



Greening development: Reducing urban tree canopy loss through incentives

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ABSTRACT

Development and redevelopment are important drivers of tree removal and canopy loss in urban landscapes. Local ordinances are often used to curtail tree removal, but punitive regulations alone may not be enough to reduce urban tree canopy loss in land development. In Florida (US), efforts to balance trees and development have often relied on fees and fines, but with a recent backlash against tree regulations and the fast pace of urban growth, we explored the possible role of incentives in urban tree policies. We interviewed 20 land developers across Florida to understand their perspectives on current barriers and potential incentives for tree preservation and planting. We collected data from developers, whose perspectives on tree preservation are often unknown or overlooked, despite their significant role in tree planting, removal, and retention in and around cities. Our results show that major barriers to tree preservation and planting include requirements to grade sites for stormwater management, site constraints, and monetary costs. Most developers did not know of any existing incentives beyond intrinsic motivations but said that financial incentives would be most appealing to them. Top incentive suggestions include increasing building density, reducing impact fees and tax liability, and changing tree mitigation policies. Another promising finding is that developers are willing to work with regulators to find solutions that benefit both parties. Future research should consider evaluating the level of support and viability of different incentives by gathering feedback from policymakers, land developers, and the public.

1. Introduction

Land development and redevelopment are significant drivers of urban tree canopy loss (Hill et al., 2010; Croeser et al., 2020; Roman et al., 2022). Mitigating the pressures and impacts of development on urban trees is a top issue for urban forestry experts (Wirtz et al., 2021) who address the issue with a range of strategies including tree planting campaigns, tree protection regulations, and green infrastructure goals. While there is some evidence that these can be effective (Hilbert et al. 2019; Salisbury et al. 2022) canopy cover continues to decline in many United States (US) cities (Nowak and Greenfield, 2012; Nowak and Greenfield, 2018).

Incorporating trees into development can increase property values

and home sale prices (Seila and Anderson, 1982; Escobedo et al., 2015; Donovan et al., 2019), enhance marketability (Tinker et al., 2006; Göçmen, 2014), and add prestige for developers (O'Herrin et al., 2016). Developers are key influencers of tree canopy as planners, financiers, and builders in and around urban areas, both currently and historically (Maruani and Amit-Cohen, 2011; Roman & Eisenman, 2022). While some developers recognize the benefits of trees (Despot and Gerhold, 2003; Kellogg et al., 2017) and follow regulatory requirements (Maruani and Amit-Cohen, 2011), rapid urbanization and redevelopment often result in trees being prematurely removed (Hilbert et al., 2019; Roman et al., 2022) and insufficiently replanted (Croeser et al., 2020; Romero, 2021; Conway et al., 2022).

In the US and Canada, many cities have tree ordinances and by-laws

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to regulate public and private property trees (Coughlin et al., 1988; Conway and Lue, 2018; Lavy and Hagelman, 2019; Pike et al., 2021), an approach to tree protection that has progressed in the US since the 1980s (Hauer and Peterson, 2016). Municipalities tend to have tree protections that are punitive: requiring permits for tree removals (O'Herrin et al., 2016; Conway et al., 2022), mandating replacement trees or payment in lieu of re-planting (Wirtz et al., 2021), and fining those who damage or remove trees without government approval (Conway and Lue, 2018; Romero, 2021). Cities with such tree ordinances can reduce tree canopy loss (Landry and Pu, 2010; Hilbert et al., 2019; Ordóñez-Barona et al., 2021; Romero, 2021; Salisbury et al., 2022), minimize tree damage (Vander Weit and Miller, 1986), enforce tree protection during construction (Ames and Dewald, 2003; Steenberg et al., 2018; Pike et al., 2021), prioritize trees early in the planning process (Ames and Dewald, 2003; O'Herrin et al., 2022), and require replanting (Conway et al., 2022). However, tree ordinances can be difficult to enforce (Clark et al., 2020; Conway et al., 2022), lack adequate penalties (Clark et al., 2020) and restrictions (Ordóñez-Barona et al., 2021), have too many exemptions (Lavy and Hagelman, 2019), or may be unpopular with the public – especially if viewed as too restrictive (McSween et al., 1977; Conway and Lue, 2018; Clark et al., 2020).

In Florida (US), the tension between rapid development and regulating urban tree canopy has been escalating (Koeser et al., 2021). Florida's population increased 14.5% from 2010 to 2020 (US Census Bureau, 2019) and urban land cover is projected to continue increasing (Carr and Zwick, 2016). Almost half of Florida's communities have tree ordinances (Hauer and Peterson, 2016; Salisbury et al., 2022). Although regulations can effectively reduce canopy loss (Landry and Pu, 2010; Hilbert et al., 2019; Ordóñez-Barona et al., 2021; Romero, 2021) punitive tree protection laws are not always publicly supported (Zhang et al., 2007; Zhang and Zheng, 2011; Conway and Bang, 2014) or politically viable (Romero, 2021). In 2019, Florida state legislators passed a statute (Fla. Stat. § 163.045, 2022) which represented a backlash to punitive tree policy at the state level by reducing local protections for trees on private residential property (Koeser et al., 2021). At the time the law was passed, Florida communities with heritage tree ordinances had almost 7% more canopy than those without (Hilbert et al., 2019; Salisbury et al., 2022), leaving urban forest managers concerned about the future of the state's trees given this policy change (Koeser et al., 2021).

