Existing System Evaluation: Summary Report

JUNE 23, 2017

Palm Tran

Route Performance Maximization Initiative

JARRETT WALKER + ASSOCIATES

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Table of Contents

Table of Figures

1 Introduction and Executive Summary

This report is the first step in the Route Performance Maximization Initiative (RPM) for Palm Tran, the primary public transit operator of Palm Beach County. The RPM is a multi-phase planning effort focused on improving Palm Tran's network to better meet the mobility needs of the growing population of the Palm Beach County.

Planning and the Public Conversation

This first phase of the RPM Initiative comprises two major elements: first, this report will provide a thorough overview of the current state of the transit network, evaluating its performance and design along multiple criteria to identify existing strengths, as well as opportunities for improvement. Then, several Service Concepts illustrating conceptual transit networks for Palm Beach County focused on meeting different goals will be designed and presented to the Palm Beach County Board of County Commissioners.

In the second, future phase of the RPM, this report, as well as the Service Concepts, will serve as the foundation for a conversation among the public, stakeholders and elected officials that will ultimately shape a new plan for transit in Palm Beach County.

Palm Tran Overview

Palm Tran is the primary public transportation agency serving the various jurisdictions within Palm Beach County, with connections available to Broward County Transit to the south, as well as to the Tri-Rail commuter rail system serving a variety of destinations throughout South Florida. Palm Tran provides conventional fixed route bus service to the main urbanized area of the county along the Atlantic coast, and routes connecting the coastal jurisdictions to the towns of South Bay, Belle Glade, Pahokee and Canal Point on the eastern shore of Lake Okeechobee.

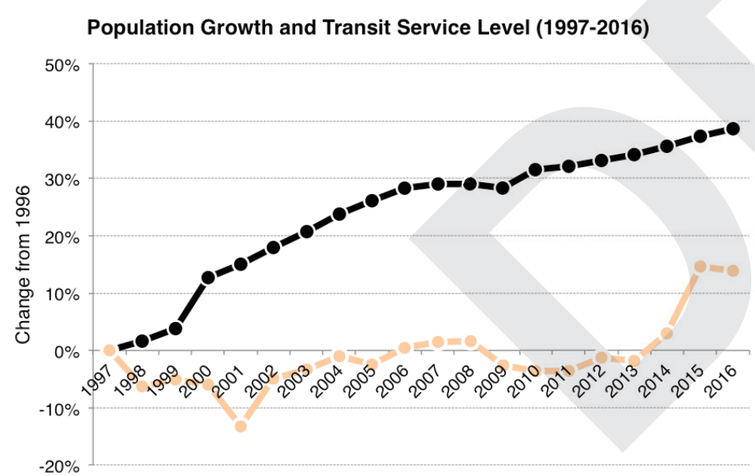
Figure 2 shows the existing transit network operated by Palm Tran, colored by the frequency of the service during the midday period.

- Pink lines (like Routes 1 and 62) operate every 20 minutes.
- Blue lines (like Routes 2 and 3 operate about every 30 minutes, though some blue routes operate about every 40-45 minutes.
- Green lines (like Routes 10 and 73) operate about every 60 minutes, though some green routes operate less frequently.
- Dashed green lines (like routes 4 and 60) operate only at peak hours, or less frequently than every hour during the midday.

Many of Palm Tran's routes converge at TriRail stations, where long-distance commuter rail connections to Broward and Dade Counties are available throughout the day.

Rapid Population Growth, Stable Transit Resources

Since the 1996 transit expansion and reorganization that created Palm Tran, Palm Beach County has grown rapidly, from under 1,000,000 residents in 1996 to nearly 1.4 million today. After the initial service expansion in 1996-1997, the level of transit service resources (fixed route revenue hours) has been mostly stable in the intervening period, at around 400,000 annual revenue hours. Figure 1 shows the change in fixed route revenue hours and population in Palm Beach County since 1997, the first full year after the establishment of the agency. As a result, the level of transit service provided per capita has steadily dropped, from 0.42 annual revenue hours per person in the County in 1997 to 0.34 today.



Data source: Bureau of Economic and Business Research, University of Florida. National Transit Database, 2015.
*2016 population data based on ACS 1-year estimate.
*2016 revenue hours total based on sum of NTD monthly estimates.

Figure 1: Palm Beach County Population and Palm Tran Revenue Hours: 1996 - 2016

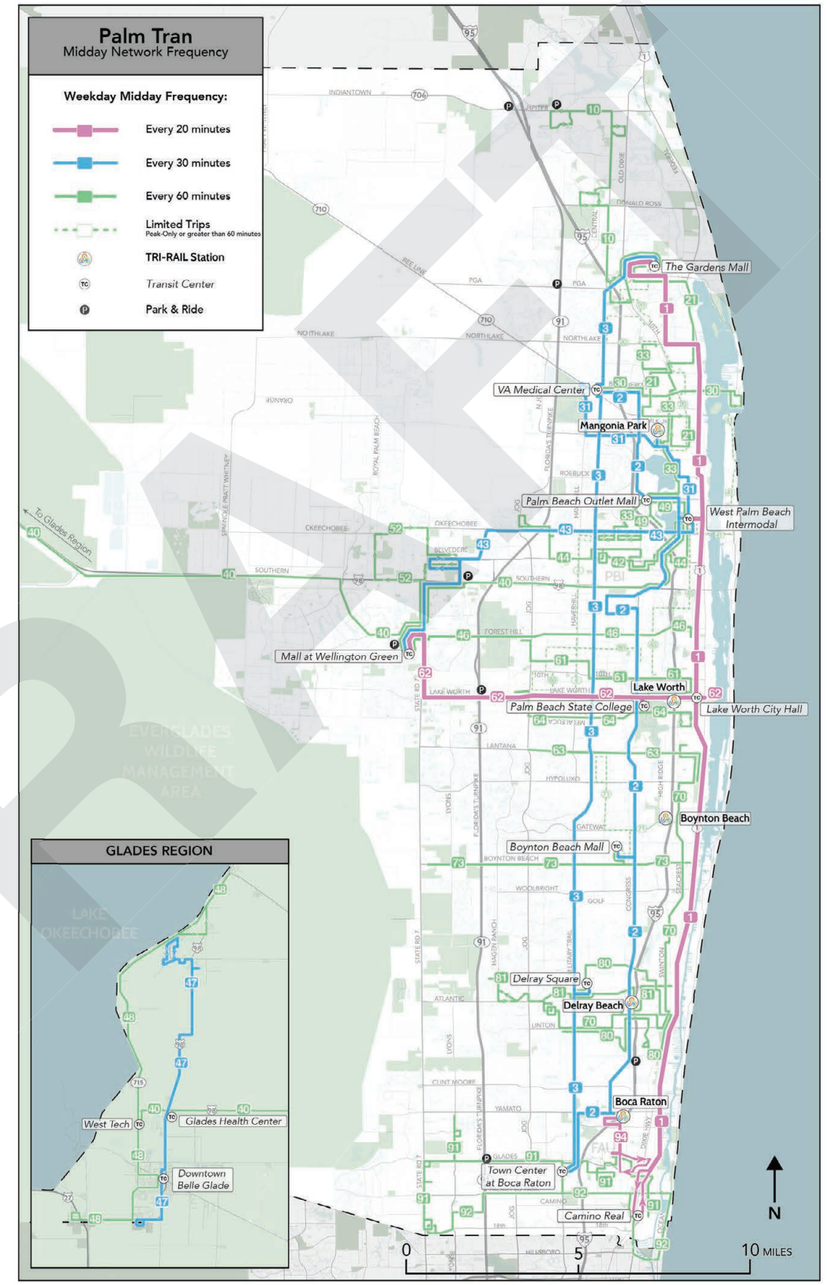


Figure 2: Existing Palm Tran Network

Transit Serves Numerous Goals

If the Palm Tran system were designed *only* for maximum ridership, it would focus only on areas where there are many potential riders, and transit is useful for many of their trips. In other words, Palm Tran would be thinking like a private enterprise and targeting a market where its product is competitive.

Yet maximizing ridership is not the only goal of public transit systems. While private transit companies may focus on profits, and therefore on exclusively high-ridership routes, public transit is almost always expected to meet other goals. In nearly every city, there is an expectation that transit service should be provided in some or all places regardless of the ridership it attracts.

Unlike governments, businesses are under no obligation to open storefronts in places where they would spend a lot of money to reach few potential customers, or where their products can't compete. For example, McDonald's is not required to provide a drive-thru restaurant within walking distance of every resident living in Palm Beach County. If it were, then thousands of houses would need to have their own McDonald's at the end of the driveway. The company would quickly go bankrupt, as a result of operating all those restaurants serving few customers.

Some transit agencies are accused of failing to maximize ridership, as if that were their only goal. But they are not private businesses, and as public agencies they are intentionally providing coverage services that they know will not generate much ridership.

The officials who ultimately make public transit decisions hear their constituents say things like *"We pay taxes too"* and *"If you cut this bus line, we will be stranded"* and they realize that coverage, even in low-ridership places, is an important transit outcome to some people.

The 2016 Palm Tran TDP update asked the Palm Tran Service Board to consider how to balance high frequency service against other potential goals. The notes from their discussion clearly capture but the Board's intention to move the system towards more of a ridership focus (a process the RPM Initiative is a part of), while characterizing the tradeoff doing so requires at a relatively fixed level of service:

> "Overall, Board members indicated more need for frequency over coverage, as higher frequency would likely bring more ridership and is more attractive to riders. There is still a need to balance transit coverage so that riders can access the system."
> Palm Tran Transit Development Plan 2017-2026, p. 3-8

Ridership and Coverage Goals are in Conflict

Ridership and coverage goals come into direct conflict with one another. If a transit agency wants to do more of one, it must (within a fixed budget) do less of the other, due to fundamental geometry and geography.

In the fictional town shown in the diagrams below, the little dots indicate dwellings, commercial buildings and other land uses. The lines indicate roads. Most of the activity in the town is concentrated around a few roads, as in most towns.

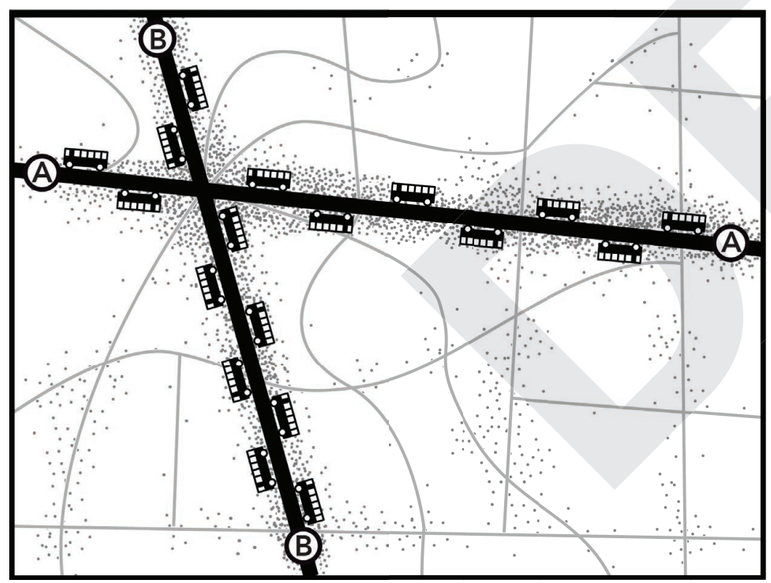


Figure 3: Ridership-Focused Network Diagram

A transit agency pursuing only a ridership goal would run all of its buses on the streets where there are large numbers of people, walking to transit stops is easy, and where they can run straight routes that feel direct and fast to customers. This would result in a network like the one in Figure 3, and total ridership would be high because many people would find the two frequent routes useful.

If the town were pursuing only a coverage goal, on the other hand, the transit agency would spread out services so that every street had some bus service. As a result, all routes would be infrequent, even those on the main roads. Because service would rarely be coming when somebody wanted to travel, total ridership would be low. This is the case in Figure 4.

In these two scenarios, the town is using the same number of buses. These two networks cost the same amount to operate, but they deliver very different outcomes.

While an agency can pursue ridership and provide coverage within the same budget, *it cannot do both with the same dollar.* Within any fixed budget, the more it does of one, the less it does of the other.

These illustrations also show a relationship between coverage and complexity. Networks offering high levels of coverage – a bus running down every street – are naturally more complex.

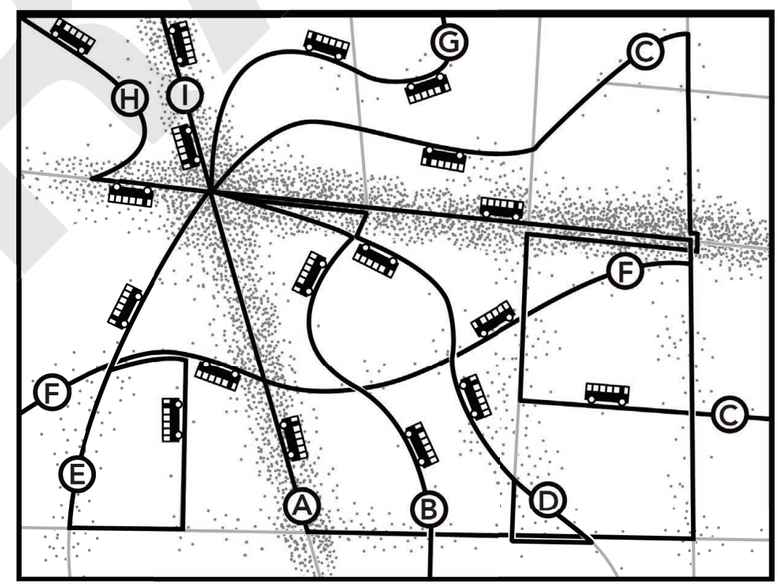


Figure 4: Coverage-Focused Network Diagram

Note that the choice between maximizing ridership and maximizing coverage is not binary. All transit agencies, including Palm Tran, spend some portion of their budget pursuing each type of goal. A particularly clear way for transit agencies to set a policy balancing ridership and coverage goals is to decide what percentage of their service budget should be spent in pursuit of each.

We estimate that, in the existing network, Palm Tran is spending about 60% of its service in ways and in places that generate high ridership, and about 40% in ways and places where low ridership is the predictable result.

The "right" balance of ridership and coverage goals varies between communities. It can also change over time as the values and ambitions of a community change.

Key Choices for Transit in Palm Beach County

At the end of this report, we present three key choices that the public, stakeholders and elected officials may want to make as part of this transit plan. These choices are suggested by the existing conditions and performance of transit and land use in Palm Beach County.

Balancing ridership and coverage goals

In every public transit system, a basic trade-off must be made between doing things that increase ridership (such as concentrating service into more frequent routes) and doing things that increase geographic coverage.

How should Palm Tran balance ridership and coverage goals in its network? The recommendations and aspirations of the TDP indicate a desire to move towards a greater ridership focus, but to what extent? Within a fixed budget, a shift towards higher frequencies and higher ridership would require cutting coverage, and vice versa.

How far should people be asked to walk to transit service?

One aspect of designing transit networks to achieve high ridership is reducing duplication in the network, where the same area is covered by multiple transit services that provide little benefit in their overlap. This is often a result of very short unique segments that provide service directly to a limited area, but that transit must run on top of other routes in order to reach. If people were willing to walk a longer distance to reach transit, especially if that transit came more frequently, perhaps the resources used to run a largely duplicative service could be reoriented towards improving service frequency or span elsewhere.

Whether or not Palm Tran wants to ask its customers to walk further to reach its service will be an important question for the RPM Initiative, especially in parts of the service area like central West Palm Beach or Delray Beach where many routes run very close together, serving overlapping markets. Many parts of Palm Beach County feature challenging walk environments, with many physical obstacles that present barriers to walking from neighborhoods to the main streets, or crossing the main street to reach a transit stop. The extent, if any, to which Palm Tran chooses to ask customers to walk further than they do today is one way of unlocking existing service resources that could then be used for other purposes.

Balancing weekday, evening and weekend service

Increasing evening, weekend and holiday service can serve ridership-related values (because all-week transit networks tends to attract higher ridership than limited-day networks) and coverage-related values (because people with lower-incomes, in particular, crucially need to access jobs on weekends and holidays). Palm Tran currently runs a little over half its weekday service level on Saturdays, and less than half on Sundays.

Many people work on weekends, in jobs that are more difficult to reach than during the week due to the lower transit service level. People who might choose to use transit for errands or leisure trips if it were convenient may also find using transit on the weekend a less appealing choice, if its frequency and span are curtailed. Providing useful, frequent service to strong markets on the weekend is one potential strategy to grow system ridership and efficiency, but it can come at a cost. Within a fixed budget, lengthening the span of service each day or each week would require reducing weekday frequencies or reducing coverage (i.e. cutting some routes).

Is the current level of service meeting the needs of Palm Beach County?

