second, there is a limited amount of land suitable for development in pinelands "receiving" areas, which will fundamentally limit the number of PDCs that can be redeemed (a cap on demand). Viewed optimistically, when the PDC marketplace reaches these limits, perhaps all available PDCs have been redeemed and a considerable amount of land has entered permanent protected status. Conversely, the PDC market could simply grind to a halt due to the supply-side or demand-side market failures just described (or both).

Looking forward, the PDC Bank, the NJPC, and the other entities tasked with managing the pinelands area will need to address these issues in order to maintain the marketplace for PDCs. We propose some possible solutions here, though each would need considerable additional research prior to implementation. First, the PDC Bank could attempt to make PDCs more valuable and thus incentivize landowners to sever PDCs from their underlying property. The most straightforward path would be demand-side interventions requiring the purchase and redemption of PDCs in a greater number of land-use and development scenarios, as opposed to the current focus on new housing development projects. For instance, road, water, and other infrastructure projects could be mandated to demonstrate purchase and redemption of PDCs as a condition for receiving approvals from the NJPC. A related concept would be to require other types of publicly funded projects (such as school or municipal building construction) to purchase and redeem PDCs as a condition for approval or even to incentivize the designation and severance of PDCs for targeted parcels of land in priority conservation and preservation areas (something which could be useful, for instance, in constructing a wildlife corridor). This is essentially a variation on the historical role of the PDC Bank itself as a figure in the marketplace—another strategy which could be revived, in coordination with an injection of funding from the State of New Jersey. In most instances, these strategies would require pinelands municipalities to alter their zoning ordinances, though changes in state and county rules, as well as the NJPC CMP might also be necessary.

Other approaches are also possible on the supply side. The most direct route to improving the "conversion rate" could be some sort of direct incentive for PDC holders to sever the credits from the underlying property. This could come in the form of some type of direct payment, for instance, a payment from the PDC Bank for simply electing to sever the credits from the land, independent of whether those credits are actually sold and redeemed. (Remember that severing PDCs from the land requires a deed restriction on future development.) Considerable additional funding for the PDC Bank would be necessary in order to facilitate this strategy. Another approach involves expanding the sources of PDCs. Currently, PDCs are generated only in three of the NJPC's land use designations. The types of "sending" areas could be expanded to also incorporate the "forest" designation, thus creating a new source of PDC-generating lands while also committing more types of pinelands territory to preservation goals. However, given that there is not currently a supply shortage in the market for PDCs, adding thousands of acres into the program could cause prices for PDCs to collapse. Careful consideration of how best to phase in the new sending areas in order to least adversely affect existing PDC holders would be necessary.

The most assertive suggestion would be for the PDC Bank itself to play more of an active role in the market for PDCs. This could and, from a land preservation perspective, should emphasize expansion of the "public sales" strategies previously undertaken by the bank. But a more active role in the PDC market for the Bank could also encompass the activities undertaken by other financial institutions active in so-called market making. By serving as a clearinghouse (guaranteeing buyers and sellers can complete a sale), the PDC Bank could improve liquidity in the market for PDCs and also facilitate more active trading. In this regard, and more fundamentally, the PDC Bank could invest in streamlining some of the administrative operations it is responsible for with investments into improved trading and accounts management technologies. The majority of transactions associated with the PDC program still happen on paper.

We offer these suggestions because readers will remember that there are no restrictions on who can purchase PDCs. Based on our analysis of sales data for this project, over the life of the PDC program, secondary sales (meaning transactions for PDCs that had already been sold by the original holder; the types of sales at the core of all major stock markets) have accounted for just 20% of all transactions. This type of "thin" trading can discourage financial investors. Funds and investment groups with an environmental or biodiversity focus are becoming more common by the day; PDCs could become an attractive investment class for such entities (or even just environmental groups more broadly) except for the fact of "thin" trading and the logistical challenges of actually completing a transaction for PDCs. A more active market is typically a much healthier and more attractive market. In this instance, a more active market could lead to even greater land preservation outcomes.