Rather than solely relying on punitive regulations (punishing developers and property owners for unapproved tree removal), experts propose incorporating more incentives into urban tree policy (Coughlin et al., 1988; Ordóñez-Barona et al., 2021). Incentives can encourage tree preservation and planting (Ordóñez, 2021; Ordóñez-Barona et al., 2021). Developers' and builders' decisions are largely driven by monetary benefits (O'Herrin et al., 2016; Kellogg et al., 2017; Ordóñez-Barona et al., 2021) and market forces (Tinker et al., 2006; O'Herrin et al., 2016; Kellogg et al., 2017). The most frequently cited financial incentive is a tax rebate for preservation (Coughlin et al., 1988; Despot and Gerhold, 2003; Clark et al., 2020; Ordóñez-Barona et al., 2021), while other incentives are much less common but include counting trees towards stormwater credits (Berland et al., 2017), cost-sharing of maintenance (Clark et al., 2020; Ordóñez-Barona et al., 2021), transferring development rights (Coughlin et al., 1988), and trading open space preservation for increased building density (Brevard County, 2022; Henderson County, 2022; Martin County, 2022). Given the central role of developers in this complex system of land management regulation, it is imperative to understand their perspectives on punitive regulations and incentives.

In this study, we aim to understand developers': 1) decision-making around tree preservation, 2) barriers to tree preservation and planting, and 3) incentives to preserve and plant more trees. Our research on Florida developers' perspectives and experiences represents a rich and novel contribution to the literature, where developers' roles are increasingly recognized but their perspectives have not been unpacked. Our findings suggest several promising incentive ideas that can be used

to guide further research and policy discussions.

2. Methods

Florida is a large peninsular state located in the southeastern United States. It is bordered by the Gulf of Mexico to the west, the Caribbean Sea to the south, and the Atlantic Ocean to the east. The state has relatively flat terrain, and tropical to subtropical forested and wetland ecosystems (Beck et al., 2018). With 22.2 million residents (U.S. Census Bureau, 2022) Florida has the third-largest population in the US. After decades of consistent growth, it became the fastest-growing state in 2022 (Perry et al., 2022).

To understand the current barriers and potential incentives for preserving and planting trees in land development, we interviewed 20 land developers across Florida to gather their experiences and perspectives. We chose a semi-structured interview format to ask a set of core questions, follow-up with clarification when needed (Jamshed, 2014), and gather participants' thoughts and experiences (Jacob and Furgerson, 2012). The questions were presented in three sections: 1) decision-making around trees; 2) barriers to tree preservation and planting; and 3) incentives to tree preservation and planting (Appendix A). We pretested the questions on a retired urban forester with years of experience working with developers before finalizing them (Jacob and Furgerson, 2012). We obtained approval from the University of Florida's Institutional Review Board (IRB Project #: 202201090).

We identified participants through 1) referrals from developers or professionals in related industries that work with developers and 2) an internet search engine (Google). We recruited participants from the North, Central, and South Florida regions (Fig. 1) across different niches in the industry (new and redevelopment, residential and commercial, developer and builder-developer) to get a variety of perspectives (Baker and Edwards, 2017). Developers were emailed an invitation to participate in the study and asked to review the consent form and provide their availability for the interview.

All interviews were conducted by the same interviewer. Interviews were conducted from May 2022 to October 2022 and lasted between 50 and 90 min. We used the videoconferencing platform Zoom (Zoom Video Communications, Inc., San Jose, United States), to record and transcribe the interviews. After each interview, the interviewer downloaded the transcript and edited the document by replacing the participant's name and company details with codes for anonymity and corrected any text that was transcribed incorrectly. The cleaned transcripts were then uploaded to a qualitative data analysis software program (NVivo, Lumivero, Denver, United States) for coding and analysis. The interviewer created the coding framework using inductive (themes generated from the interviews) and deductive (themes from published literature) methods to categorize the data into codes (themes) for thematic analysis (Corbin and Strauss, 1990; Boyatzis, 1998). We used qualitative descriptive content analysis to generate codes from the data, which are presented with descriptive summaries, response counting, and select quotes to provide relevant information for practitioners and policymakers (Sandelowski, 2000).

3. Results

Of the 40 land development companies contacted, 20 agreed to participate in this study. The distribution of 20 developers from different regions of Florida and different niches in the industry (Fig. 1) provides a rich data set for qualitative analysis. We organized the results to match the objectives of the study and present our thematic analysis.

3.1. Decision-making around trees

3.1.1. Land development in Florida today

The interviewees expressed various concerns and challenges when asked about the state of the land development industry in Florida today.