The amount of transit service available in Palm Beach County (in terms of revenue hours per year offered on Palm Tran's fixed route system) has been stable, even as the County has grown over the last two decades. As a result, Palm Tran now offers a relatively low level of transit service per capita compared to peer agencies in Florida and elsewhere in the county. This means that there is less transit available to respond to changes in land use: new development, increased density, or new

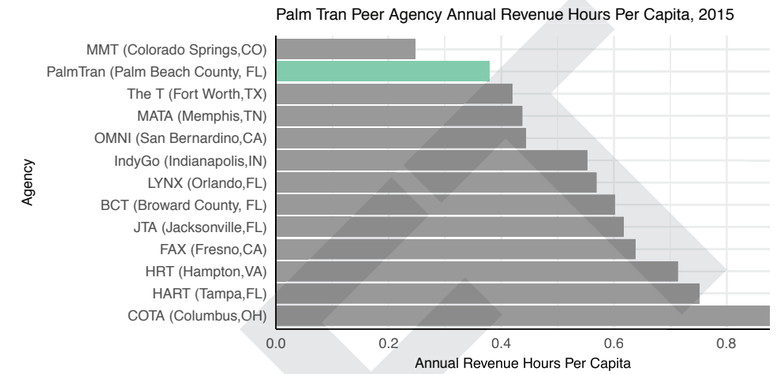


Figure 5: Palm Tran Peer Service Quantity (Revenue Hours) per Capita

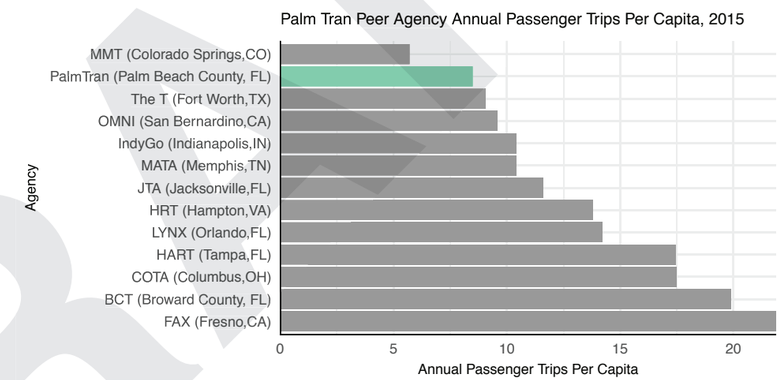


Figure 6: Palm Tran Peer Annual Boardings per Capita

destinations, like hospitals or shopping malls. Palm Tran's ridership per capita, a measure of the relevance of transit service to people's travel behavior, is quite low as well.

The RPM Initiative will consider different ways that the performance of the existing system could be maximized, but in order to provide a comparable level of service to peer agencies in places like Orlando, Tampa or Broward County, the County would need to find the funding to expand the supply of transit service. Whether or not a higher level of transit service is desirable is a question only Palm Tran's leadership, elected officials, as well as stakeholders and members of the public, can answer.

Implement changes incrementally, or all at once?

Ultimately, the RPM Initiative will produce a new plan for Palm Tran's network that the agency will then implement. This implementation could

happen all at once, or more gradually. There are advantages and disadvantages to either approach, and Palm Tran's leadership will face an important question about which one to choose.

Implementing a big service change in one go is a major effort that requires substantial staff time and capability, but offers the opportunity to message and inform the public about all aspects of the plan at once. On the other hand, a more incremental approach means that fewer people are suffering a large disruption to their existing service at any one time. The trade-off is that with an implementation period stretched over many years, some disruption will always be occurring to some people which can lead to fatigue with change among riders and the public. Incremental implementation also makes it harder to judge the results of network changes relative to background changes in economic and demographic conditions.

2 The Transit Market

The Geometry of High Ridership

Attracting riders requires more than clean, courteous, comfortable or even frequent service. Many factors outside the control of Palm Tran – land use, development, urban design, street networks – strongly affect transit's usefulness.

A good way to visualize how these factors impact ridership and costs is to ask: "How far does a bus need to go to serve 1000 people or jobs?" The farther you have to go, the more expensive it is to provide service.

If a transit network is designed for high ridership, it will focus on places where ridership potential is high and cost is low. This potential lies mostly in the development pattern, specifically in four geometric features:

- **Density**: How many people, jobs and activities are near each bus stop?
- **Walkability**: How many people can actually walk to the bus stop?
- **Linearity**: How far off a direct path does the bus travel to reach important destinations?
- **Proximity**: Does the bus traverse long, empty gaps to reach people and jobs?

These are geometric facts of the city and its design, which directly impact ridership potential.

All of these factors affect both the costs of providing transit in a particular place and how many people will find the service useful. **Density** and **walkability** tell us about the overall ridership potential: *"Are there are a lot of people around, and can they get to the transit stop?"*

Linearity and **proximity** tell us about both ridership potential and cost: *"Are we going to be able to serve the market with fast, direct lines, or will we have to run indirect or long routes, which cost more to operate (and cost riders time)?"*

A transit provider can influence the level of ridership their services generate, within their fixed budget, by targeting corridors and places where the "Ridership Recipe" is in effect. However, they cannot directly control the urban form of the places they serve.

The transit agency can try to provide a level of transit service that is as useful as possible, but the built environment has the power to limit transit ridership regardless of service.

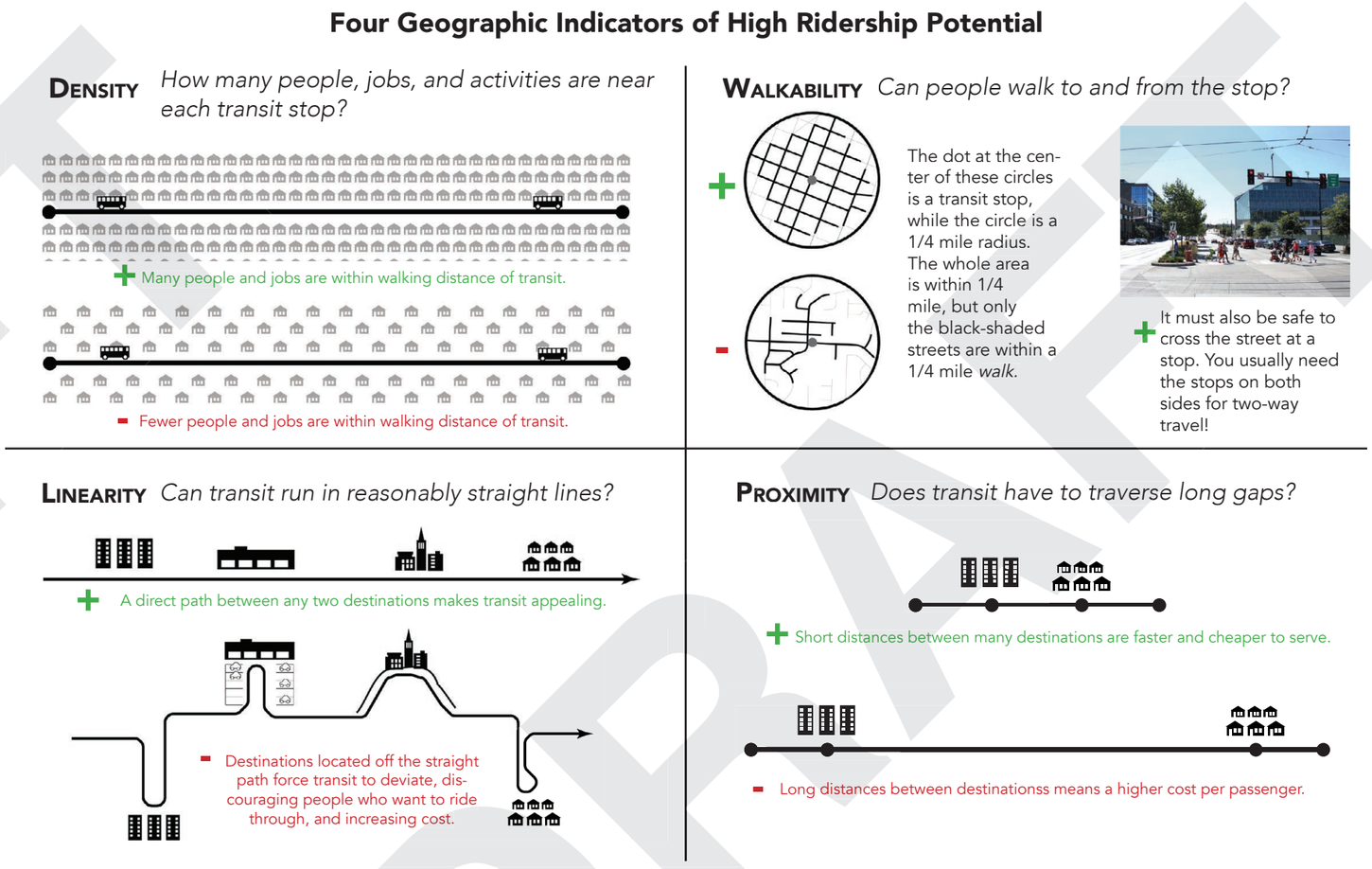


Figure 7: Four Geographic Indicators of High Ridership Potential

In the short term, Palm Tran could improve ridership by targeting service in areas where the necessary conditions for ridership already exist. In the long term, significant ridership gains could come from intensification of land use in areas that are already served today.

Ridership vs. Coverage Goals

Ridership, however, is not transit's only goal. Services that are not designed around a ridership goal are called **coverage services**. Transit agencies receive many requests for service to places where the geographic conditions are unfavorable, often because relatively small numbers of people have a severe need for service. Coverage service may also be operated in order to respond to criteria of equitable distribution of service across an area.

Coverage service has predictably low ridership, but this is not a sign of failure so long as the agency has clearly decided to run those services for a non-ridership purpose, with low ridership expectations.

Coverage service is most easily justified in the context of severe needs. Groups mostly likely to need transit are senior citizens, children under 18, and persons with limited incomes. Not everyone in these categories is a potential transit user, but concentrations of these groups usually indicate areas with higher needs. If located in places that do not offer the features of the ridership recipe, these can form reasons to run low-ridership service for coverage purposes.

Residential Density

Residential density is the simplest measure of public transit's ridership potential. While not all trips start or end at home, nearly everybody makes at least one trip starting or ending at their place of residence every day.

The map in Figure 9 shows the residential density across much of Palm Beach County, based on the most recent block group-level figures available from the American Community Survey.

From this map, we can observe thath while isolated areas of higher residential density are found in all areas of the county, high residential densities are most concentrated in Lake Worth and Boynton Beach, both along the shoreline and extending west. This is the area with the most extensive traditional development pattern, characterized by smaller lots, grid street patterns and more extensive street connectivity.

How Density has Changed

Comparing today's density pattern to that of 1990[1] (shown in Figure 8) gives a sense of how the county has grown and changed in the last 27 years, since the period immediately before the establishment of Palm Tran. Low-density development has spread inland, mostly in forms that are difficult for transit to serve.

However, densities have also increased dramatically. Much of the density growth has been near Military Trail -- a difficult transit market because of poor walkability. There has also been growth in the more walkable older neighborhoods east of I-95, as well as new nodes such as Wellington and southwestern Boca Raton.

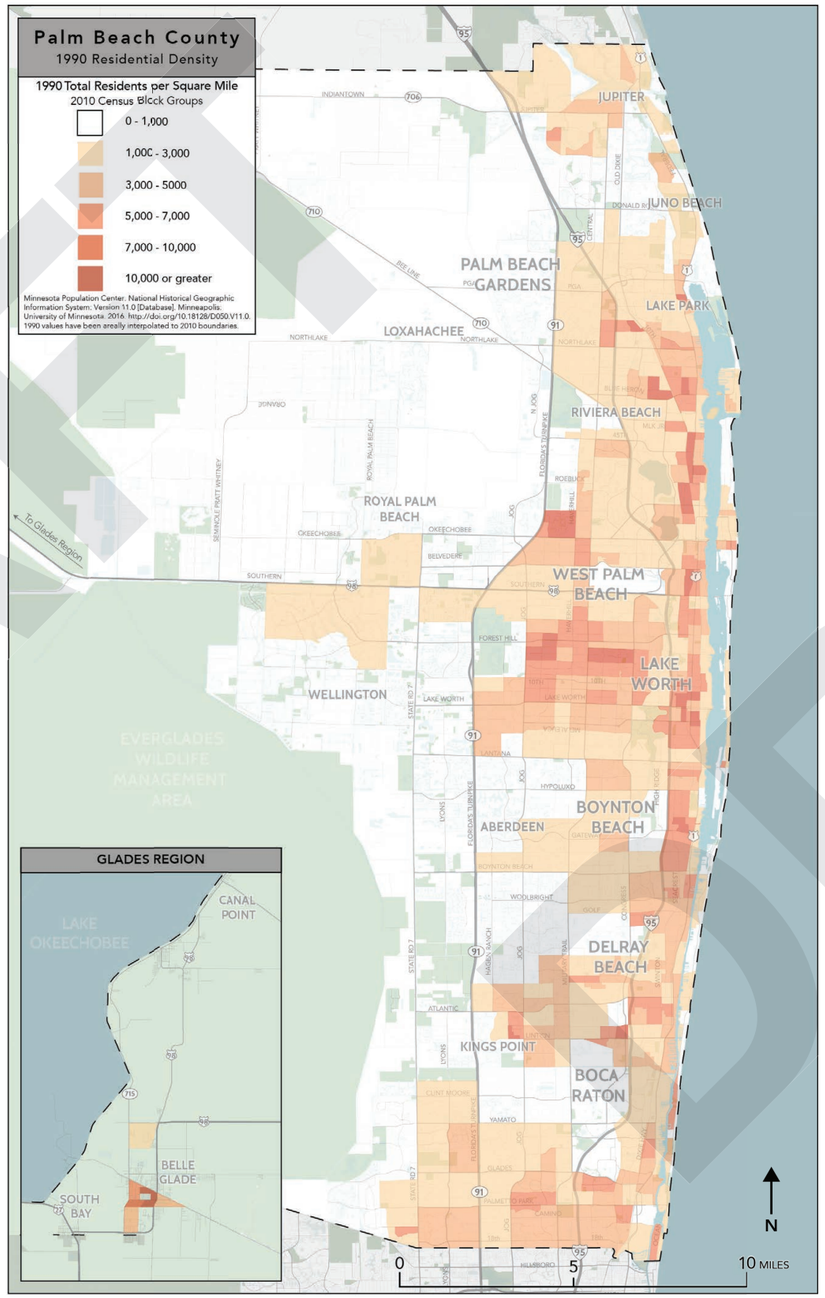


Figure 8: Palm Beach County Residential Density (1990)

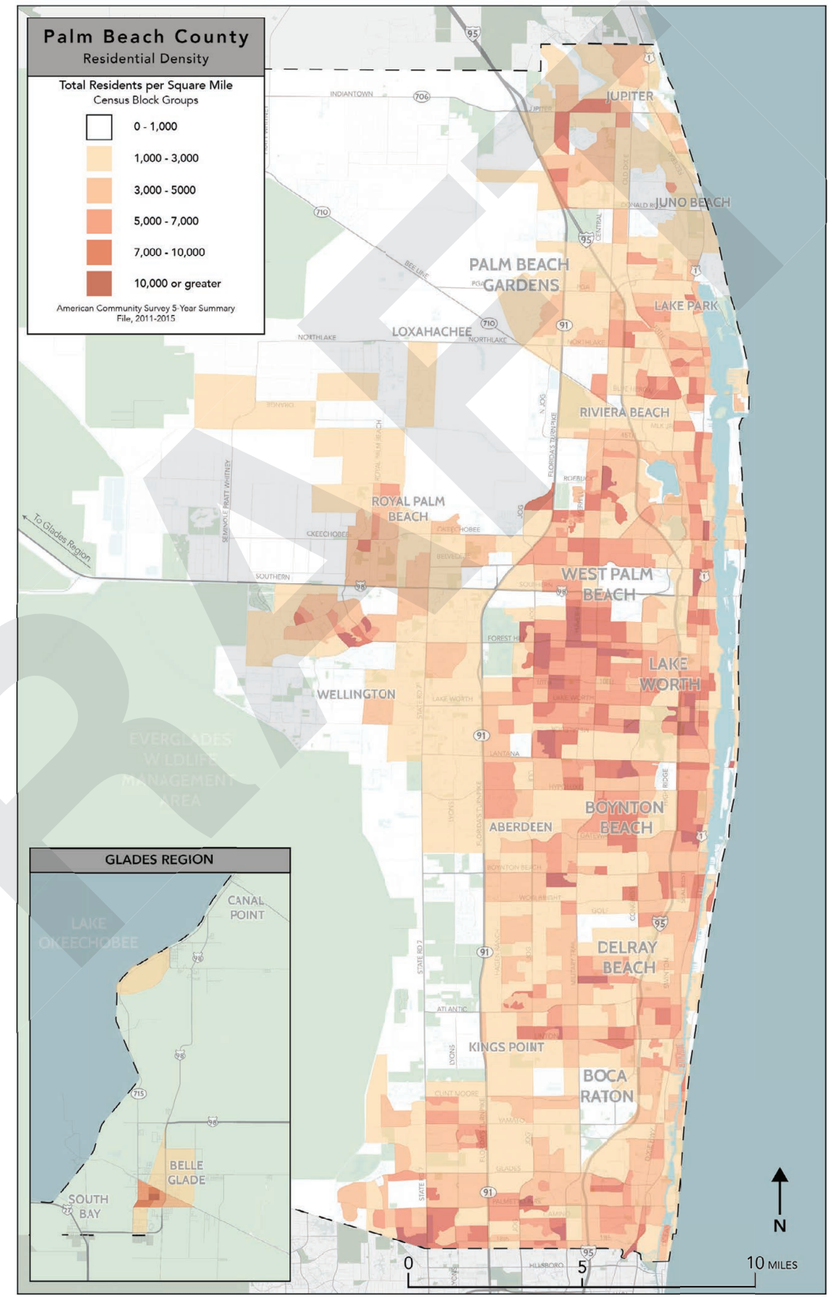


Figure 9: Palm Beach County Residential Density (ACS 5-Year Estimate, 2011-2015)

1 In this map, population totals for 1990 block groups have been assigned to 2010 boundaries via areal interpolation, in order to correct for the effects of changes in block group boundaries over that period.

Employment Density

Employment density is another valuable predictor of transit ridership. This measure represents places people travel for work, but also places people go for services, shopping, culture, health care, and more. A person's workplace may be, throughout the day, a destination for dozens or even hundreds of people. For that reason, employment density is even more powerful than residential density in predicting transit demand.