CONCLUSIONS

The PDC program uses market mechanisms to achieve land preservation goals in a very sensitive and globally unique ecosystem. The program has achieved many preservation goals since its inception in 1982 and, despite the challenges and limitations it faces, can serve as a model for many other TDR programs in the United States and around the world. Similar market-based environmental solutions focused on water rights, air pollution, carbon emissions, and biodiversity protection can all learn from the examples of the PDC program.

In any market mechanism, there are questions about equity and access—do only certain groups have the ability to access and benefit from a TDR program like the one we've described here? While additional research would be necessary to fully investigate this aspect of the PDC program, we'd suggest that the PDC program is not one that would only financially benefit wealthy people, since anyone owning land in the designated zoning areas could participate in the markets for PDCs. In this regard, the creation and operation of a marketplace for PDCs allows a new avenue for folks living in the region to participate in the land market without actually selling their underlying asset. In reviewing the lists of buyers and sellers that the PDC Bank maintains, there is a mixture of small landowners and large property developers on both lists and entities looking to transact large and small quantities of PDCs [20, 21].

In many instances, the environment is figured to be at odds with the world of markets and finance, but this is perhaps more a problem of market design than a fundamental conflict. Markets have developed alongside humans for the duration of our career as a biological species and can be among the most powerful forces shaping the world. This case demonstrates how market-based mechanisms like the PDC program can achieve land preservation outcomes, suggesting that further exploration of such mechanisms for larger sustainability challenges is useful. However, this case also suggests that there are limits to market-based solutions that need to be addressed in order to improve and maintain their overall effectiveness.

CASE STUDY QUESTIONS

1. What do you think are the factors in determining the success or failure of a TDR program?

2. Should the PDC Bank become more involved as a buyer and seller in the market for PDCs? How could this help, and harm, the market for PDCs?

3. How best could the NJPC and PDC Bank change the rules of the marketplace to improve outcomes for the PDC program and why do you think this is the best way forward? (e.g., changing land use categories that are involved; broader mandates for redeeming PDCs; incentivizing buyers and/or sellers of PDCs)

4. If you were a market observer or market regulator, what would you consider to be too much or too little trading in the PDC market? What do you think the risks of either trend might be over time?

5. Why do you think conservation groups and other environmental entities don't simply purchase and retire PDCs as a means to enact preservation goals?

6. Do TDR programs like this one raise any concerns about equity, social/environmental justice, or the potential for concentrating wealth and ownership of land resources to you? What safeguards could be implemented in TDR programs to ensure that everyone has equal access to markets for property rights?

7. Do you see finance and markets as playing a positive or negative role in addressing environmental problems? What are the benefits and drawbacks of financial and market solutions to address environmental concerns?

AUTHOR CONTRIBUTIONS

Jordan Howell: conceptualization, methodology, investigation, writing—original draft, writing—review & editing, writing—revised drafts, visualization, supervision, and project administration.

Mahbubur Meenar: investigation and writing—original draft.

Christina Friend: investigation and writing—original draft.

Jack Kelly: investigation, data curation, and visualization.

Owen Feeny: investigation, data curation, and visualization.

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COMPETING INTERESTS

Jordan Howell served as an appointed member of the New Jersey Pinelands Commission from January 2018 to September 2021 and the Chair's Designee to the Pinelands Development Credit Bank from January 2019 to September 2021. He was not compensated for either role. Opinions expressed in this case study are the authors' alone and do not represent the perspectives of either the New Jersey Pinelands Commission or its professional staff or the Pinelands Development Credit Bank program or its professional staff.