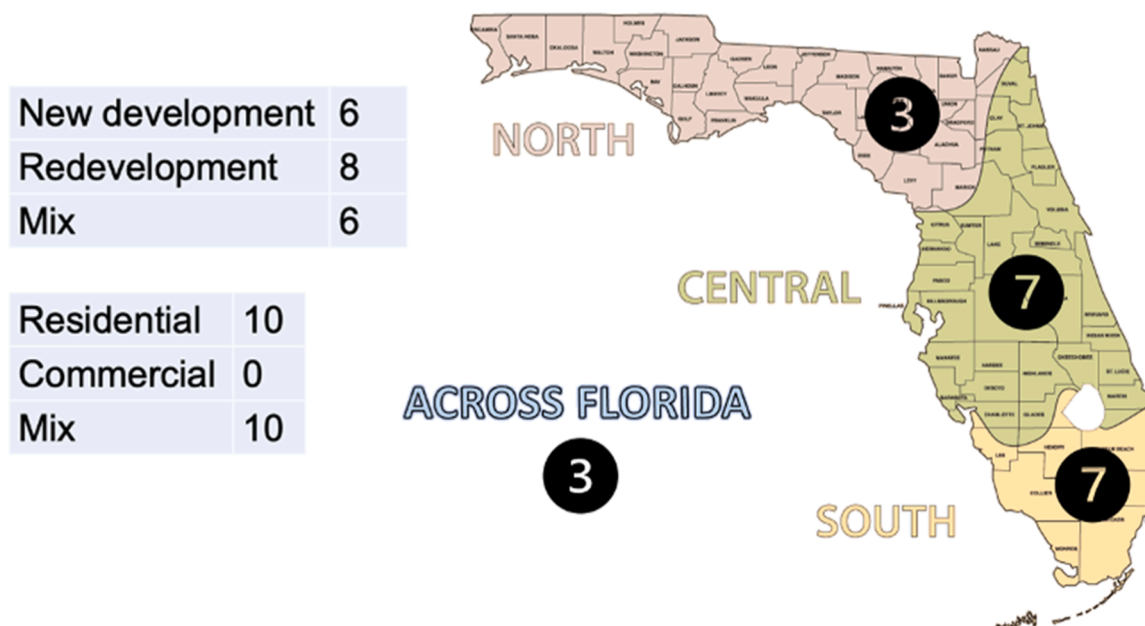


Fig. 1. Distribution of interviewees across Florida and their industry niches.

Developers are very busy working to meet the high market demand for new residential and commercial areas, consequently increasing competition with other developers. However, the biggest pressures developers face are financial, as they strive to produce as quickly and cost-efficiently as possible. Half of the interviewees discussed setbacks caused by slow bureaucratic processes. Fifteen interviewees (75%) also said the cost and availability of materials are unpredictable, largely due to supply chain delays and shortages that linger from the Covid-19 pandemic. Moreover, financial pressures fluctuate when other costs change quickly, especially materials and contractor rate increases amid inflation in the US.

The perceptions that developers had about their jobs and how others perceived them underlaid some of their decision-making around trees. Many interviewees (60%) explained that the public perceives developers as prioritizing money over all else and that they are part of a “sleazy industry” that just wants to “flat clear everything.” And while interviewees agreed that making a profit is a business priority, a few (20%) emphasized their personal love of trees and nature, despite the optics of land clearing. Land development is complex as developers balance investor goals, regulations in different jurisdictions, and multi-year timelines. They said that it takes perseverance and expertise to complete projects that are high quality and a source of pride. Some thrive amidst demanding work and consider themselves among the few who could handle the pressure, saying land development is “not for the faint of heart.”

3.1.2. Determining whether trees are retained or removed

Developers highlighted a variety of factors that impact whether trees would be retained or removed in their projects. First, they use initial site surveys to assess trees based on the regulatory code and recommendations from International Society of Arboriculture Certified Arborists and state-registered landscape architects. Developers hire an arborist to locate and document any trees a municipality or county considers protected, which varies by jurisdiction. They rely on these professionals to give them a sense of which trees could be retained during construction and be an asset to the property. Often, developers will consider setting aside individual trees or tree stands early in their planning if the arborist or landscape architect recommends it. Next, developers base their tree removal and retention decisions on code requirements. Municipalities with tree ordinances can require the preservation of trees with “grand,”

“protected,” or “heritage” status. These trees are typically larger or desirable species and often have strict tree protection requirements. But if a tree conflicts with the site plan too much, the developer might apply for a permit to remove it. Since tree protection zones for large trees can be a 20-foot [6.1 m] radius or more, it could affect the physical layout of the property, especially on smaller sites.

Second, beyond tree-specific regulations, site grading requirements are some of the most significant determinants for removing or retaining trees. Requirements from local (city and county), state (Florida), and national (Federal Emergency Management Agency) governments have strict requirements to cut and fill sites to meet stormwater best management practices. Florida’s high groundwater table, low elevation relative to most water bodies, and potential for tropical storm surge mean that most construction requires raising the site several feet above grade and creating stormwater ponds so that water flows away from buildings. One developer described the conflict between trees and site grading this way:

“Well, we all know that trees do not do well with fill around them. So, unfortunately, what happens in our systems is, there are very few natural trees that are out in the open area that we can save, because they’ll be three feet [1 m] below the fill that we’re building the houses on.”

Third, developers may decide the fate of the tree depending on how it impacts their design plans. Sometimes initial interest in developing a property will change and developers decide not to move forward because of the preexisting trees. If the trees are a regulated size class, in a problematic location, and a protected species, they might perceive removal as an “uphill battle” because regulators might not approve the removal of a healthy protected tree that is in the way of building plans. But other times, depending on the site and trees, developers (especially those who work in redevelopment) will purchase the property and redesign plans to accommodate protected trees when feasible.

Determining whether trees will be retained or removed depends on several factors that are weighed on a case-by-case basis. But generally, considerations tend to reflect the pattern of first knowing the regulations around trees, followed by the developer’s individual (or company) approach to tree preservation and planting. Developer’s actions are often shaped by past experiences working with regulators and the desire to have a good reputation in the industry.

3.1.3. Tree prioritization

There are several reasons trees are given a higher or lower priority in development projects. A prominent theme from interviews was the notion that there is a hierarchy of trees that typically favors “big, beautiful oaks.” Such comments show how developers prioritize trees that have a combination of maturity, health, aesthetic appeal, and meet species-specific preferences. Healthy mature trees rank highly, and fifteen interviewees (75%) said they prefer and spend time, money, and effort trying to preserve them. On the other hand, developers are not concerned about old or unhealthy trees that they think are going to soon die naturally. Interviewees prefer trees that are good for business: attractive, provide shade, and are located around entrances and open spaces as amenity trees. For example, eight interviewees (40%) talked about preserving trees as “amenities,” especially with the trend towards having more outdoor activities (hiking trails and open spaces near new housing developments) sparked by Covid-19. Developers want trees to complement the project rather than detract from it, thus, healthy mature trees help new projects feel more established and provide long-term benefits. Especially since Covid-19 pandemic and social distancing restrictions, more people have been recreating outdoors, motivating some developers to preserve certain natural areas.