In Palm Beach County, employment is most concentrated in the central areas of the various jurisdictions arrayed along the shoreline, including:

- In Boca Raton, around the retail area near Palmetto Park and US-1, as well as near the campus of Florida Atlantic University. Several areas near FAU exhibit employment densities of 20,000 jobs per square mile or greater (particularly in those block groups containing Boca Raton Regional Hospital and the Town Center at Boca Raton Mall.
- FAU's Boca Raton campus is itself a major employment center, although on this map it appears less dense that it is due to the zone boundary, which encompasses a large ecological site as well as the Boca Raton airport. As the main campus of the university, this site is a destination for approximately 80% of the university's 30,000 students[2], as well as thousands of faculty, administrative and support staff.
- Each of the various smaller cities between Boca Raton and West Palm Beach have areas of high employment density in their commercial centers (for example, in Delray Beach along Atlantic Ave near the Shoreline).
- The core area of West Palm Beach concentrates a very large number of employees in a small area, including both the Convention Center, the Cityplace shopping and entertainment development, as well as a number of large hotels.
- Shopping centers typically do not show up as areas of particularly high employment density, generally because they are located on large parcels with extensive parking, water features, or undeveloped land. For example, the commercial area north of Boynton Beach Blvd along Congress Ave in Boynton Beach is home to both a large indoor mall and a number of satellite big box shopping centers. While there is no doubt that many people are employed in this areas, due to the development pattern's extensive supply of parking, these jobs appear more dispersed than are those in other areas of the county, and may be more difficult to serve by transit as a result.

2 Quick Facts. Florida Atlantic University. http://www.fau.edu/publicaffairs/about/quick-facts.php

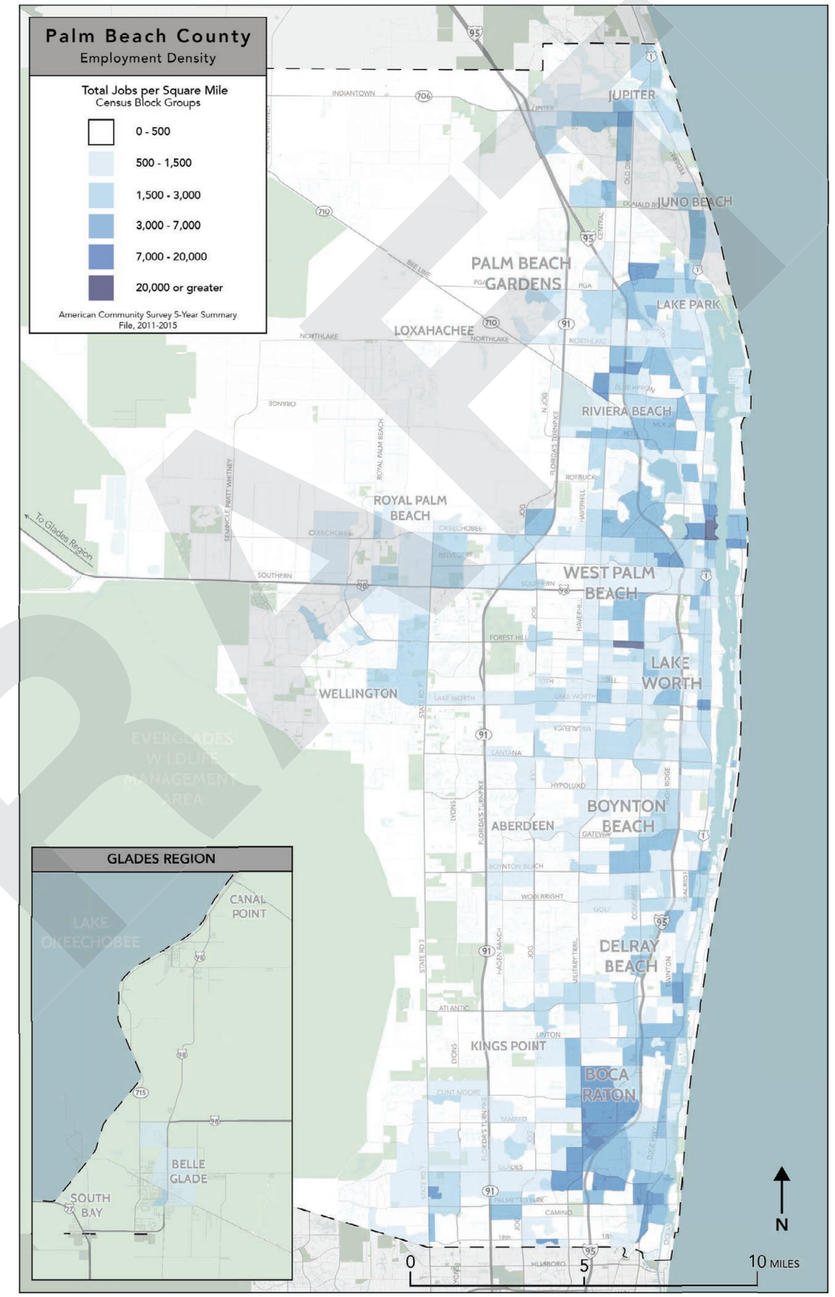


Figure 10: Palm Beach County Employment Density

Activity Density

Residential and employment density are both critical measures of a place's potential transit market relative to other parts of the service area. In Figure 11, those two measures are combined in a single map displaying the density of both types of activities. Places with more residential density are shown in increasingly dark shades of purple; areas of high employment density, in brown. The block groups shown in orange area are places where high densities of both uses are present, and where there is likely to be a strong market for travel for most or all of the day.

In most cases, employment and residential uses are separated in Palm Beach County. Especially high mixed use can be found in West Palm Beach and several areas of Boca Raton.

Though it is not one of the four major factors named in the Ridership Recipe, the *mix* of residential and job density along a corridor affects how much ridership transit can achieve, relative to its cost.

This is because a mix of uses tends to generate demand for transit in *both* directions, at *many times of day.* Transit lines serving purely residential neighborhoods tend to be used in only one direction – away from the residential neighborhood towards jobs and services in the morning, back in the evening. This limits how much ridership the service can attract relative to its cost, because:

- If ridership is only high during the morning and evening rush hours, that means the transit agency must pay to run mostly-empty buses during the rest of the day (or must pay drivers to take split-shifts, which go from very early to very late, and must buy extra buses for those few hours of peak service each day).
- If ridership is only high in *one direction* during each peak, then the provider must pay to run mostly-empty buses back in the other direction. The service may not even be advertised as two-way, but the operating costs are always two-way.

All-day and two-way demand, along an entire route, results in higher ridership relative to cost. All-day and two-way demand tends to arise on corridors that have mixtures of housing, retail, services and jobs.

Universities are also sources of all-day all-directions transit demand. This is partly because they are dense with jobs and housing. It also relates to the type of "job" done there: students come and go depending on their class schedules, from morning through the evening. Professional, retail and facilities staff have their own commute patterns. The sum of all these patterns is generally high demand, all day, every day.

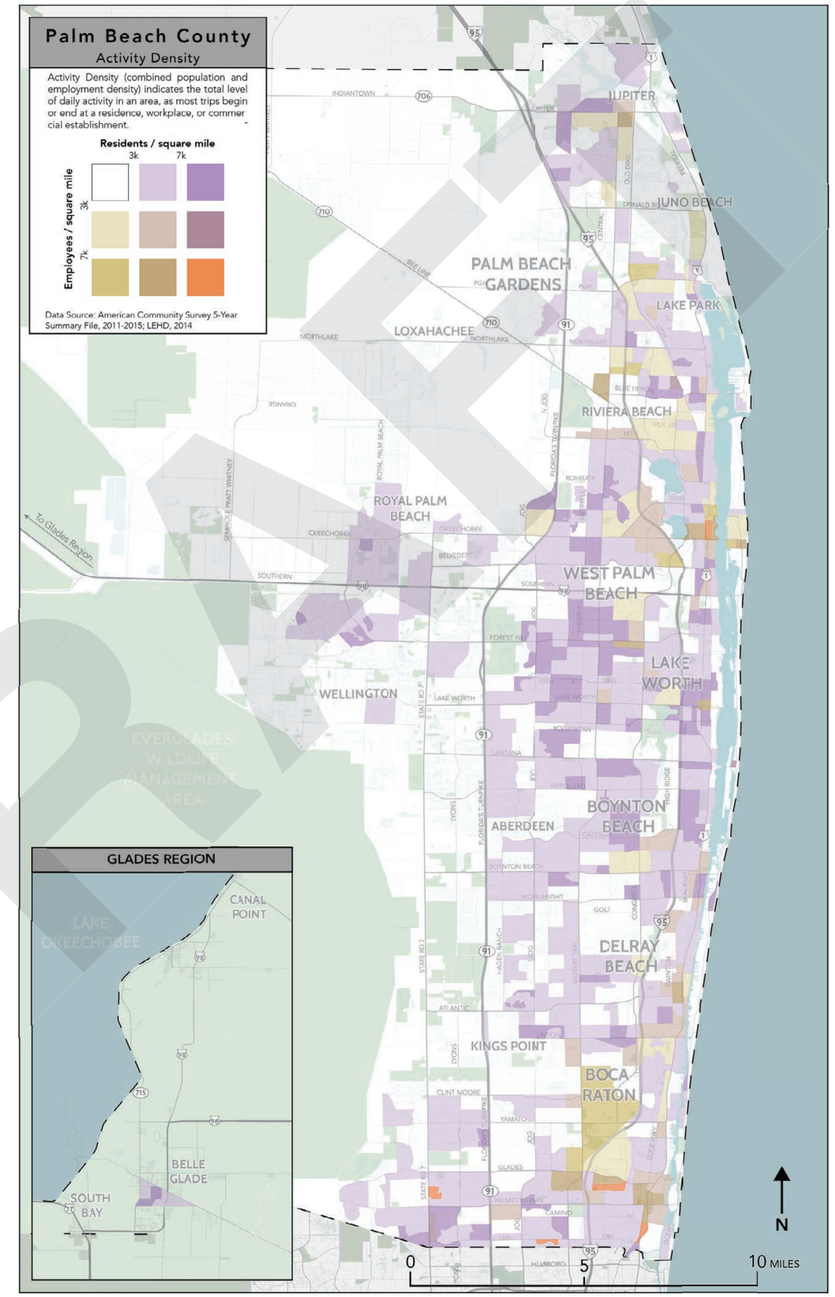


Figure 11: Palm Beach County Activity Density

Senior Citizens

One of the major drivers of transit coverage is the need for mobility among people who cannot drive. This need is particularly acute among seniors, many of whom cannot or choose not to drive themselves. This may be quite a relevant concern for Palm Beach County, as the proportion of the population above age 65 is 60% greater than that of the United States as a whole. A detailed breakdown of the County's population by age is shown in Figure 12.

Figure 13 shows the density of senior residents of each Census Block Group in Palm Beach County.

When considering how transit service can and should serve seniors' needs, we must keep in mind that seniors' needs and preferences tend to be different from those of younger people:

- Seniors are more likely to be discouraged by long walks to transit, because of limits on their physical ability, or because of concerns for their personal safety. This is particularly true where sidewalks and crossings are poor or lacking.
- According to the Centers for Disease Control, the rate of any physical difficulty among people ages 65 or older is slightly less than 30%, compared to a rate of 15% for the adult population as a whole.[3] If they do fall into this category, then a walk (or roll) of any distance may prevent them from accessing transit, though people can qualify for paratransit based on exactly this kind of disability.
- Seniors are much less likely to be discouraged by long waits for transit, because they are less likely to be employed. Thus, fewer of their trips are time-sensitive, compared to those of the general population.
- Retired people are often less likely to be discouraged by slow or indirect routes that take them out of their way, since they are less likely to be in a hurry than the general population.

Seniors are more likely to be low-income than working-age people (as are youth), but their needs and concerns related to income (such as sensitivity to fares) are similar to those of low-income people of any age.

Most transit agencies find that they must deliberately balance seniors' preferences and influence with the preferences of the rest of the population, because their preferences tend to be so different from those of other riders.

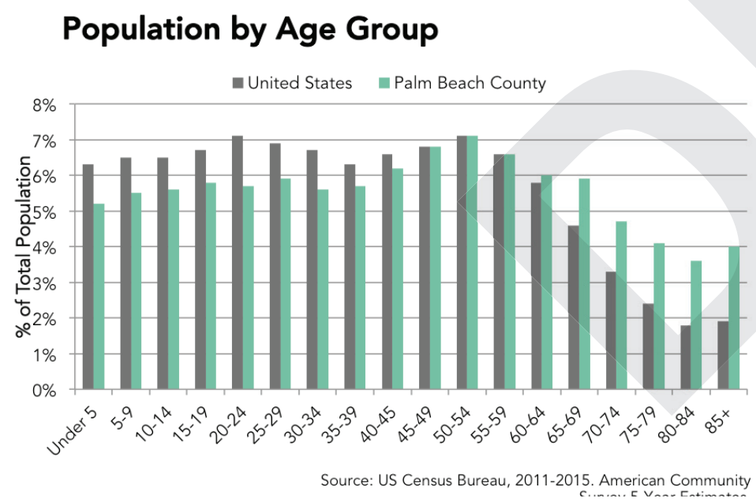


Figure 12: Palm Beach County and United States Population by Age

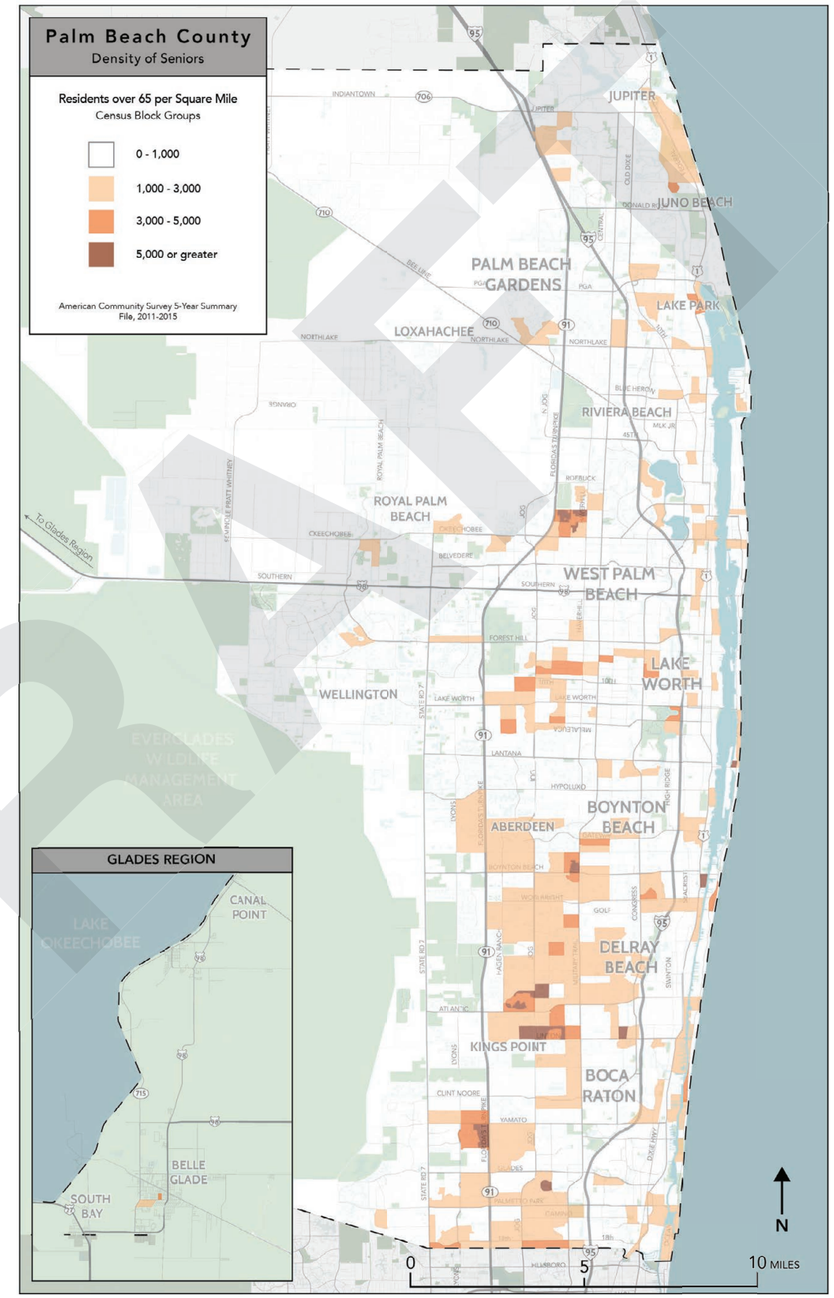


Figure 13: Palm Beach County Density of Seniors

3 Centers for Disease Control and Prevention National Health Interview Survey, 2015.

Zero-Vehicle Households

Not everybody has ready access to a personal automobile, and people who have less or no access must depend on other modes when they need to travel. This might include walking, cycling, getting a ride from a friend or family member, or, if it is reliable and available when they need to travel, transit.

The map in Figure 15 shows each census block group in Palm Beach County shaded by the density of households without a motor vehicle. In many cases, areas with few vehicles per household are also home to high densities of seniors (people over age 65); these two factors are very strongly correlated in Palm Beach County, as shown in Figure 14. The areas marked with black circles are where zero-vehicle household density is tightly matched with density of seniors, shown on the next page.

There are also areas with many zero-vehicle households that are not so clearly tied to the age demographics of their population. These include the inland area of Lake Worth and in Riviera Beach, where moderate densities of no-car households are found even in areas with low numbers of senior citizens.