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REFERENCES

1. New Jersey Pinelands Commission. CMP Summary [Internet]. 2021. Available: https://www.nj.gov/pinelands/cmp/summary/.
2. New Jersey Pinelands Commission. About the Commission [Internet]. 2021. Available: https://www.nj.gov/pinelands/about/.
3. US Fish and Wildlife Service. The Pinelands of New Jersey: Our Nation's First National Reserve and a U.S. Biosphere Reserve [Internet]. 2006. Available: https://www.fws.gov/northeast/njfieldoffice/pdf/Fact%20Sheets%20PDF%20holding/Pinelands_NJ_PDF.pdf.
4. NJ Geological Survey. New Jersey Geological Survey Information Circular: Kirkwood - Cohansey Water-table Aquifer [Internet]. 2009. Available: https://www.state.nj.us/dep/njgs/enviroed/infocirc/kirkwood-cohansey.pdf.
5. Pistone S. What makes Hammonton the "Blueberry Capital of the World?" A look inside during season's peak [Internet]. NJ.com. 2015 [cited 14 May 2021]. Available: https://www.nj.com/atlantic/2015/06/berries_by_the_numbers_an_in-depth_look_into_hammo.html.

6. Liggett LL, Grogan SR, Berg GA. Long-Term Economic Monitoring Program 2017 Annual Report. New Lisbon, NJ: New Jersey Pinelands Commission; 2017: 160.
7. New Jersey Pinelands Commission. Management Areas [Internet]. 2021. Available: https://www.nj.gov/pinelands/cmp/summary/ma/.
8. New Jersey Pinelands Commission. New Jersey Pinelands Land Capability Map [Internet]. 2021. Available: https://www.nj.gov/pinelands/home/maps/maps/documents/ltr.pdf.
9. Linkous ER. Transfer of development rights in theory and practice: the restructuring OF TDR to incentivize development. Land Use Policy. 2016;51: 162–171.
10. McConnell V, Walls M. Policy monitor: U.S. experience with transferable development rights. Rev Environ Econ Policy. 2009;3(2): 288–303.
11. Pruetz R, Standridge N. What makes transfer of development rights Work? Success factors from research and practice. J Am Plann Assoc. 2008;75(1): 78–87.
12. Colavitti AM, Serra S. The transfer of development rights as a tool for the urban growth containment: a comparison between the United States and Italy. Pap Reg Sci. 2017; 97(4): 1247–1265.
13. Nelson A, Preutz R, Woodruff D. TDR Handbook: Designing and Implementing Successful Transfer of Development Rights Programs. Washington, DC: Island Press; 2013.
14. The Urban Land Institute. Arch Creek Basin Miami-Dade County, Florida Addressing Climate Vulnerabilities and Social Equity with an Adaptation Action Area Framework [Internet]. 2016. Available: http://uli.org/wp-content/uploads/ULI-Documents/Miami_PanelReport.pdf.
15. Linkous ER. Transfer of development rights and urban land markets. Env Plan A: Econ Space. 2017;49(5): 1122–1145.
16. Daniels T. The Environmental Planning Handbook for Sustainable Communities and Regions. 2nd ed. London, UK: Routledge; 2014.
17. Pruetz R. Beyond Takings and Givings: Saving Natural Areas, Farmland and Historic Landmarks With Transfer of Development Rights and Density Transfer Charges. Burbank, CA: Arje Press; 2003.
18. Grannis J. Adaptation Tool Kit: Sea-Level Rise and Coastal Land Use. Georgetown Climate Center; 2011. Available: https://www.georgetownclimate.org/files/report/Adaptation_Tool_Kit_SLR.pdf.
19. Pinelands Development Credit Bank. Annual Report [Internet]. New Jersey Pinelands Commission; 2020. Available: https://www.nj.gov/pinelands/pdcbank/reports/PDC%20Bank%20Annual%20Report%202020.pdf.
20. Pinelands Development Credit Bank. Parties Interested in Purchasing Pinelands Development Credits [Internet]. 2021. Available: https://www.nj.gov/pinelands/pdcbank/PDC%20reports/PDC%20BANK/PDC%20Bank%20-%20PDC%20Buyers%20List%20of%20Interested%20Parties.pdf.
21. Pinelands Development Credit Bank. Pinelands Development Credit Bank PDCs Available for Purchase [Internet]. 2021. Available: https://www.nj.gov/pinelands/pdcbank/PDC%20reports/PDC%20BANK/PDC%20Bank%20-%20PDC%20Bank%20Sellers%20List.pdf.