Other preservation-worthy trees are those that are regulated and do not conflict with the site plans. Preferred locations for trees vary by site and type of development. Therefore, a site with trees on the perimeter might be desirable for one location and undesirable for another. Interviewees emphasized that the protected trees should not be too numerous or hinder the development of most of the site.

Finally, developers shared several species preferences. Many said that they prefer live oaks (*Quercus virginiana* Mill.), but not laurel oaks (*Quercus laurifolia* Michx.) or pines (*Pinus* spp.). Interviewees also expressed that they know arborists and city staff who have similar tree preferences and assessments. Live oaks are more often protected by local ordinances, long-lived, relatively pest and disease-resistant, and are consistent with the “Old Florida” aesthetics that some developers desire. On the other hand, laurel oaks tend to be shorter-lived, and pines have a low tolerance for construction impacts, which makes them less desirable species to preserve and plant. Interviewees had differing opinions about palms – both in general and in regard to specific species such as sabal palm (*Sabal palmetto* (Walt.) Lodd.), royal palm (*Roystonea regia* (Kunth) O.F.Cook), areca palm (*Dypsis lutescens* (Wendland) Beentje & Dransfield), and date palms (*Phoenix* spp.). Some developers liked palms because they have the “Florida look,” are easy to transplant, and do not lift sidewalks. Others disliked them because they think they are overplanted and do not provide much shade. Several developers also talked about their efforts to plant environmentally sustainable trees and plants, which is becoming more profitable and aligns with some companies’ sustainability goals, consumer preferences, and regulatory requirements.

3.2. Barriers to tree preservation and planting

3.2.1. Factors that limit tree preservation

The majority (80%) of the developers talked extensively about site grading and space constraints as significant barriers to tree preservation. In Florida, grading for stormwater is a major part of land development. The process often starts with engineering the site to drain water away from structures. This typically involves “cut and fill,” which raises the structures to a higher grade and uses pipes or grading contours to move water to stormwater retention ponds and swales. When these changes raise or lower the grade around trees, it is difficult to preserve the tree in place without significant cost and risk to the tree’s health. This is especially challenging on smaller sites and where there is poor drainage. One participant described it this way:

“If we’re trying to build a 90-unit project on a three-acre site that has poor drainage, then rest assured, every tree on that site is going to get cut down

just because there’s no room to save a tree. We will have to reconfigure the entire site, build our ponds, and then replant trees in all the spaces left available.”

Many interviewees (60%) mentioned conflicting site priorities that are part of the design or are required by code that can displace trees. The buildings, roads, sidewalks, parking lots, stormwater retention ponds, and other infrastructure take up most of a site, while trees tend to occupy smaller areas like planting strips in the public right-of-way or in open space areas. Trees can also conflict with utilities, which require strict minimum distances and placement that can lead to tree removals. This goes hand in hand with the tree’s location as a factor in tree removal. While developers might consider a tree valuable and want to retain it, the exact location on the site also needs to be optimal to keep the tree.

Developers said that cost also limits tree preservation because it is expensive to preserve trees on site. First, much of the land itself is expensive, so “site programming,” what they plan to do with the land, is maximized. This results in most space taken up by buildings and hard-scape to get the highest possible return on investment. Half of the developers said they like to incorporate trees into their projects because it makes the site more marketable and attractive, but the degree that they are willing to spare land for trees, rather than building it out, varied from person to person. Another issue is that tree relocation is expensive and difficult, so preserving a tree and relocating it to another part of the project is often too costly and hard to justify, compared to removing a tree and paying a tree mitigation fee. Choosing to pay a fee instead of preserving trees is especially relevant when there is a client, such as a commercial retailer, that wants a specific layout that conflicts with existing trees.

3.2.2. Factors that limit tree planting

When asked about factors that limit tree planting, developers shared fewer issues compared to preservation. In fact, eight interviewees (40%) said that they often plant more trees than were on the site prior to development and wish there was more positive recognition or lower tree removal fees associated with their planting efforts. Nevertheless, high cost was most frequently cited (60%), largely due to material and labor costs to install trees in the landscape. Participants said that tree stock is expensive, especially when municipalities require trees of a larger caliper or an uncommon species. Another issue arises when developers put a lot of money and effort into preserving and planting trees and then see “unnecessary removals” from the Homeowner’s Association (HOA) after they hand over the property management. Fifty-five percent of interviewees wish there was more education and outreach to HOAs and residents so that the trees are given a better chance to grow into the canopy that they intended when they designed the project.

Eight interviewees (40%) also said tree planting was limited by space constraints. Like the issues already discussed around factors limiting preservation, utility requirements and site programming tend to restrict planting spaces. However, when talking about tree planting, some interviewees shared that regulators were typically the ones creating barriers to tree planting because they consider some of the utility and species requirements overly restrictive. While they understood some of the reasoning behind requiring trees to be planted further from utilities and the *Right Tree Right Place* concept, this inadvertently limits the space for trees. Additionally, the market is pushing development trends toward more building density, smaller lot sizes, and larger new homes replacing smaller older homes, which also tends to limit tree planting space. Most developers who do urban and suburban infill development cited this as a major reason why they would plant fewer trees on a site than were present prior to taking on the project.

3.2.3. Difficulties working with regulators

Developers highlighted several difficulties they face when working with regulators on tree preservation and planting. Interpersonal issues were cited most frequently, particularly lack of communication and

interpersonal conflicts with government employees (40%). Seven interviewees (35%) said that government staff have different interpretations of the code, which can translate into regulators either being more strict or more lenient, which can make the permitting and approval process more challenging and uncertain. Four interviewees (20%) also mentioned that some regulators are unnecessarily strict or confrontational, which makes them harder to work with, but overall, they have positive relationships with regulators and try to achieve mutually beneficial agreements. Some developers also said they wish regulators would talk to each other more, which could reduce re-reviewing plans, subsequently resolving tree issues earlier in the process. Most said that this is not intentional, *“it’s just the way it is.”*

Another issue that developers struggle with is slow and often time-consuming development review processes. Forty-five percent of the interviewees recalled instances when they wished regulators worked with them more on tree issues early and did not leave problems until late in the review process or until they were big enough to hold up a project. It seems that interpersonal issues play a role in how they view the process of integrating tree preservation and planting into their projects, for better or worse.