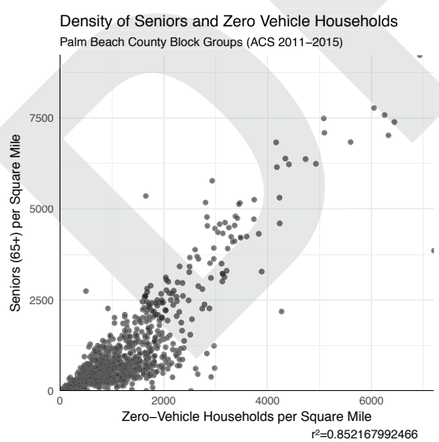


Figure 14: Zero-Vehicle Households vs. Seniors

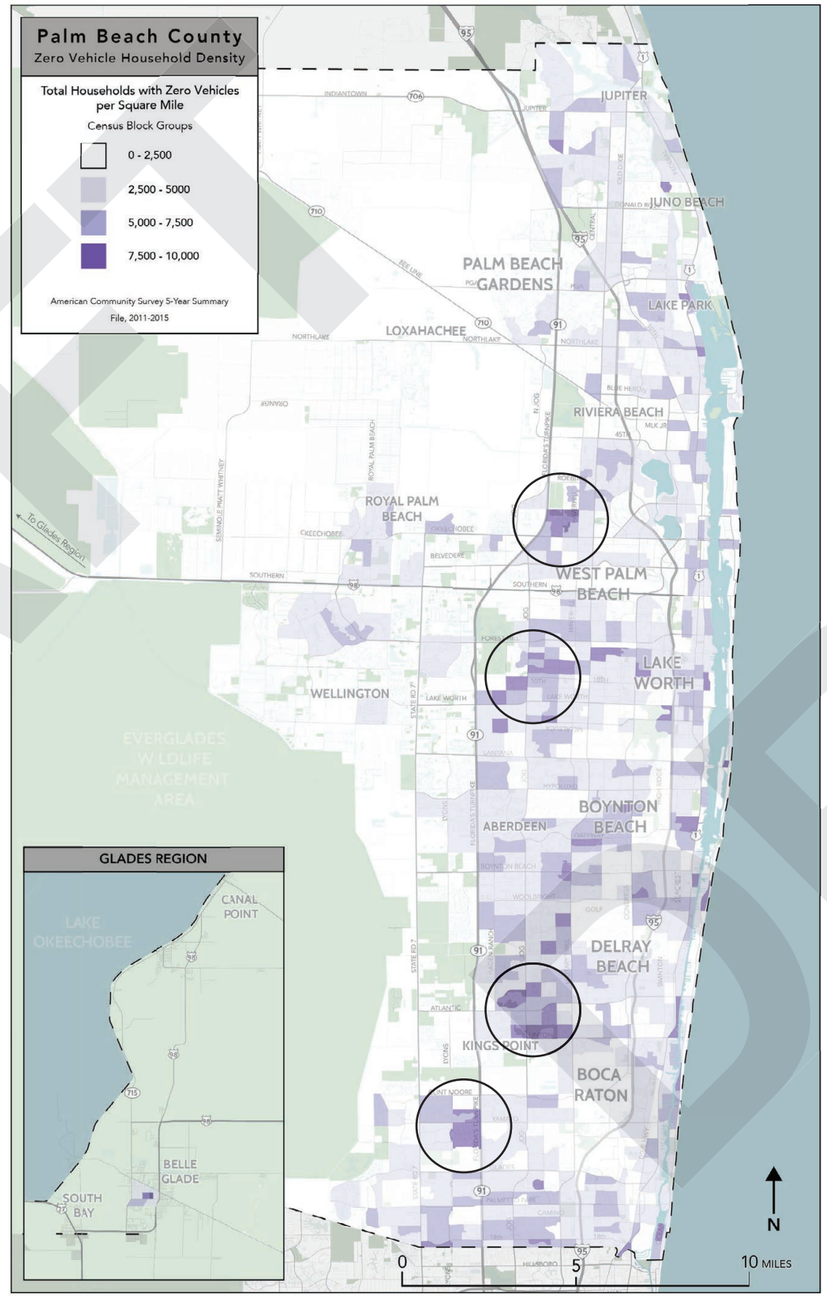


Figure 15: Palm Beach County Density of Zero-Vehicle Households

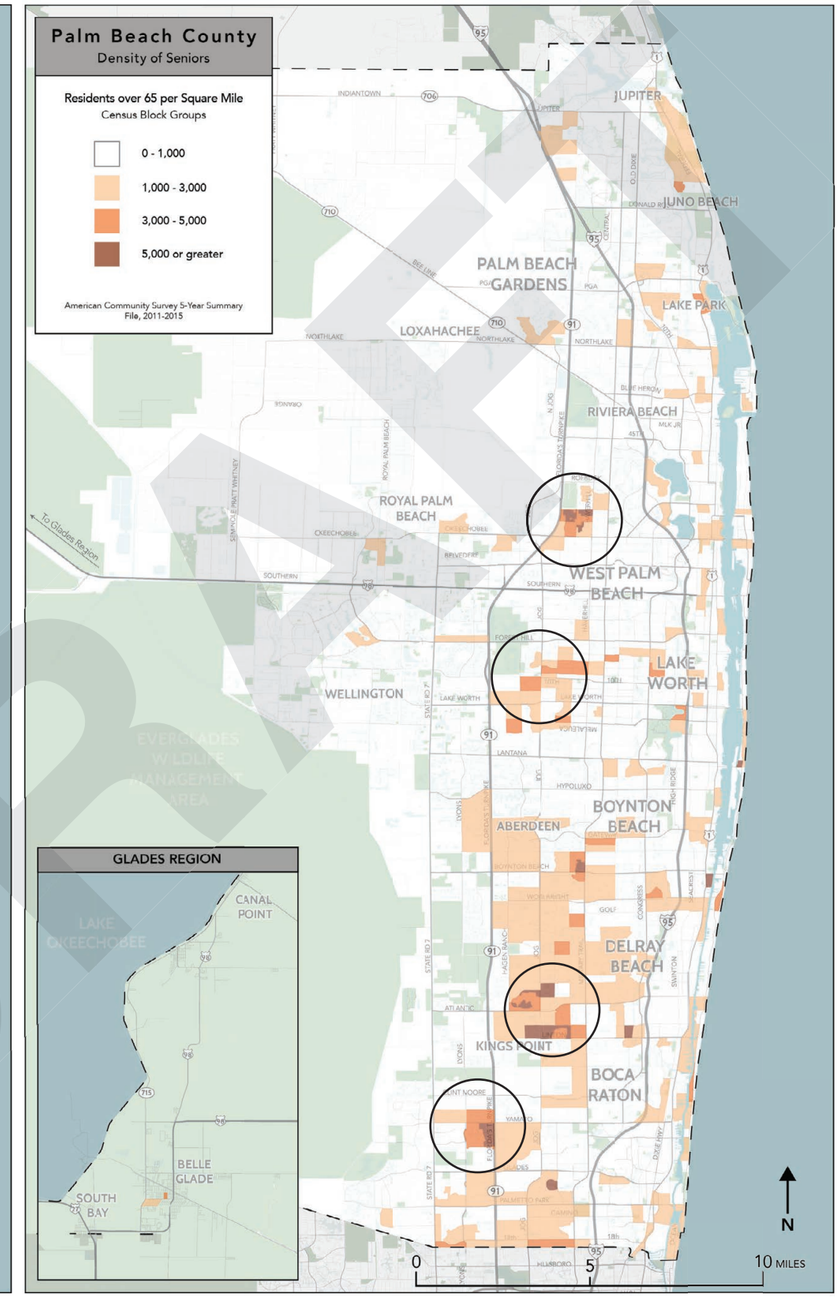


Figure 16: Palm Beach County Density of Seniors

People in Poverty

Transit is often tasked with providing affordable transportation for low-income people. Federal laws also protect peopel with low incomes from disparate transportation impacts, which can lead agencies to provide transit service in places where poverty is high even if it does not maximize ridership.

Serving low-income people can meet either a ridership goal or a coverage goal, depending on the built environment in which they live. When the key elements of the ridership recipe (above) are met, low income people tend to be strong drivers of high ridership. However, when low income people live in hard-to-reach areas, their low income does not usually generate enough demand to compensate for the cost of reaching them. In that case, serving them implies a coverage goal.

A common misconception is that transit, especially all-day transit, is only useful to low income people who cannot afford a car. This is a simplistic view on a complex matter. People at all points on the income spectrum make choices about how to travel, based on their personal evaluation of a set of factors including cost, travel time, safety and comfort.

It is certainly true that people with fewer resources have an incentive to spend less on transportation. The more carefully a person must manage their money, the more attractive transit's value proposition may be. However, this doesn't mean that lower-income people will automatically choose transit because it's the cheapest option. The service available to them must be useful and reliable for the kinds of trips they need to make. Nor does it mean that a person further up the income spectrum will not use the same transit services as low-income people, if they find those services sufficiently useful.

The map at right shows the density of people living in poverty in each Census Block Group in Palm Beach County. The largest concentrations of areas of high poverty density are found in the portion of the county from Boynton Beach north to Riviera Beach, focused on Lake Worth and southern West Palm Beach. This core area is very dense in general, compared to the service area as a whole. Walkability is uneven, but generally good in the older urban fabric east of I-95.

Key points of particularly high and extensive density of people in poverty include include:

- Throughout Lake Worth, Riviera Beach and West Palm Beach.
- Small areas within the central portions of Boynton Beach and Delray Beach.

These areas can be easily served by transit seeking to generate high ridership, either due to their surrounding density, or because they are on the way to important destinations. For example, the block groups within Boynton Beach near the Intracoastal Waterway are easy for transit to serve, because they are located along US-1, the primary transit corridor connecting the town centers of the County's various beachfront communities.

More difficult to serve are the single small zones of high poverty, due to the distance that must be traversed to reach them. For example, the pocket of high poverty density at State Route 7 and Sandalfoot Boulevard is far from other destinations in the county and is therefore naturally expensive to serve with transit even though the need is high.

Finally, Palm Beach County has few areas of truly isolated, rural poverty. The central town area of Belle Glade, in the Glades region at the western side of the service area, is the prime example within the service area. In order to reach this market, Palm Tran's Route 40 must travel a very long distance west through undeveloped land without any potential ridership. The result is low productivity, but it is providing an important social function, extending access to the transit system, and thus to all the opportunities available in the main urbanized portion of Palm Beach County. This is a classic example of a coverage service maintained despite low ridership because of critical access needs.

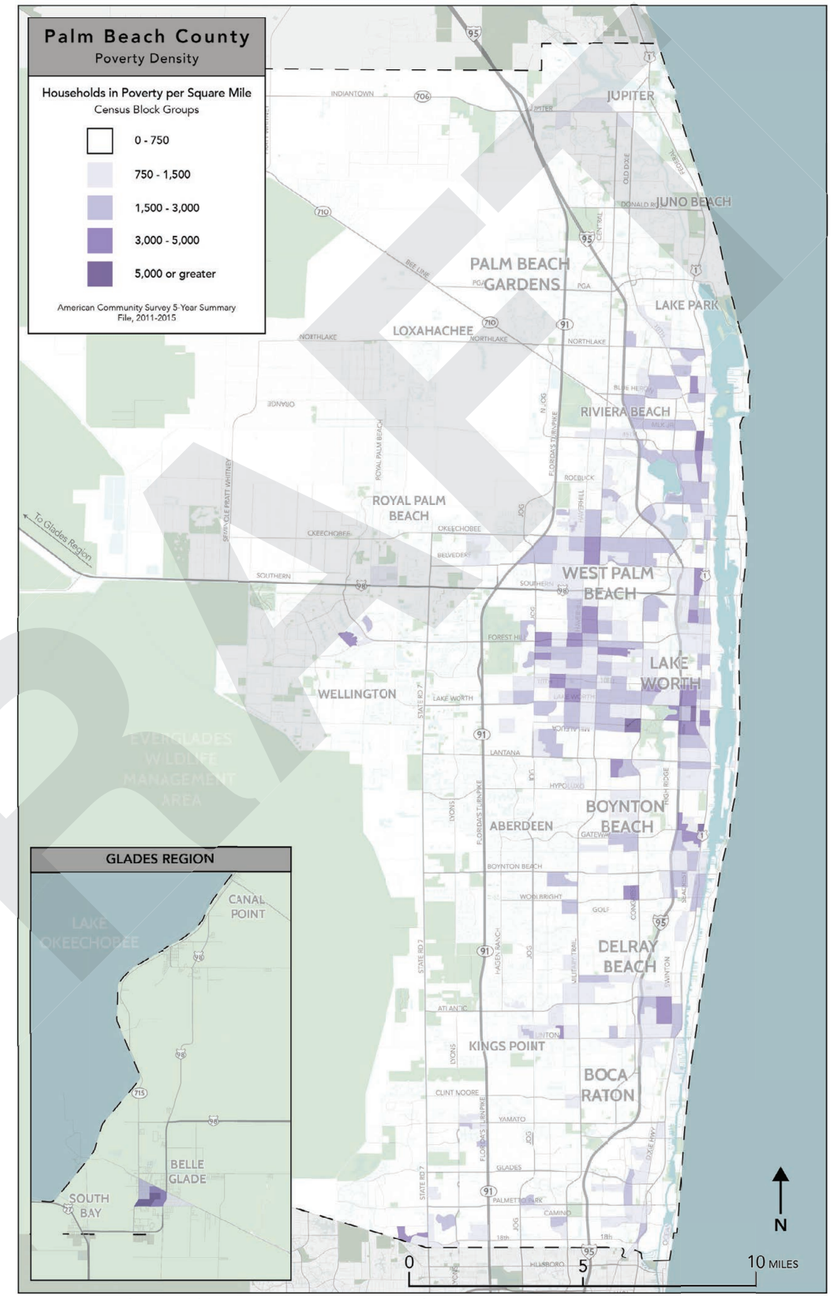


Figure 17: Palm Beach County Density of People in Poverty

Race and Ethnicity

Federal civil rights law protects people from discrimination in the provision of transit service on the basis of their race or ethnicity. It is important to understand where large numbers of non-white people live, so that service changes can be evaluated in light of impacts to those people.

While information about someone's income tells us something about their potential interest in riding transit, information about ethnicity or race do not (except to the extent that race or ethnicity correlate with income or density, and in certain cases they do). However, avoiding placing disproportionate burdens on non-white people through transportation decisions is essential to the civil rights dimension of the transit planning process.

The map at right shows where the 24.3% of Palm Beach County residents who are non-white reside and 20.4% who are Hispanic or Latino reside[4], using a technique called dot-density mapping. This map places a dot withing the boundaries of a block group for every 50 residents of one of five major race/ethinicity categories living in that area.

People of all races and ethnicities are present in all areas of the county. The highest concentration of African American and Hispanic residents is found within the generally dense central area of county including Boynton Beach, Lake Worth, West Palm Beach and Riviera Beach. Density of Hispanic and Latino people is focused on Lake Worth and West Palm Beach, while Riviera Beach, Boynton Beach and to a less extent Delray Beach have the block groups with the greatest concentrations of African Americans.

Again, we do not recommend that network planning differ based on race or ethnicity of the areas served. The purpose of this data is the opposite. It provides a basis for confirming that service remains equitable regardless of race or ethnicity.

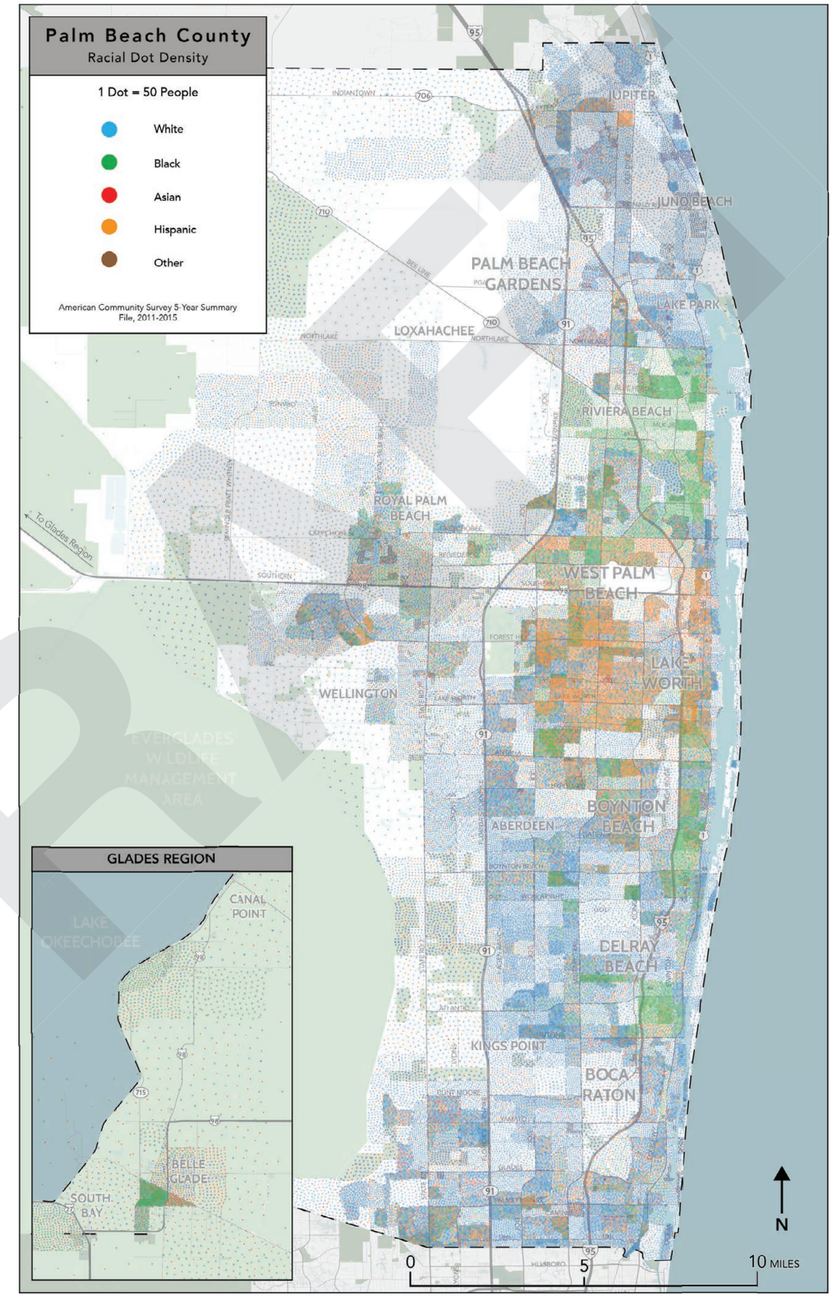


Figure 18: Palm Beach County Race and Ethnicity Dot Density Map

4 Source: U.S. Census Bureau, 2011-2015 American Community Survey 5-Year Estimates

3 Transit Service Analysis

Peer Analysis

For the performance of Palm Tran's entire network, and as an aide in thinking about Palm Tran's particular transit choices, it helps to compare the network to peers. Obviously no place precisely replicates Palm Tran's economic, demographic and geographic conditions, so a group of peers provides a range rather than a prescriptive target.

These comparisons illustrate a range of outcomes (in terms of ridership and productivity) that are the result of the particular choices each agency and its community have made, in the context of the particular characteristics of its service area.

We looked for peers that are broadly similar in population, service levels, and the mix of development types. Figure 19 shows the service area population of each of the peers examined in this analysis. Their populations range from just over 500,000 (Fresno, CA) to approximately 2 million (Orlando, FL). These agencies offer between 125,000 and 1.3 million annual fixed route revenue hours, and carry between 2.5 million and 38 million annual passenger trips. Agencies selected for this analysis include:

- Known Florida peers with service area of 1 to 2 million people (Orlando, Broward County, Jacksonville, Tampa)
- Transit agencies in service areas of more than 500,000 people operating a comparable number of fixed route revenue hours to Palm Tran (480,000 annual fixed route revenue hours) and/or carrying a comparable number of annual passenger trips (approximately 10 million unlinked passenger trips).

Information was drawn from the National Transit Database, for which the most recent available year for all peers is 2015.

Low Quantity of Service (Revenue Hours[5])

As shown in Figure 20, from 1996 to 2015, the number of annual revenue hours of service provided by Palm Tran has been remarkably stable at close to 400,000 hours, though it has increased recently to 480,000. Over the same period, many other peers have significantly increased service hours, though many had to cut service during the depths of the 2008 recession. Among comparable peer agencies, Palm Tran's service quantity per capita is the lowest of all the Florida peers, and among the lowest overall.

Palm Tran has mostly operated a stable quantity of service since its 1996 formation, while Palm Beach County has grown by more than 40% since that time. Thus, over time, the total amount of service per capita has declined. In practical terms, the same service quantity spread across more people implies challenges in providing service to newly developed areas, or improving high ridership routes, since those emerging needs are competing with the long-established services other people are already relying on.

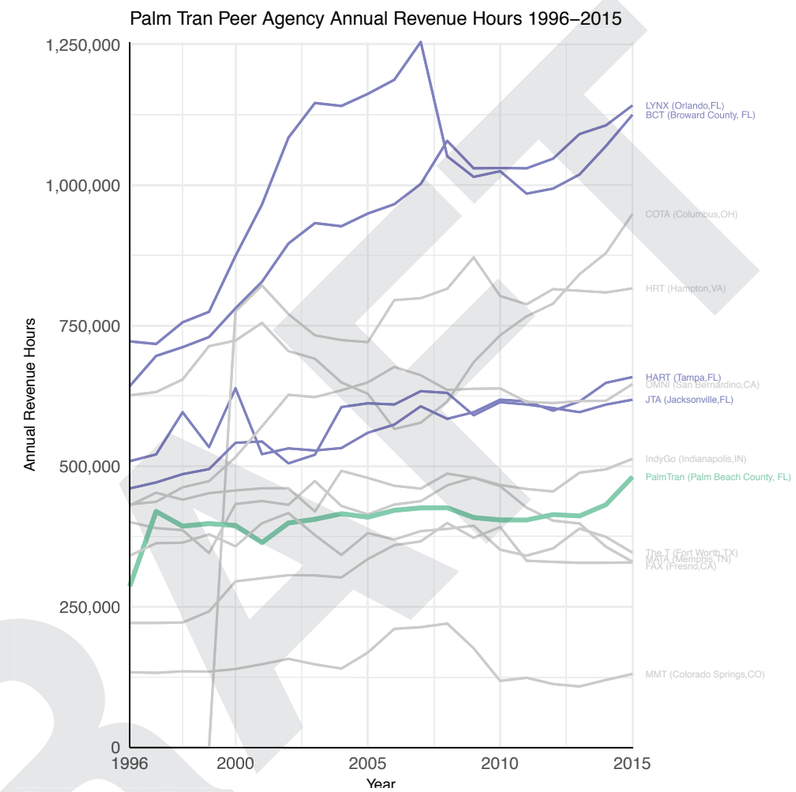


Figure 20: Palm Tran Peer Service Quantity (Revenue Hours) 1996-2015

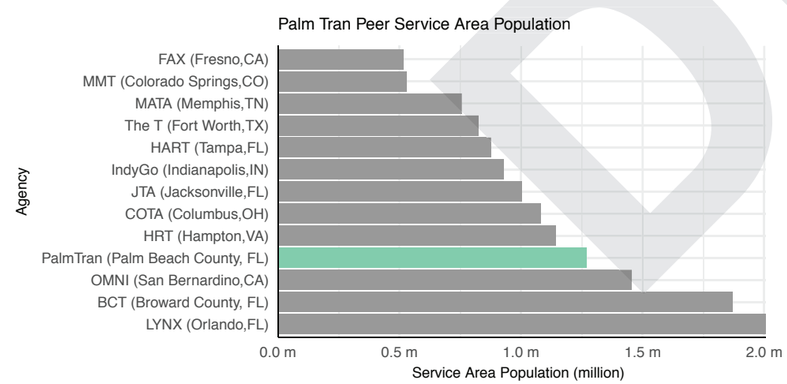


Figure 19: Palm Tran Peer Service Area Population

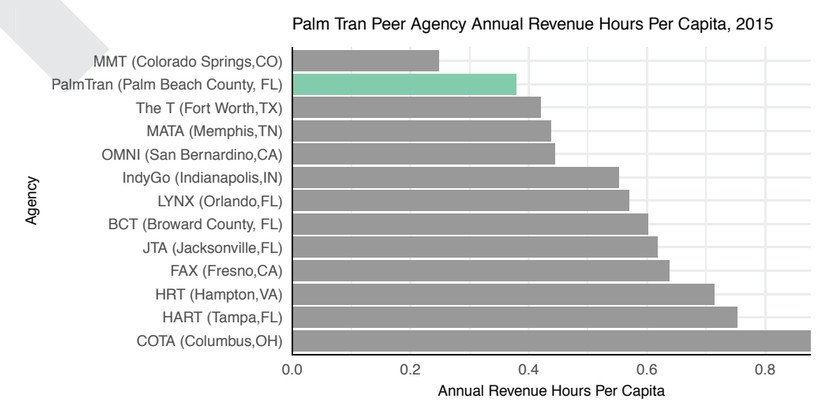


Figure 21: Palm Tran Peer Service Quantity (Revenue Hours) per Capita

5 A revenue hour is one bus operating in service for one hour.

Total Ridership

As with total service hours, the annual ridership on Palm Tran is lower than most peers. Ridership steadily increased from 1996 to 2013, with a small decline since 2013. Palm Tran has the lowest ridership among Florida peers.

Service Relevance (Ridership/Capita)

As with quantity of service, comparing ridership across agencies and regions requires examination of both absolute values and performance relative to the population of the region. When we examine transit ridership per capita, we refer to it as a measure of the relevance of the service, because a greater number of transit trips per capita means that a larger proportion of that region's travel is being executed through this mode.

The number of riders per capita is the third lowest among peer agencies. Thus, the relevance of transit to people in Palm Beach County is low compared to peer agencies. In comparing service hours per capita to riders per capita, there is a strong correlation between the two, suggesting that you get what you pay for in terms of the relevance of transit in the community.

Productivity (Ridership/Service Quantity)

In terms of productivity, Palm Tran ranks about the middle of the pack at about 22 riders per hour of service. Among Florida peers, Palm Trans ranks third. With relatively flat service hours and increasing ridership, productivity on the Palm Tran fixed route system increased sharply from 1996 to 2013, peaking at nearly 30 riders per hour of service. But with recent declines in ridership and increases in service hours, productivity has declined.

Ridership declines can happen for many reasons related and unrelated to transit service, such as changes in transit fares, gas prices, and local employment conditions. Since the price of oil began its decline in 2014, many agencies have observed drops in ridership as the price of driving diminished. While this is likely a factor for Palm Tran as well, decreasing ridership in the face of increasing service hours also sometimes suggests that recent investments in service may not be geared toward ridership focused service.

Palm Tran's low level of service per capita relative to these peer agencies is not an indication of any failure on the part of the agency, or its staff and leadership. Rather, it is the reflection of the different decisions that have been made in other places, where communities have chosen

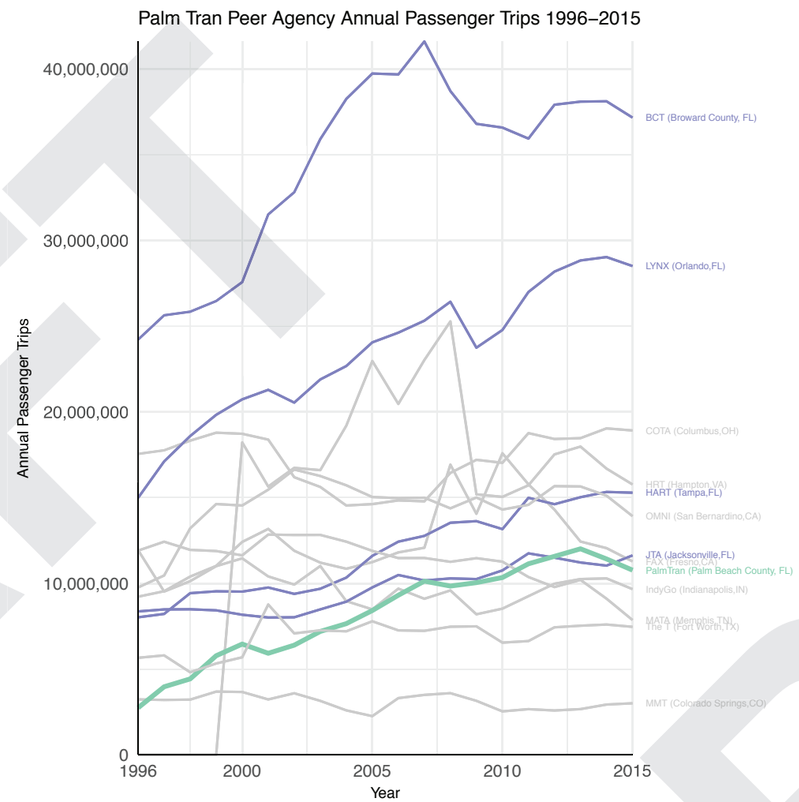


Figure 22: Palm Tran Peer Annual Passenger Trips, 1996-2015

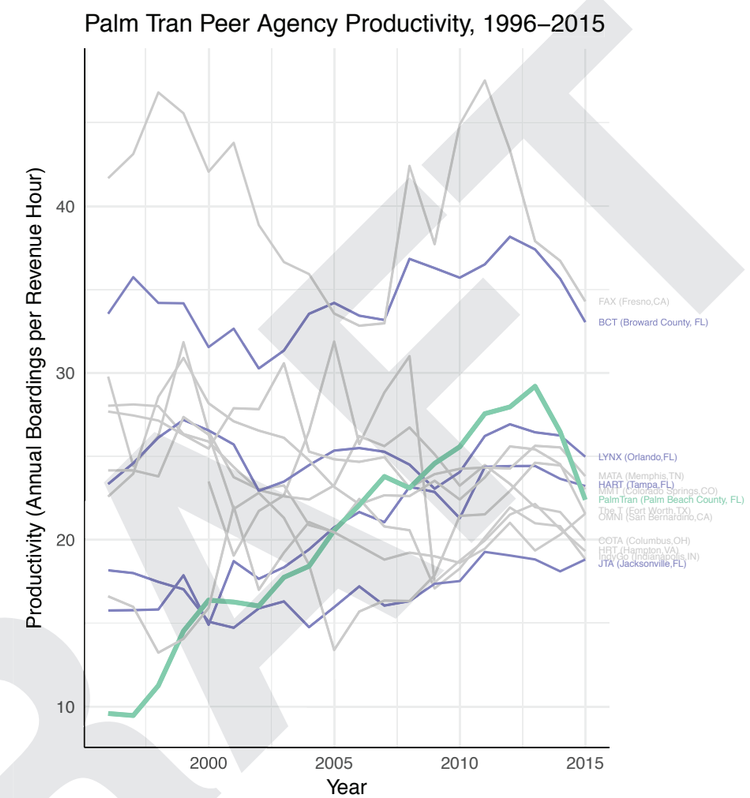


Figure 24: Palm Tran Peer Productivity, 1996-2015

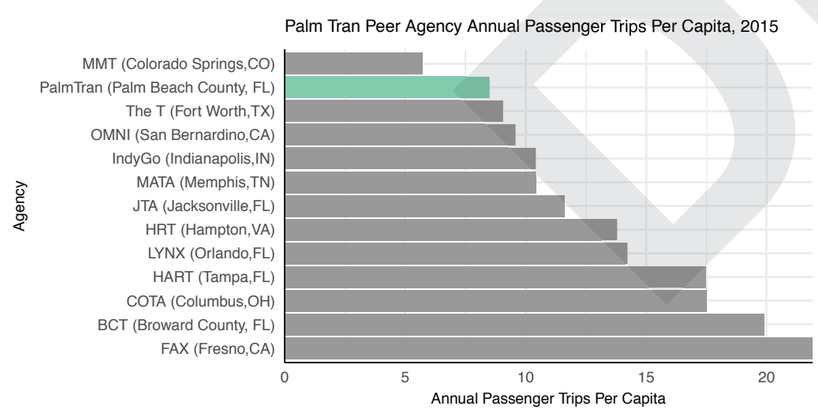


Figure 23: Palm Tran Peer Annual Boardings per Capita

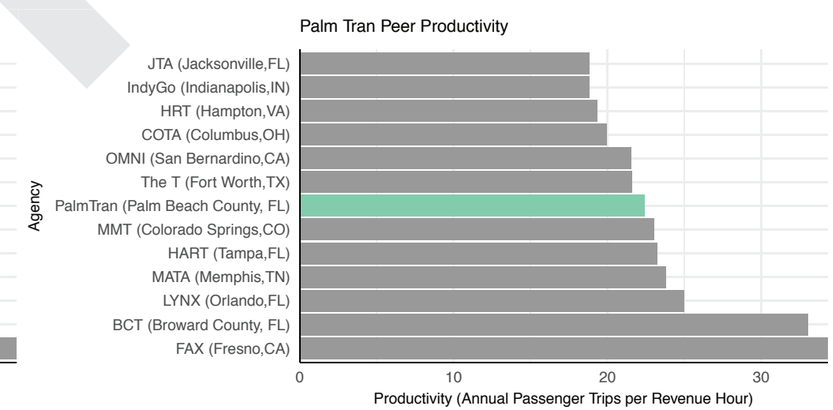


Figure 25: Palm Tran Peer Agency Productivity

to fund transit at a level that allows them to provide more service per capita. This is a choice that Palm Beach County could consider in the future, if its citizens and their elected leaders came to feel that a greater transit service level would be beneficial.

Frequency is Freedom

In transit conversations there is always a great focus on *where* transit is provided, but unfortunately little concern about *when* it is provided. The "when" of transit service is described as frequency (how many minutes between each bus) and span (how many hours a day, and days a week, it runs).

Low frequencies and short spans are one of the main ways that transit fails to be useful, because it means service is simply not there when the customer needs to travel.

Even though Google Maps or an app on a phone can be consulted for directions, frequent transit service is effective at attracting ridership because it has the simplicity of a road: you can use it anytime you need to. Frequent service allows someone to maintain a map of the transit system that is much like a road map, in that no schedule is needed to know how to go places whenever you want to.

Palm Tran currently offers three routes that operate at headawys close to this "no schedule needed" threshold. Routes 1, 62 and 94 come every 20 minutes for most of the day on weekdays (but only hourly or half-hourly on weekends). These three routes are shown in pink in the map on the next page.

Frequent service can be thought of as a cubed value, in that it has three independent benefits for the rider.

- Reduces waiting time (and thus overall travel time).
- Improves reliability for the customer, because if something happens to your bus, another one is always coming soon.
- Makes transit service more legible, by reducing the need to consult a schedule.

Many people assume that today, with real-time transit arrival information and smartphones, nobody needs to wait for a bus anymore, and frequency therefore doesn't matter. If a bus only comes once an hour, that's fine, because your phone will tell you when it is a few minutes away and you should start walking.

Despite all these new technologies, frequency still matters enormously, because:

- Waiting doesn't just happen at the start of your ride, *it also happens at the end*. You may not need to leave the house much before your departure, but if your bus is infrequent, you have to choose between being very early or too late.
- Many of the places we go don't let us hang out until our bus's arrival is imminent. We can easily do this when leaving home, but it is more awkward when leaving a restaurant or a workplace that is closing.
- Real-time arrival information doesn't make the bus more reliable, but frequency does. Your smartphone can tell you when your bus is arriving, but it cannot prevent your bus from having a problem and being severely delayed, or not showing up at all. Only frequency – which means that another bus is always coming soon – can offer this kind of reliability.

As explained throughout this chapter, from examination of Palm Tran's network, people in Palm Beach County are already responding tremendously to the relatively frequent services that are already in operation. Most of Palm Tran's busiest routes, and those that generate ridership most efficiently, are those routes that operate more often.