3.3. Incentives to preserve and plant more trees

3.3.1. Existing incentives

Despite working in Florida for many years, most interviewees (80%) could not identify a single program or government incentive to preserve and plant trees. Some conceded that there could be incentives available that they were not aware of, but the participants were confident that if something existed, they would know about it. Instead, some developers are motivated intrinsically (35%), usually tied to the belief that trees are good for the community and business because they provide some financial benefits. As one person explained: *“The local government didn’t say, “if you save these trees, we’ll give you some trade-off.” It was really more of a self-directed incentive.”* Furthermore, eight interviewees (40%) were only able to recall disincentives and the penalties that the government enforces. These participants said that they sometimes retain trees on site rather than removing trees and paying government fees (mitigation payments). By retaining trees, developers reduced the number of trees to replant, which reduced some costs.

Four developers identified existing incentive programs. The first incentive was a Green Certification program, which recognizes projects with a robust landscaping package. This was motivating to one person because their company benefited from having this designation. The other three incentives were in city and county codes that offer credit for preservation. First, Nassau County’s code credits preserved trees toward mitigation of tree loss on a sliding scale based on the tree’s size. This incentive saves developers money and motivated tree preservation because they did not have to pay for tree removal or mitigation fees. Second, the City of Stuart’s (Martin County) code incentivizes the preservation of natural areas by allowing developers to cluster buildings, also leading to more tree preservation and developer cost savings. Third, the City of Saint Petersburg (Pinellas County) allows developers to increase building density in exchange for an enhanced landscape package, which could be achieved through additional planting. More detail about these codes/policies are provided in Appendix B.

3.3.2. Proposed incentives to help developers preserve and plant trees

The interviewees suggested 13 incentive policies and program ideas that they think would motivate developers in Florida to preserve and plant more trees (Table 1). The most common suggestion was that generally, monetary incentives are the most motivating (55%). All 20 of the interviewees said they would like to be offered incentives, even though some were skeptical about what could be effectively employed. They were most interested in incentives that reduce costs or help them increase profits, and liked the idea of having incentives rather than just the disincentives that they are most used to. As one developer explained:

Table 1

Incentive ideas with the number of interviewees (out of n = 20 total) who mentioned the idea. Includes a brief description of the incentive and exemplary quotes.

Incentive idea	Description	Exemplary quotes
Increased density tradeoff (8)	Allow developers to increase the density of the buildings/units, in exchange for additional tree preservation and planting.	<i>“So, it’s a trade-off. I want to build a little bit of a bigger building on my site, but in return, I’ve got to do enhanced green space.”</i> <i>“So that would be an incentive, to allow increased density, increased FAR, possibly reduced setbacks, in exchange for planting more trees.”</i>
Reduce impact fees (7)	Allow developers to contribute a lower amount of money in some impact fee categories (e.g., stormwater infrastructure) in exchange for additional tree preservation and planting.	<i>“If the city said, “Look, instead of paying \$50,000 in impact fees for your project, I’ll reduce it to \$25,000 if you agree to plant 50 more trees.” I’m up for that. My attitude might be, provided there’s room of course, well that’ll beautify my project, I’d rather put my money into my project than pay it as a fee to the government.”</i>
Reduce tax liability (5)	(a) Allow developers to reduce tax payments over the course of several years to offset the cost of tree preservation and planting. (b) Allow the land seller to pay lower taxes in exchange for tree preservation after the sale.	(a) <i>“I think the decrease in impact fees and tax liability, lowering tax liability, if you can make that happen in your education, your research paper, I think those are ways to save money and to preserve trees well.”</i> (b) <i>“Also, I think maybe some tax abatement if the landowner sells property with a condition in the contract that requires the builder to preserve X number trees, or percentage of trees over 36 in. [91.4 cm], which can be verified by a tree survey. Then that seller should possibly get a tax incentive because he’s trying to be a good steward of the land and not just sell his property for the highest price. He’s actually trying to do more by restricting his lands to ensure that there’s benefit in the long-term from the tree canopies.”</i>
Plant instead of paying into a Tree Fund (5)	Allow developers to plant trees on public or other private properties instead of only paying mitigation fees into a city’s/county’s Tree Fund.	<i>“I can probably plant trees at half what it costs the city to plant trees. So if they wanted to incentivize me in the sense that instead of paying to the Tree Fund, I’ll go plant some trees. Pre-approve the tree planting and let’s go plant some trees.”</i>
Rewards program (3)	This applies more to builders and urban infill developers, where they get credit for tree preservation on an individual tree basis. For each tree they preserve on a site they get credits that can be applied to other sites in the form of reduced tree mitigation, landscape points, or a faster permit process.	<i>“Almost like a running tab of hey I saved five trees over here, I’ve got to take out two on this other lot of mine. I’m getting no credit for what I saved but I’m having to pay for the two I took out. So is there a way to, this may be a lot of work for someone, but is there a way to kind of trace that or track that through a system to where it keeps you kind of whole. And I think</i>

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Table 1 (continued)