Palm Tran Network Frequency

Figure 26 displays Palm Tran's network in terms of its typical midday frequency. On this map, purple lines represent Palm Tran's most frequent services, operating every 20 minutes during the midday. Blue lines show routes that typically arrive every 30 minutes, green lines every 60 minutes. Dashed green lines show routes where frequencies are greater than every 60 minutes, or where a limited number of trips are available during the midday period. A larger version of this map is shown rotated on the next page.

As mentioned earlier, Palm Tran operates three routes at frequencies near the 15 minute frequent standard:

- Route 1 serves US-1 for most of the length of the County, from the Gardens shopping center in the north to the Camino Real transit center in Boca Raton in the south. It serves numerous important regional destinations, including the dense core areas along the intracoastal waterway of Riviera Beach, West Palm Beach and Lake Worth, as well as very continuous moderate density from Boynton Beach south. Route 1 is Palm Tran's longest, highest-ridership route. The corridor is also served by limited-stop Bolt trips in the morning and afternoon.
- Route 62 serves the dense residential area of central Lake Worth along the Lake Worth Road corridor. This is the most concentrated residential area in the County, and is also the portion of the service area with the largest concentration of people in poverty. Lake Worth Road passes directly through this very strong transit market, and as a result, Route 62 generates ridership very efficiently.
- Route 94 is a short feeder route from the Boca Raton Tri-Rail station through Florida Atlantic University's campus, turning around via 20th Street, US-1 and Glades Road in Boca Raton. FAU is a major regional destination, with tens of thousands of students and many more staff and faculty, and Tri-Rail is the region's major high-capacity transit line. Because the station and the campus are relatively close, the service connecting them must be convenient enough to be a compelling alternative.
  - Route 94 does not offer continuous 20 minute service throughout both peaks and the midday period; instead, its frequency is tailored to peaked Tri-Rail service and FAU travel demand, with 15 minute frequency from 6:00 am to 10:00 am, and 20 minute service from 1:00 pm until the last departure at 8:41 pm. During the "midday" period of 10:00 am to 1:00 pm, Route 94 runs every 40 minutes.

Apart from these routes, the rest of Palm Tran's network operates every 30 minutes, or less often. Among these routes, there is a wide diversity in levels of ridership and productivity (ridership per unit of cost), owing to both the variety in density across the service area, and because given its current resource level, Palm Tran has prioritized more frequent service on its key corridors.

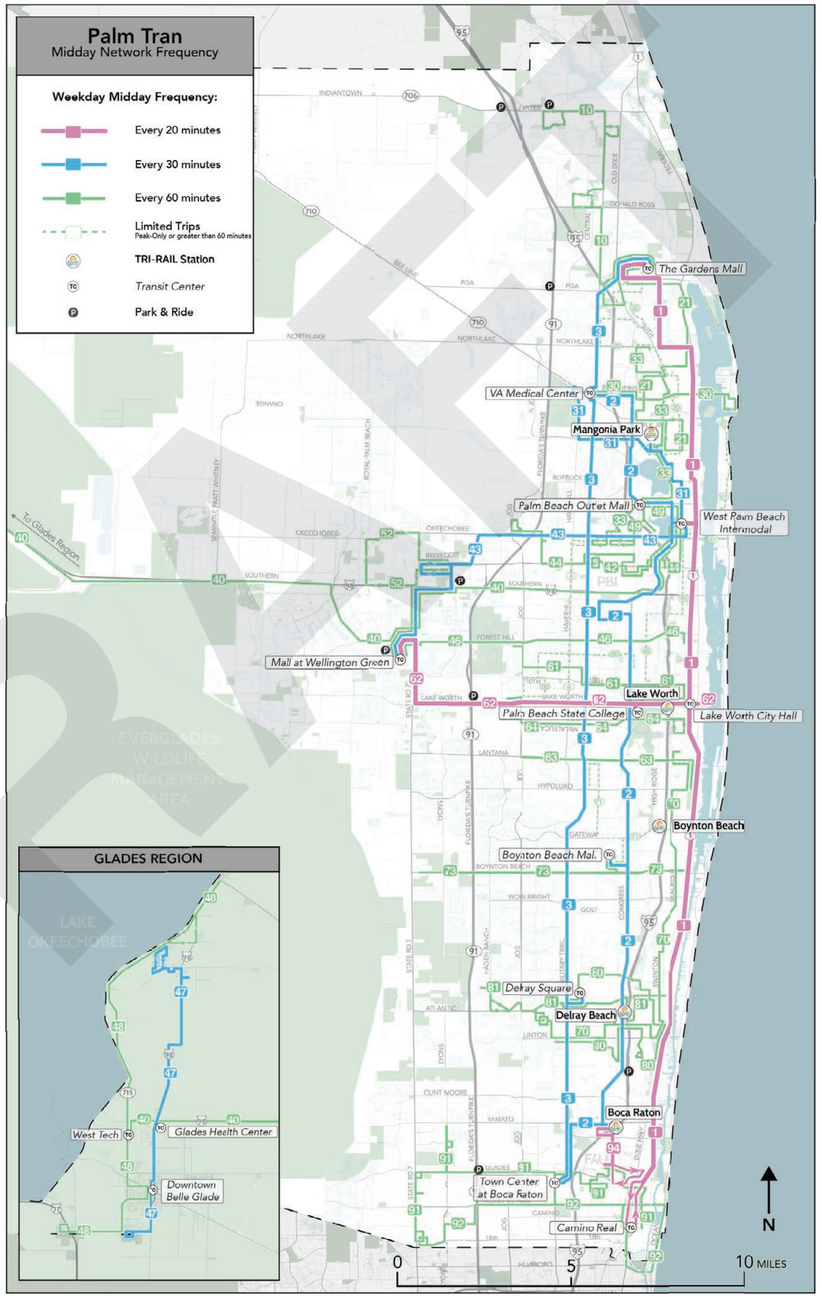


Figure 26: Palm Tran Midday Network Frequency

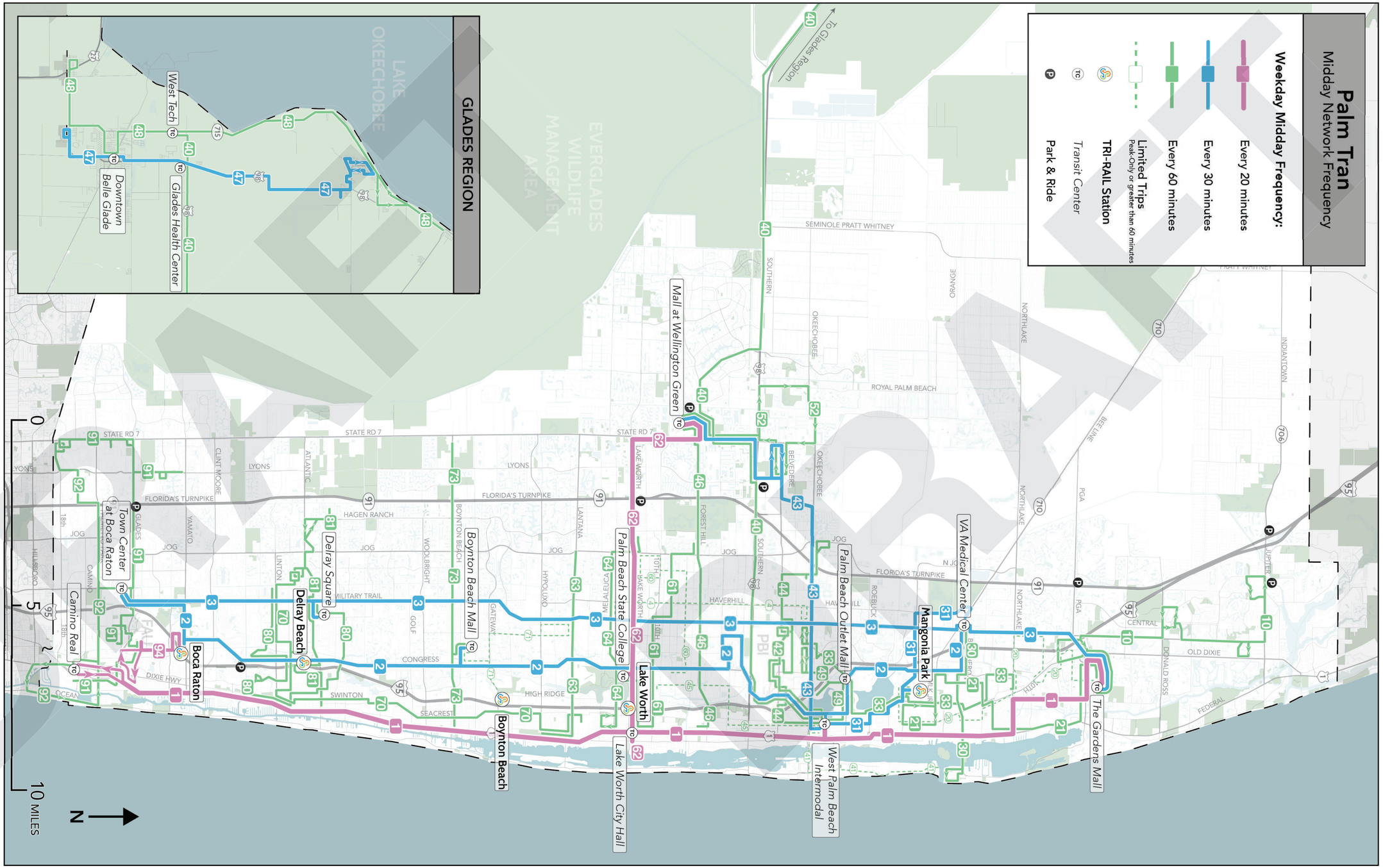


Figure 27: Palm Tran Midday Network Frequency (enlarged)

Span of Service

On weekdays, Palm Tran's service day begins between 5:00 am and 6:00 am, and concludes between 9:00 pm and 10:00 pm. Figure 28 shows the prevailing frequency of each of Palm Tran's routes during each hour that they are in service. Red bars represent 15 minute headways, purple 20 minute, blue 30 minute, and green 60 minute.

This chart provides a more detailed view of frequency than the map on the last page. We can observe the generally flat, continuous service level on routes 1 and 62, the main 20 minute routes, and on routes 2 and 3 running north-south across the county. The same is true for the 30 minute routes: none feature higher peak frequencies.

Among the remaining 60 minute routes, a few do "turn up" to 30 minute frequency during rush hours, including routes 30, 33, 44, 46, 48 and 70. The rest offer a flat 60 minute headway throughout the day.

Grey cells of this chart represent hours where frequencies are lower than 60 minutes, or where select trips at variable headways from trip-to-trip are present in the schedule.

Weekends

On weekends, Palm Tran's service level is much lower. As we can see from the chart, all routes save Route 1 operate only hourly, typically at reduced spans. On Sundays, a limited subset of the network is in operation, with most routes ending service between 4:00 pm and 6:00 pm.

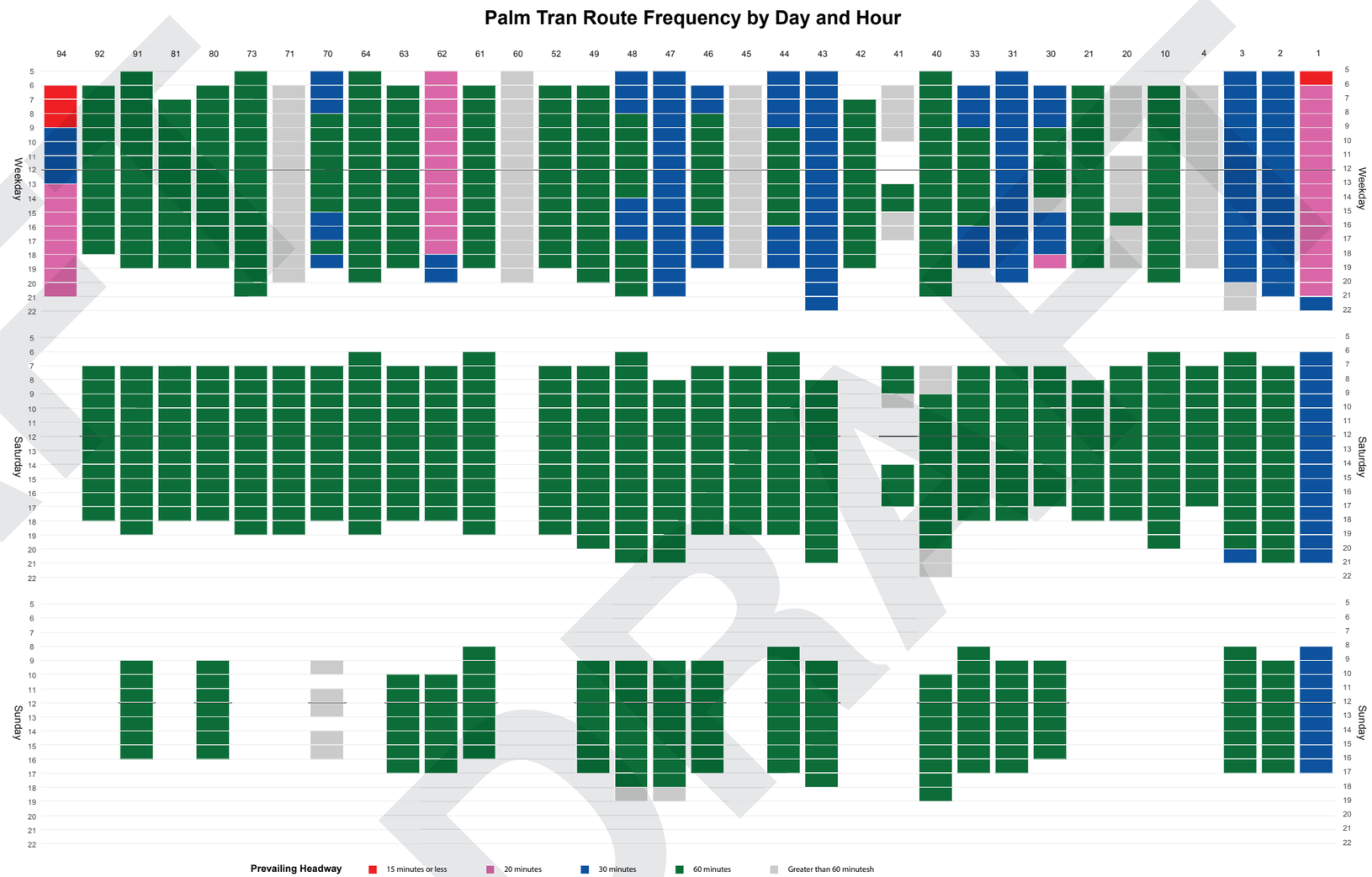


Figure 28: Palm Tran Route Frequency Table

Ridership

To get a high-level view of system ridership, Figure 29 shows the total average daily weekday boardings (from April 2017) at every stop in the network[6]. In this map, dots' sizes are scaled by their daily ridership.

The long corridors with the highest frequency (Lake Worth and US-1) immediately stand out, with generally consistent high ridership along most of their lengths except where there are long gaps in development.

Routes running every 30 minutes also show ridership patterns strongly related to density and walkability.

Palm Tran transit centers, where many bus routes connect, typically show up as single or collections of large dots, indicating the transfer activity between modes or routes at each. A similar pattern can also be detected at key on-street transfer points in the network, such as along Military Trail and Congress at the intersections with Lake Worth, Lantana, Boynton Beach, Atlantic, and Linton.

There are numerous important destinations or isolated dense areas served by transit that display very strong ridership at a particular location, but lower ridership on nearby route segments. These are often campuses of hospitals or educational institutions which have chosen to locate in places that are outside of the main continuously developed area of the County.

Some examples include:

- Bethesda Hospital and the Canyon Town Center, along Boynton Beach Boulevard between Lyons & State Road 7 (served by Route 73 and marked with an A in Figure 29). While this end of Lyons Road is mostly undeveloped (the area around the hospital is mostly made up of agricultural and light industrial uses), the hospital and shopping center are both destinations likely to be of interest to lots of people. This area poses a challenge for transit, because to reach these nodes, the bus route must traverse both the undeveloped outer segment of Boynton Beach Boulevard and the inner segments where denser residential and commercial areas are often physically separated from the sidewalk by walls, ditches, or both.
- Palms West Hospital, near the intersection of US-98 and Forest Hills Road, marked with a B on the ridership map. This hospital is located near the end of the continuous development pattern of the County.
- Century Village near Yamato & Lyons (served by Route 91), marked with a C, is an example of a place where a dense residential development pattern and a high density of seniors and households with zero vehicles is matched with strong ridership at its nearby stop. However, the surrounding area is quite low-density, and the route segments leading to the site it itself have relatively few boardings. As a result, ridership is generated from Century Village less efficiently than it would be if an identical property were located along a more heavily developed corridor on the way to important destinations, such as US-1.

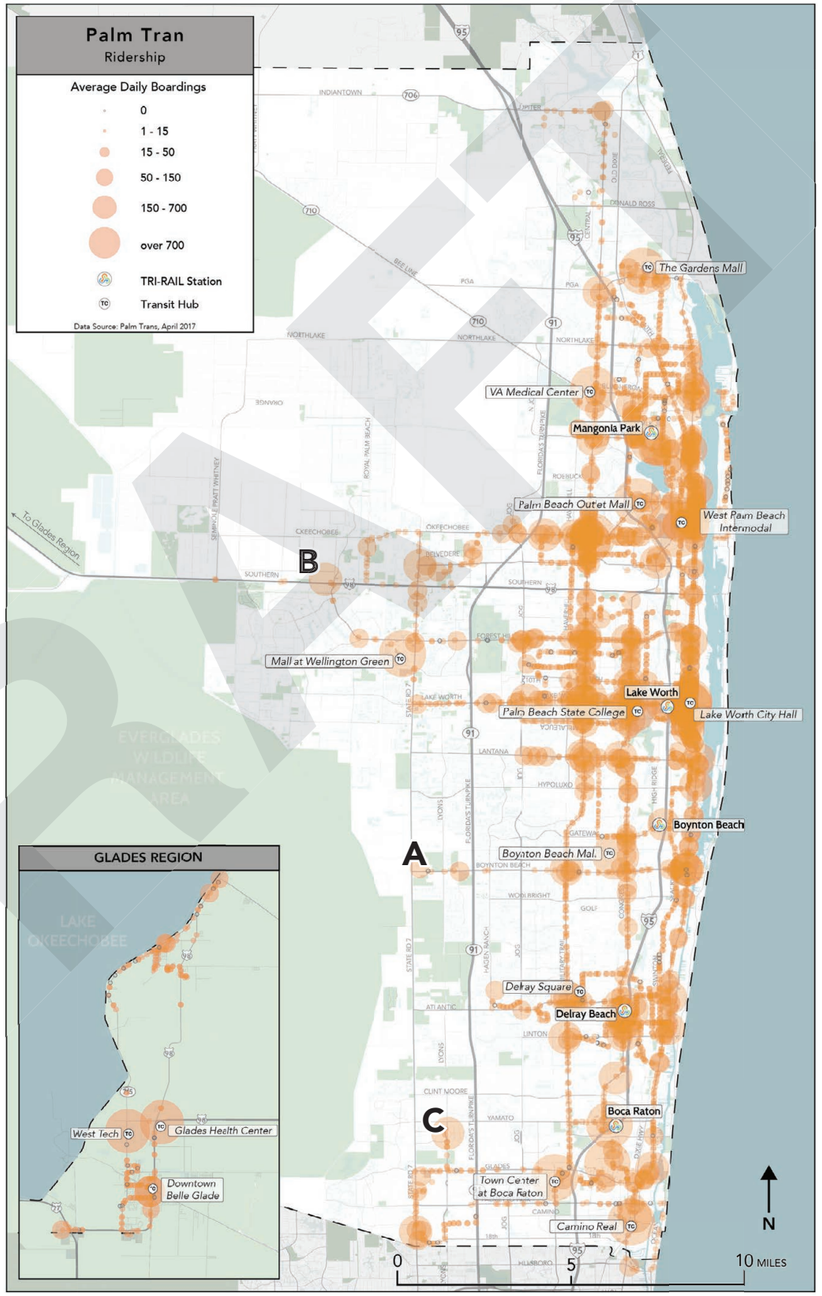


Figure 29: Palm Tran Average Daily Weekday Boardings

6 Where a route is served by two stops, their average daily boardings are summed.

Ridership and Service by Time of Day

In Palm Tran's network, as with many transit networks, ridership is strongest during the morning peak, when the school and work commutes occur simultaneously. Ridership then drops in the middle of the day, before rising again in mid-afternoon when schools let out.

While the 10am hour appears to show a major drop in ridership relative to service level, this appears to be an artifact of an event that effects the Automatic Passenger Counter system between 10:30 and 10:45 am each day. No similar issues are apparent at any other times during the day, but it is likely that ridership during the 10:00 am hour is somewhat higher that apparent from the chart on the this and the following pages.

The afternoon peak is less intense and longer than the morning peak, as people leave schools, universities and work at different times, and then spend the afternoon and evening embarking on multiple trips to socialize, complete various errands, and return home.

While Palm Tran's ridership and service provision certainly has peaks in these periods, peak period ridership is not the overwhelming driver of demand seen in some cities, particularly those where traditional 9-to-5 employers are densely clustered in a downtown core. The average AM peak hour ridership (here from 7:00 am until 10:00 am) is 16% higher than the noon hour. The average PM peak hour ridership is approximately 24% higher[7].

This pattern expresses itself very clearly in daily ridership on Palm Tran, as is shown in Figure 30. This chart shows the boardings and level of service in terms of trip starts for each of the day, relative to the average number of boardings and number of scheduled trips for the noon hour from 12:00 pm to 1:00 pm.

Throughout the midday, Palm Tran continues to be useful for all sorts of trips, whether to jobs that start and end outside of the rush hours, for shopping trips or other errands, or for all of the other daily needs that might draw someone to chose to make a trip on transit. One important aspect of this is the service design- Palm Tran's busiest routes' frequencies have been designed to be consistent throughout the peak and midday. This means that routes like Route 1, 62, 43 or 3 offer a consistent wait time and level of convenience all day long (apart from delay related to rush hour congestion).

In considering this graph it is important to note that service that is offered only for the peak period is often more expensive to operate, because (a) the short shifts required are inefficient and (b) fleet must be owned and maintained that is used only briefly. It is common, therefore, for agencies to design service to a higher tolerance for crowding during the peaks, which corresponds to allowing the boardings line in Figure 30 to go well above the service line. The fact that this does not occur at Palm Tran suggests the possibility that the service could be more concentrated on peaks than is ideal.

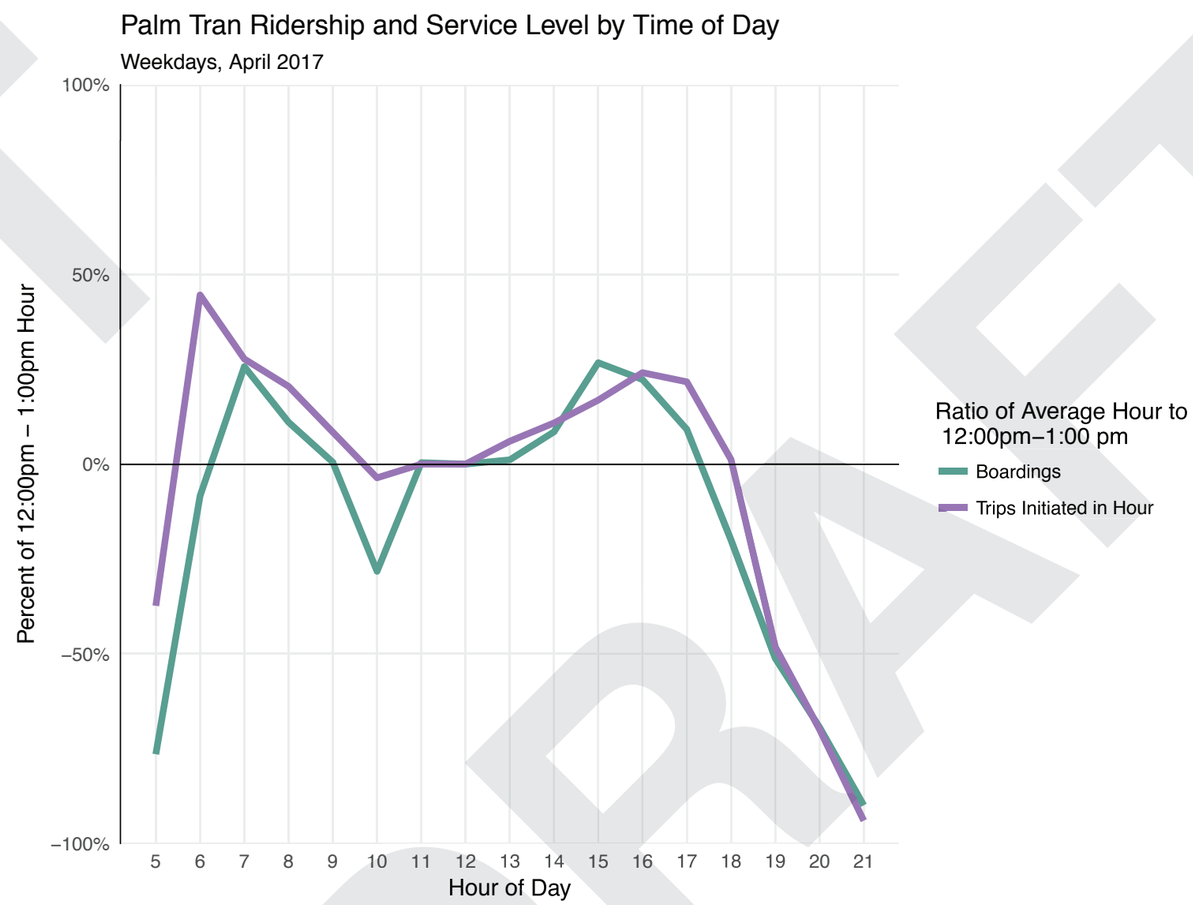


Figure 30: Palm Tran Ridership and Level of Service (Trip Starts) by Time of Day

7 The 3:00 pm - 4:00 pm hour is typically the highest ridership hour of the day for US transit systems, since it is the period during when most high schools conclude classes each day.

The peaking of individual routes is quite variable[8]. Routes like Route 70 or Route 30, which offer the customer a greater level of frequency and convenience during the peaks often have a greater level of peak ridership (and thus, a greater level of peak service is necessary to accommodate that demand).

Route 62, where service is consistent throughout the day, show a moderately peaked pattern close to that of the network as a whole. By contrast, Route 61 has flat hourly service all day long; ridership is consistent across the midday an peak periods.

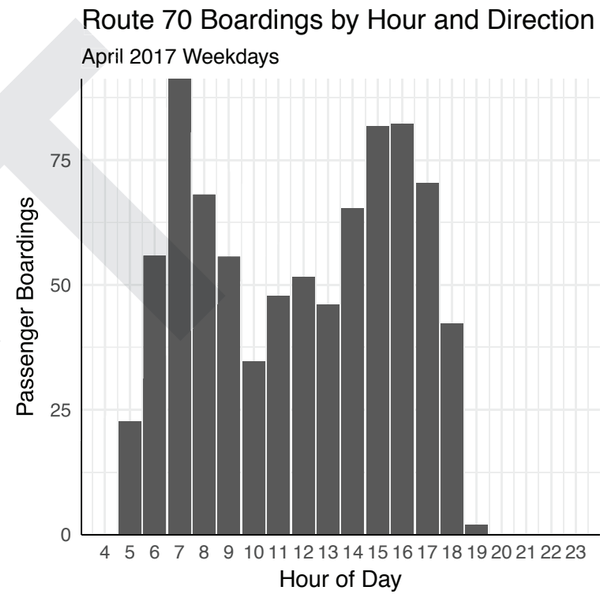


Figure 31: Palm Tran Weekday Ridership by Hour

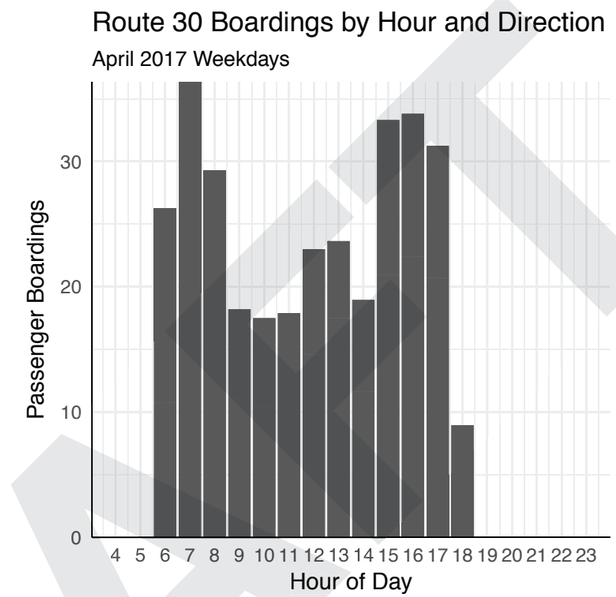


Figure 32: Route 30 Ridership by Hour

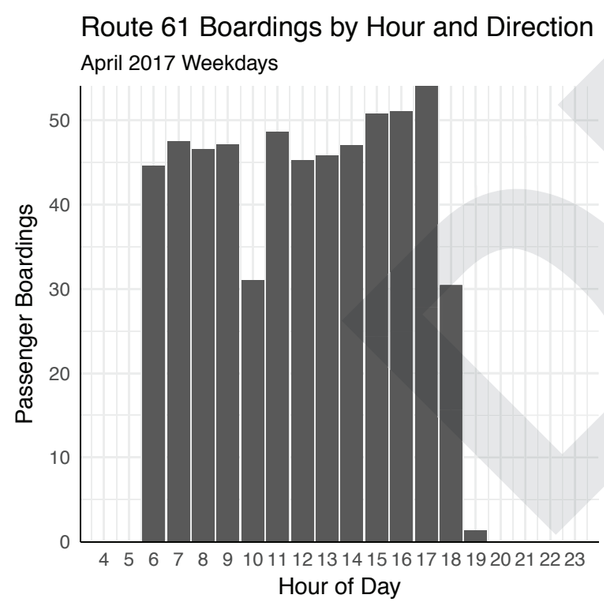


Figure 34: Route 61 Ridership by Hour

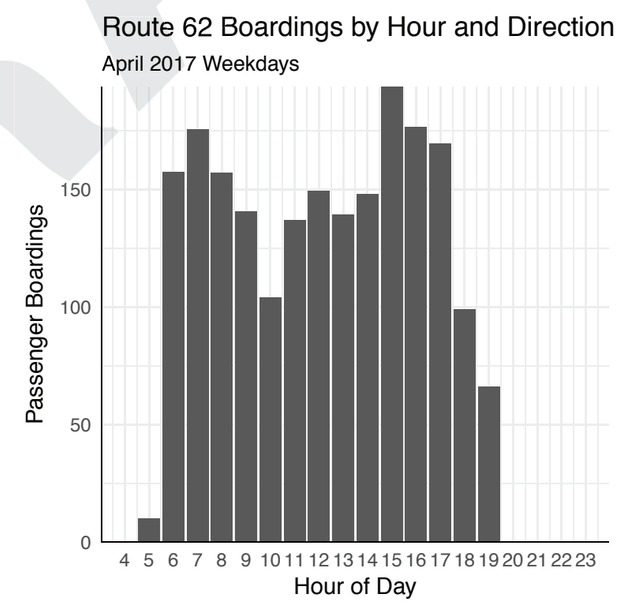


Figure 33: Route 62 Ridership by Hour

8 Again, an event within the APC system makes the ridership within the 10:00 am hour appear lower than it likely is.

Frequency and Productivity

Implicit in any goal to increase ridership, or to achieve other outcomes that depend on increased ridership, is a constraint: there is a limited amount of funding available in any year. Palm Tran cannot spend infinite amounts of money in pursuit of each additional rider; thus, in order to achieve higher ridership, opportunities to improve or expand service must do so efficiently.

Any goal that relates to higher ridership, then, actually arises from higher ridership *relative to cost*. If a transit agency wants to increase ridership within a fixed budget, it will examine where (or when) in its network ridership relative to cost is already high, and consider reallocating service to those routes or those times.[9]

Because no transit agency has a limitless budget, someone who cares about maximizing ridership would not be satisfied simply by a large dot on the boardings map shown earlier in this report until they knew how much service was offered to achieve that large dot.

In this report, productivity is measured as boardings per revenue hour or service hour.

Productivity = Boardings / Service hour

Productivity is strictly a measure of efficiency in achieving a ridership goal. Services that are designed for coverage goals will likely have low productivity. This does not mean that these services are failing or that the transit agency should discontinue them, because they may be succeeding at delivering a basic level of transit service to a large area or number of people. It just means that the budget dedicated to those services is not being spent to maximize ridership.

The scatterplot shown in Figure 36 presents one way to visualize productivity by route. Each route is plotted based on its midday frequency (on the horizontal axis) and its productivity (on the vertical axis). In this chart, productivity is calculated in terms of boardings per revenue hour, where revenue hours include both pure revenue run time (when the route is driving between its start and end points, picking up passengers), and

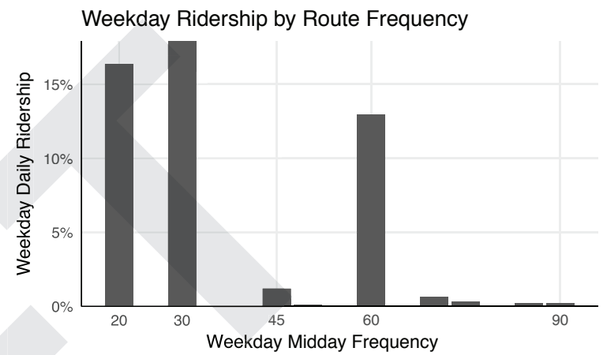


Figure 35: Palm Tran Route Productivity by Midday Weekday Frequency

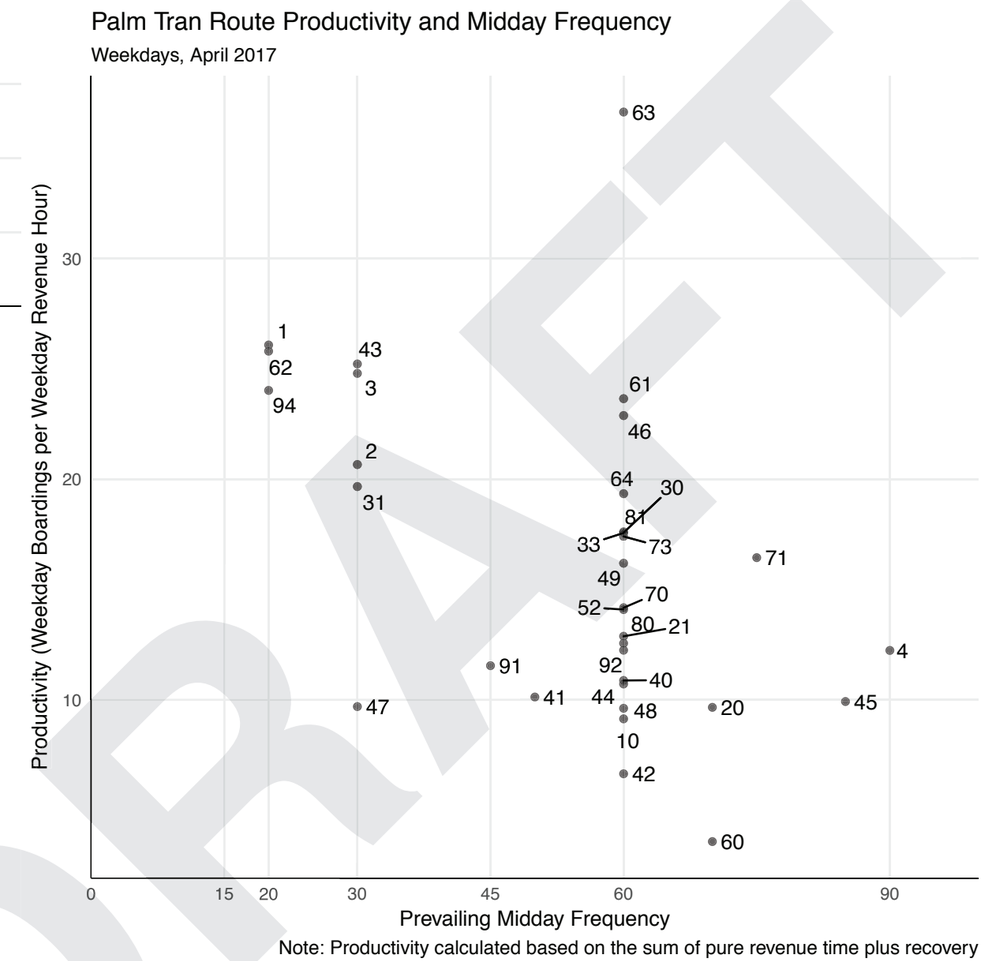


Figure 36: Palm Tran Route Productivity by Midday Weekday Frequency

High Frequency, High Productivity

The most frequent routes (1 and 62, and 94) are among the most productive. This means not only that they are getting more ridership, but that they are getting more ridership *relative to their cost*. As we can see from Figure 35, Palm Tran's limited set of 20 minute routes make up almost as much of total daily ridership as the entire 30 minute network, and more than all routes operating at hour frequencies. This is an indication of how effective frequent services can be at drawing high ridership when they are targeted towards markets where walking is possible, density is high, and destinations are close together and don't require undue deviation.