Incentive idea	Description	Exemplary quotes
Faster permit process (2)	Process development applications and building permits faster in exchange for additional tree preservation and planting.	<i>that would kind of incentivize builders on lots where they could keep more trees or plant more, because they know they would have a potential credit to offset a penalty later.</i> <i>“So we’re talking about 18, almost 24 months it’s taking to get a project approved. You scale that down to 6 months, 10 months, maybe 12 months for larger projects, you would see more people willing to be more inclined to preserve trees and green space. Because it’s financially beneficial to us. The cost it takes to carry property if you already own it, or if you don’t own it and the seller’s carrying it, which means that they’re gonna have a higher sale price on that land. Which then gets back to wanting to require you to clear-cut more, so they basically offset the additional cost.”</i>
Tree relocation credit (2)	Offer cost reductions, credits/recognition, or reduce penalties in exchange for tree preservation and relocation, especially for specimen trees.	<i>“Some consideration for extraordinary preservation or extraordinary relocation, the costs associated with that, some recognition of that in reductions, in other things.”</i>
Stem wall builds (2)	Allow developers to build stem walls, which raises the grade of the building onto a block wall and only requires clearing the area for the buildings and roads/driveways (working with the existing grades, instead of balanced site construction).	<i>“And we used to build that way before all the regulations, but there’s this always a push now to make sure all the water on that lot goes to the streets. It’s sort of a hybrid. You could create hybrid subdivisions that would be super attractive because you only take down those trees that are the driveway and the house, and that’s it that’s all you take down. But no city has embraced that.”</i>
Reduce parking requirements (1)	Allow developers to put in fewer parking spaces and use the space for trees instead.	<i>“But these municipalities have this archaic requirement for extra parking, and it just seems to me that if they got a more reasonable approach to that, it’s not only going to help create more green space and areas that we can landscape, but it has a positive impact on the environment.”</i>
Reduce permit fees (1)	Reduce permit fees in exchange for tree preservation and planting.	<i>“Or you know maybe there’s a reduced permit fee that you pay the city possibly.”</i>
Planned development overlay (1)	A planned development overlay is a type of land use zoning that would allow the municipality and developer to create special regulations for a specific site to increase tree preservation and planting.	<i>“And that’s where the incentives come in, because the developer’s choosing to go that route instead of just the normal route, which would be he’s got to take the trees out.”</i>
Sell land at a reduced cost (1)	City donates or sells vacant or unused land to developers at a reduced cost in exchange for tree preservation and planting.	<i>“Maybe the city donates land to us, because the land cost is huge. If there was some site that they are just sitting on that they don’t have any use for. Or give us some sort of below-market price cost? I don’t know. That sounds</i>

Table 1 (continued)

Incentive idea	Description	Exemplary quotes
Expand wetland buffer to include trees (1)	Offer flexibility with wetland buffer requirements so that tree preservation areas can be included and credited without reducing the buildable area.	<i>always down to money with us, but truly that’s how the business operates.”</i> <i>“But if I can even increase my wetland boundary to preserve a tree line but reduce my upland buffer to make up so I don’t lose the buildable area, that would be definitely an incentive too.”</i>

“Again, a monetary thing is much better than paying a fee for taking it [trees] out.”

3.3.3. Opportunities for change

Many of the developers thought there were opportunities to change the systems to make tree preservation and planting more doable. Over half (55%) thought having more flexible regulations could help developers configure sites to incorporate more trees while meeting other site requirements and staying within budget. Sixty percent of interviewees said that more collaboration would be a positive step and are willing to develop solutions with regulators as a “unified front.” For example, half (50%) of the participants brought up the need for affordable housing as a high priority for many developers and regulators, with some pointing out that a regulatory incentive that trades additional building density for additional tree preservation and planting could benefit both regulator and developer goals. One developer said:

“But there’s no provision in our code that allows us if we do something like that to actually have more density. So, it would be a win-win for both housing crisis and the tree canopy.”

Several interviewees (25%) shared that effective incentives will require detailed and innovative thinking, but incentives are better than just relying on regulatory disincentives and increasing tree removal fees to try to change developer’s behavior. Making new incentives available to developers could also help break through some of the political barriers affecting trees. As one developer explained:

“That whole property rights argument in Florida is powerful, and the lobby is powerful, and the development lobby is powerful. And at the end of the day, we see fewer and fewer regulatory schemes that are effective today...So I think incentives are a better way to look at it. And I think the devil’s in the details, but I think incentives and a trade-off is the best way to go.”

Other notable suggestions include the need for innovative designs for stormwater ponds and tree wells (when grade is to be raised around a tree). One idea was to promote and install smaller stormwater ponds in Florida that are designed to store the same amount of water on less land. Another recommendation was to improve tree well technology because they often see tree wells installed poorly and believe they could be better designed. Lastly, they shared ideas about modifying tree regulations. One interviewee proposed that cities change their policies to be able to use Tree Fund money (i.e., money that is often collected from developers by a city/county as a fee for removal during development and used to fund future tree planting) to fund tree farms. They thought this could help produce more stock at a lower cost, which could help developers more effectively source the trees that cities want and help alleviate concerns that the funds are not being used effectively. Another suggestion was to get help from the Florida State Legislature to create state-wide incentives, which could increase awareness and scope.

Finally, a few developers (30%) made a distinction between builders’ and developers’ approach to trees, saying that builders, who are largely focused on the construction of the homes on the site, do not work as hard as developers (who oversee the whole project) to preserve and plant

trees. These developers pointed out examples where they think a lack of quality tree planting and lack of creative tree preservation is more typical of builders than developers. Interviewees also proposed opportunities to educate builders and others in the industry, noting that arborist associations could collaborate with builders' associations more.

4. Discussion

4.1. Decision-making around trees

With Florida's ongoing population growth, increased development is trying to meet market demand (O'Herrin et al., 2016), resulting in a rapid pace of land conversion and continued urbanization (Nowak and Greenfield, 2018) that threatens tree canopy cover (Ordóñez-Barona, 2021). Aligning with past literature, we found that developers consider projects more successful when there is a greater return on investment (Kellogg et al., 2017), which is typically achieved through reducing costs (Tinker et al., 2006) and completing projects as fast as possible (Göçmen, 2014). As a result, tree preservation and planting, which typically increase costs (materials, labor, space), need to demonstrate financial benefit to be desirable.

Interestingly, the role of arborists and landscape architects was a more important part of developer decision-making than we expected. Other studies have shown that developers and builders do not consult with these professionals early or often enough and often make decisions without the help of arborists (Despot and Gerhold, 2003; O'Herrin et al., 2016). However, our study shows that developers tried to work with arborists at the beginning of projects and throughout, relying on arborists' assessments to determine which trees should be prioritized for preservation or relocation. Often this is done because local regulations require developers to hire arborists to do site surveys, without which they might rely on land surveyors or engineers who are always consulted at the beginning of projects. Our findings suggest that once developers have worked with arborists, the arborist's expertise is valued, and they become integral to the development process. We found that some developers are willing to heed advice from arborists and other landscape professionals to preserve trees where possible.

4.2. Barriers to tree preservation and planting

In our study, site grading requirements were the most frequently mentioned barrier to tree preservation and planting in development. Federal, state, and local regulations dictate how to engineer the site for stormwater management, which usually involves "cut and fill" to raise and lower the grade (Livingston, 2001) and "pipe and pond" practices like creating stormwater ponds (Penniman et al., 2013). Our findings therefore revealed a conflict between trees and stormwater that has not been previously discussed in the scholarly literature, but this conflict was communicated so early and often that it is clearly a key barrier, particularly in Florida. Prior scholars have suggested that government agencies could better integrate tree preservation with stormwater practices so that land developers can comply with regulations and best practices for both (Kuehler et al., 2017). Interviewees generally noted a lack of flexibility or innovation in codes to promote trees as part of stormwater infrastructure, which is ironic considering that past scholarship and policies broadly view trees as part of green stormwater infrastructure (Konijnendijk et al., 2004; Berland et al., 2017). Our findings suggest that requirements to grade sites often outweigh tree preservation requirements.

Furthermore, as with other literature, developers in our study shared that site constraints (Despot and Gerhold, 2003; Riedman et al., 2022) and costs (Göçmen, 2014) are major limiting factors for tree preservation and planting. The conflict between trees and utilities, specifically rules around minimum distances and precise utility locations, was mentioned more than expected. It is possible that with the spread of the *Right Tree Right Place* concept and lower tolerance for utility

interruptions, some utility and tree placement policies are stricter and leading to more tree removals and fewer places to plant trees.

4.3. Incentives to preserve and plant more trees

All 20 of the land developers interviewed in this study were interested in incentives to preserve and plant more trees, and many were thankful for the chance to share their perspectives. Most interviewees considered monetary incentives to be most motivating, echoing scientific literature which also shows that financial incentives are desirable (Göçmen, 2014). Interestingly, the top-mentioned incentive ideas (increased density, reduced impact fees and tax liability, and changing tree mitigation policy), differed from other studies that listed tax rebates most often (Coughlin et al., 1988; Clark et al., 2020; Ordóñez-Barona, 2021). Financial incentives and code requirements are cited most often (Liberalezzo et al., 2020), and could give developers the flexibility to design projects with trees in ways that could reduce costs (Ordóñez-Barona, 2021).

Many developers were open, and some quite eager, to share their ideas for potential incentives and solutions. While an increased density tradeoff was shared by the most interviewees, this was not mentioned often in the literature. An incentive program that trades increased density for additional tree cover could potentially encourage developers to set aside more land for preservation while simultaneously building higher density housing. The interviewees suggested that such an incentive would result in more trees being preserved, and the developer is rewarded with a higher return on investment from more units on the same area of land and lower costs from fewer tree removals.

Denser development is already part of efforts to create more affordable housing, which improves housing availability for the public (Moreno-Monroy et al., 2020). Currently, the state of Florida is in a housing crunch. Research has shown that the number of renters increased from 1.29 million in 2000 to 1.86 million in 2016 (Kang and Jeon, 2021). During this same period, the proportion of housing units priced within reach of low income residents decreased from 20.1% of total rental stock to 12.9% (Kang and Jeon, 2021). Increasing development density was already recommended as a solution to land conversion in Florida (Carr and Zwick, 2016), and our findings suggest that incentivizing tree preservation and planting through density tradeoffs could possibly be integrated with affordable housing incentives.

There are several opportunities to apply what was learned in this study. First, local governments can consider these results during policy discussions. Florida developers shared valuable insights that may be beneficial for pilot programs and promoting collaboration across research, practice, and policy. There is no single solution to preserve trees on private land, rather a combination of policies, regulations, incentives, and community engagement can help cities achieve their goals (Ordóñez-Barona, 2021). As suggested by previous literature, regulators could bring in incentives early in the land development process during the site programming stage (Seila and Anderson, 1982; Hauer et al., 2020).

While some barriers are unique to Florida, many proposed solutions hold relevance to other places, especially where population growth and densification are expanding. Furthermore, there is a need for more research on incentives (Ordóñez-Barona, 2021). Interviews yielded initial ideas, but we do not know the extent to which developers, policy makers, and the general public support each incentive. Future research can provide more representative quantitative data by distributing a survey to a larger pool of developers to test which incentives are most desirable. Future research could also focus on other actor groups, such as builders, engineers, land planners, and regulators, to evaluate the ideas from developers to determine which are most viable. Moreover, our set of interview questions lacked key questions about the types of projects developers engage in (single homes vs. multifamily) and the scale of their operations. Future research could investigate which incentives would be most relevant to developers, considering the specific types of

projects they prioritize.

Financial incentives offer an innovative solution that continues to attract attention from regulators as a shift of focus from bare minimum approaches to best practices (Ordóñez-Barona, 2021). Many developers in our study are willing to collaborate with regulators on these issues. Our interviewees suggest that if structured properly, incentives could reduce costs for developers while also helping regulators meet their tree-related goals. While environmental regulations have long been central to land management generally and the housing market specifically (Kiel, 2005), adding more punitive regulations alone does not seem sufficient to enhance urban tree canopy. Incentives could be a more innovative strategy to help developers and regulators meet their goals by working together.

5. Conclusion

As urbanization and densification progress, balancing land development and trees has become a point of controversy, especially in Florida. While regulating urban trees is a common and effective way to reduce urban tree canopy loss, there is a need for new tactics to find common ground between regulators and developers. This is especially true given trends at that state legislative level to attempt to preempt local protections. In this study, we interviewed land developers across Florida to better understand their perspectives on existing barriers and potential incentives for tree preservation and planting. Most of the developers are interested in financial incentives, especially increased density, reduced impact fees and tax liability, and changes to tree mitigation policy. However, site grading requirements and financial costs are significant barriers. A promising discovery is that developers expressed willingness to work with regulators as a unified front. Moreover, they noted the potential for novel building and development practices such as the use of block foundations and tree wells to reduce the need for or mitigate the impacts of site-wide grading.

CRedit authorship contribution statement

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work of this paper.

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Appendix A. Interview questions

Section 1: General information about the interviewee.

1. What is your role at your company, and what type of development do you do? (e.g., primarily redevelopment or new development, residential or commercial)
2. What region of Florida do you work in, and what is the size of your service area? (e.g., several cities, metro area, region)
3. Please tell me what it's like to work in the Florida land development industry today? (e.g., pace, pressures, priorities, culture)
4. Please walk me through your typical process for determining if trees are retained or removed in a project?
 - a. What influences whether trees are given a higher or lower priority in a project?
5. What landscaping strategies do you use to meet sustainability or green infrastructure goals, such as preserving or planting trees for stormwater or shading requirements?
 - a. How does that strategy benefit your company?

Section 2: Barriers to tree preservation and planting

6. What factors typically limit tree preservation for you and your company?
 - a. Similarly, what factors typically limit tree planting?
7. How do local or regional trends impact your decisions about trees?
8. Please tell me about the difficulties you face when working with regulators on tree preservation and planting in your projects.
9. Please describe a time when your plans for trees conflicted with others' expectations.
 - a. Who were the stakeholders disagreeing with your plans? (e.g., government staff, public, client)
 - b. How was it resolved, and what could help prevent this conflict in the future?

Section 3: Potential incentives for tree preservation and planting

10. Please tell me about incentives that have led you to preserve or plant trees.
 - a. Why was that incentive motivating to you and your company?
11. What other incentive policies or programs could motivate you and other developers in Florida to preserve and plant more trees?
 - a. How might local governments be involved in your solution?
 - b. How might landscape architects and arborists be part of your solution?
12. How could the current systems be changed to help developers plant and preserve more trees? (e.g., processes, policies, incentives)
13. What do you think it would take to make tree preservation and planting more doable, given the barriers you've shared today?
 - a. How would this work for you and your company?

Appendix B. Existing incentive programs identified by interviewees

Several respondents noted current programs and policies in Florida that they considered incentive for tree preservation. They are noted in-text and described in greater detail here:

Nassau County, Florida, United States:

All new developments are required to mitigate 25% of protected tree loss, calculated based on the combined DBH of the removed protected trees. Replacement trees must be planted to match each centimeter/inch of DBH lost. Up to 50% of the replacement requirements can be fulfilled by contributing to the County's tree mitigation fund as a fee in lieu of actual tree planting.

The incentive mentioned in our interviewee's statement appears to

be referenced in the Preservation Credits section of the County's Municipal Code, available at this link: https://library.municode.com/fl/nassau_county/codes/code_of_ordinances?nodeId=APXALADECO_OR_DINANCE_NO.97-19NACOFI_ART37NAREPR.

On-site retention of protected trees qualifies for tree preservation credits to reduce overall tree replacement requirements based on their diameter at breast height (DBH) as follows:

- Trees with a DBH of 12 to 24 in. receive a 115% credit.
- Trees with a DBH of 24.1 to 38 in. receive a 125% credit.
- Trees with a DBH of 38.1 in. or greater receive a 150% credit.

To be eligible for on-site tree preservation credits, each tree proposed for retention must be evaluated by an ISA-certified arborist to ensure health and proper mitigation techniques for long-term viability in the post-development environment. These credits are specifically for replacing protected trees removed, and they can be transferred only in unified multiple lot developments. Preservation credits for the total DBH of protected trees retained on-site will be applied during the review of the tree protection and replacement plan.

City of Stuart, Martin County, Florida, United States:

The city of Stuart has an ordinance explicitly dealing with the augmentation of building density through clustering on environmentally sensitive sites (https://library.municode.com/fl/stuart/codes/land_development_code?nodeId=CHVREPRREDEST_5.10.00CLDE).

When development sites encompass environmentally sensitive areas, such as lowlands, developers have the option to cluster developments in less sensitive upland areas. This clustering is permissible at 150% of the standard maximum density for the site.

City of Saint Petersburg, Pinellas County, Florida, United States:

One of our interviewees noted that developers could increase building density in exchange for an enhanced landscape package, which could be achieved through additional planting. We were unable to find reference to this when searching the City's code (https://library.municode.com/fl/st.petersburg/codes/code_of_ordinances) using the terms: density, increased density, maximum density, development, landscape, enhanced landscape package, tree, preserve.

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