High Productivity at Low Frequency

Generally, routes operating at lower frequencies are less productive than the 20 minute routes. However, there are a number of important outliers achieving very high productivity at low frequency. While lower frequency routes are less convenient for the rider, because they require more waiting time, an infrequent route serving a strong market without excess deviation or duplication can still achieve high ridership relative to cost. This is typically an indication of the strength of the market and the presence of favorable geometric conditions. This is also a good marker of places that may yield high productivity at a higher service level by attracting more ridership.

In the 30 minute category, Route 43, which connects West Palm Beach Intermodal TC to the Mall at Wellington Green, is nearly as productive as Route 62, the most productive 20 minute route. The two routes serve a similar market (connecting dense, mixed use areas along the Intracoastal waterway into the dense residential areas west of Lake Worth and West Palm Beach), and terminate at similarly important anchor destinations.

Route 3 in the 30 minute category is another highly productive infrequent route. Like the Route 1, which it parallels, Route 3 provides service north-south across much of Palm Beach County along a relatively continuously developed corridor (Military Trail). While Military Trail is not as dense along most of its length as US-1, Route 3 does cut directly through the dense, relatively walkable area of Lake Worth, Palm Tran's strongest market based on the performance of other routes serving it.

Several 60 minute routes serving the dense central area of Lake Worth

9 There are other ways to increase ridership within a fixed budget. Agencies can also increase ridership by improving the design of their routes or the network as a whole, so that trips become faster and easier for a large number of people; by shifting service to days and times when it attracts more riders; or by working with partner agencies to create disincentives to driving.

and West Palm Beach are among the most productive in the network. These include routes 46, 61 and 64, on Forest Hill, 10th and Malealuca, respectively.

Each of these routes offers a similar set of movements to the very successful Route 62, connecting dense residential areas in central Lake Worth or along the shoreline to transfer points to North-South routes like routes 1,2 or 3, as well as commercial nodes at Wellington Green, Jog & Forest Hill, and Jog & Lake Worth. While these routes may appear closely spaced when drawn on a map of the entire County, these key corridors are each about 0.8 miles apart, which means that the midpoint between each route is about 0.4 miles. Thus, the walkable coverage area in between each route does not generally overlap, since most people are willing to walk about 0.25 to 0.5 miles reach a bus stop.

Low-Productivity Outliers

On the other hand, routes that are currently not producing ridership very efficiently can also teach us some important lessons about Palm Tran's network. Once again, productivity is a metric of how well a route is serving a goal of generating high ridership, but not all routes are designed to achieve this goal. A route can score low on productivity and still be very successfully delivering coverage service, extending some access to the transit system to people located in very low-density or hard to serve locations.

Route 47 Average Weekday Boardings by Stop

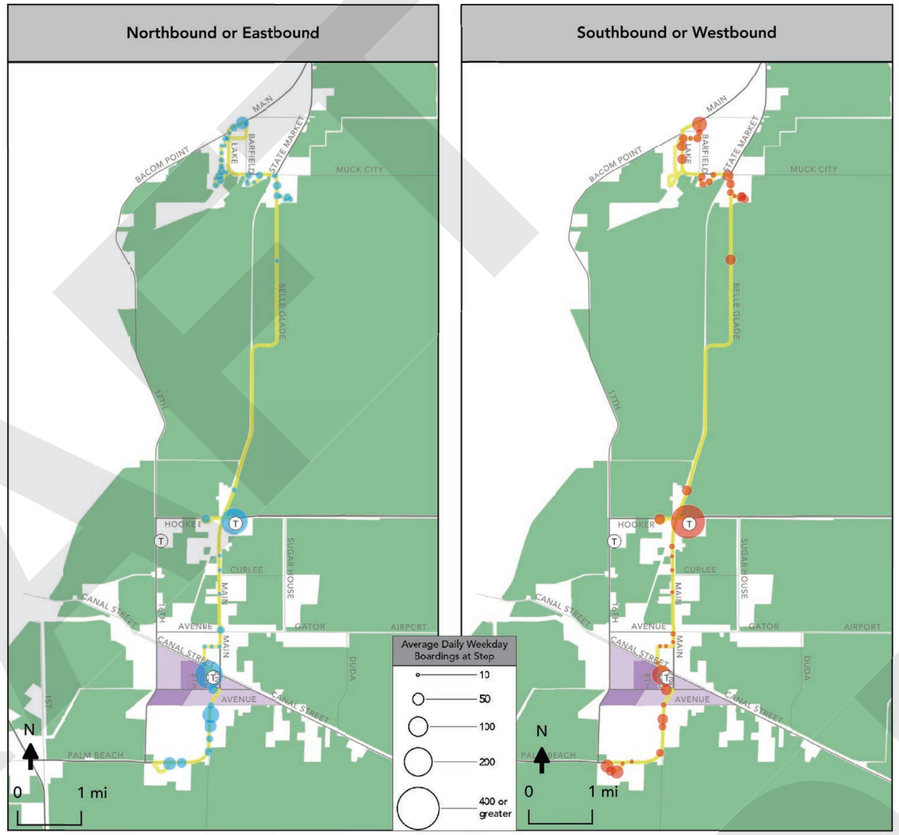


Figure 37: Palm Tran Route 47 Average Weekday Boardings by Stop

Route 42 Average Weekday Boardings by Stop

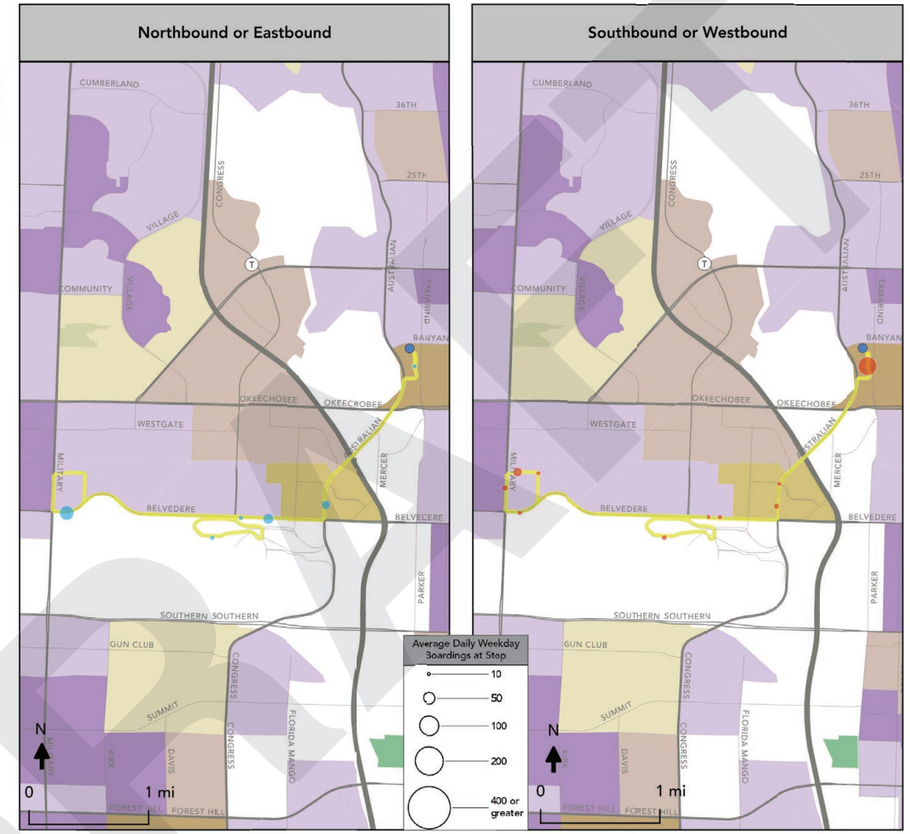


Figure 38: Palm Tran Route 42 Average Weekday Boardings by Stop

Route 47, a 30 minute route connecting the rural towns along Lake Okeechobee, registers a productivity of just 11 boardings per revenue hour. While around 600 people ride the route on an average weekday, comparable with more productive urban routes like Route 33, several factors account for its low productivity: first, Route 47 must traverse a great deal of agricultural land in order to connect its main markets in Belle Glade and in Pahokee. In the terms described in the "Ridership Recipe" earlier in this report, its markets lack a high degree of proximity. Time spent driving through farmland in revenue service is time where few or no people are boarding the bus. Second, its 30 minute headway and longer span increase cost as well, though these factors also increase utility.

Route 42 in West Palm Beach is a very short 60 minute service that connects West Palm Beach Intermodal Transit Center to Palm Beach International Airport, and to the commercial node at the intersection of Belvedere Road & Military Trail. These are important destinations likely to be of interest to many people, so why isn't the route achieving high productivity? In this case, the contributing factors are mainly related to the overall network design of the area:

- Short trips tend to be more attractive to customers at higher frequencies, since they are more competitive with walking or fast but costly ridesharing options.
- Route 42 provides a service that in many respects is duplicative of Route 44, which operates on many of the same segments, but over a longer span, with higher frequency during the peak periods. While Route 44 takes a longer path between the Intermodal Transit Center and the airport, this routing also reaches potential destinations and residential neighborhoods, both in the vicinity of the airport and along its routing to the west towards its western anchor at the commercial and government node near Okeechobee and Jog Road. As a result, Route 44 is likely more useful to more people. The routing of Route 42 is about 15 minutes faster than that of Route 44, but both are operating at very low frequencies, ensuring wait times that few travelers, who are typically keeping to a schedule, will want to endure.

A Common Relationship

In examining transit systems in cities around the U.S., we have often found a positive relationship between frequency and productivity of transit routes similar to the relationship observed in Palm Tran's network.

The chart in Figure 39 at right shows the individual routes from 24 U.S. transit networks, each plotted according to their midday frequency (on the horizontal axis) and their productivity (on the vertical axis).[10] Palm Tran's routes' midday frequencies and productivity (the data shown in Figure 36 on page 28) are overlaid.

Among all of the routes in this chart, there is a clear curve detectable, up and to the left. More frequent services tend to have higher productivity (ridership per service hour), even though providing high frequency requires spending *more* service hours. More frequent service is more useful because it reduces waiting times and the penalty for missing a trip; as a result, transit agencies typically orient this most expensive type of service to their best markets, resulting in high productivity.

While a higher frequency increases the denominator of the productivity ratio, if the service is targeting a dense, multi-use market, the higher ridership can more than makes up for it.

This is how we know that high frequency contributes to high ridership, rather than simply representing a responsive transit agency that raises frequency where ridership is high. If higher frequencies were not causing higher ridership, then the dots on this chart would be a flat horizontal cloud, instead of a curve upward to the left. When a transit agency increased the frequency on a route, its ridership would increase proportionally, and *its productivity would remain unchanged.* Instead, higher frequencies are associated with *higher* productivities.

This happens because frequent service is the most useful and convenient service for riders; thus, transit agencies typically target this most expensive service towards their strongest markets. When frequent service is available to people in a suitably dense, walkable environment, high ridership is a common result.

Palm Tran's low-frequency routes show a very wide band of productivity, which is not unusual. Transit agencies operate under financial constraints, so in many cases, promising markets cannot be served at high frequency without impacts to other portions of the network.

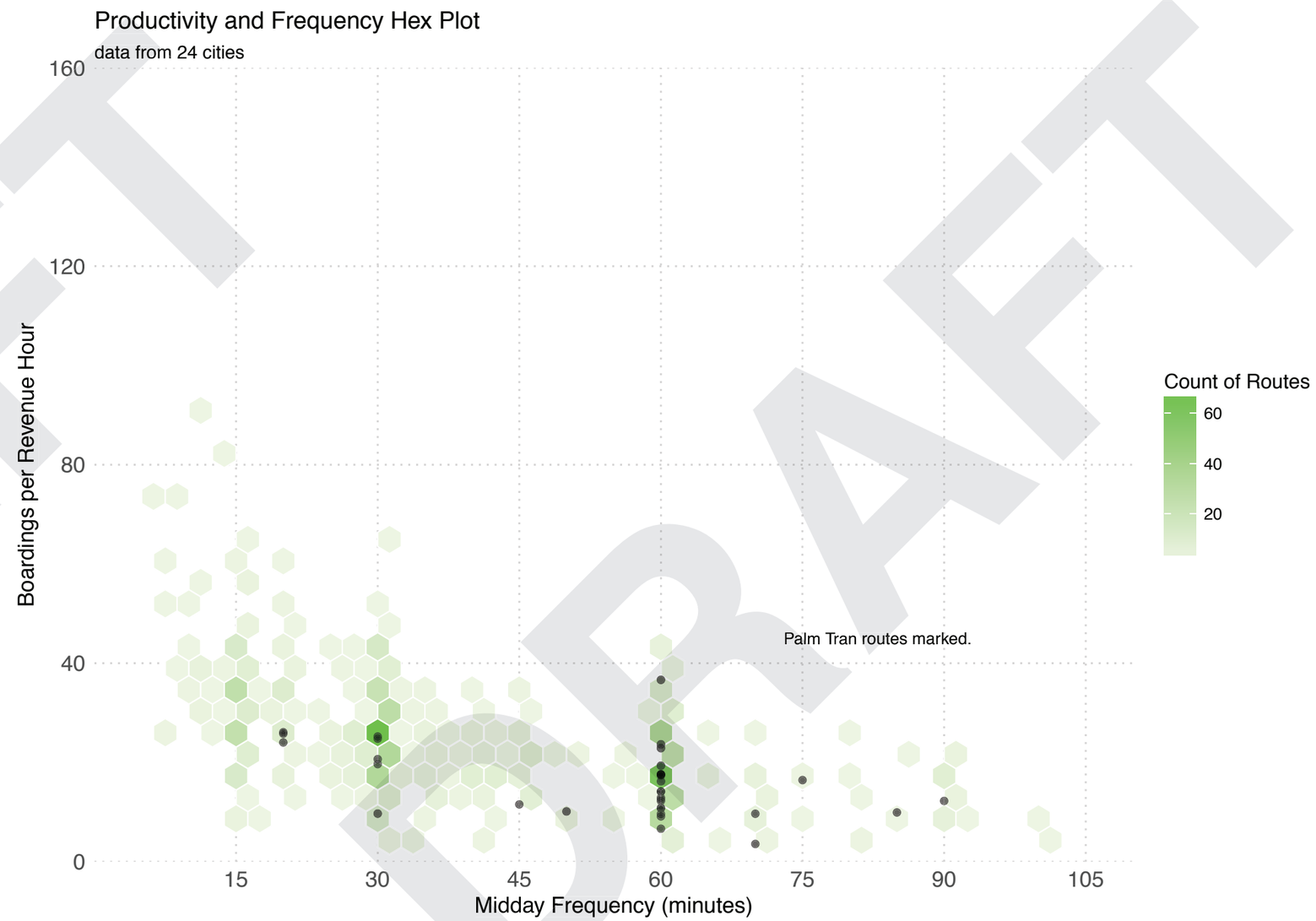


Figure 39: Frequency and Productivity: Data from 24 Cities

10 In each space of the chart, routes occupying the same area are "binned" together into hexagons, which are then shaded based on how many routes they contain.

System Coverage and Frequent Network Reach

Examining productivity gives us a sense of how well each route in the network is doing at generating ridership efficiently. To understand how well the system is performing at meeting the coverage goal, we examine the total number of people who are near a transit stop. Transit agencies pursuing a goal of high coverage will seek to maximize the number of people who are near some level of service. A similar measure can also tell us about the ridership goal: how many people are near to the most useful services (those that come every 20 minutes)?

Figure 40 shows the number of people and jobs near the 20 minute Network and any service, within either 1/4 mile of 1/2 mile of a transit stop. Currently, fewer than 30% of the population of the County is within 1/4 mile of a transit stop, and less than 40% of County jobs. At 1/2 mile, fewer than half of either are near transit.

This is particularly striking because Palm Tran already provides quite extensive coverage of the parts of the County where high densities of population and jobs are found, particularly between the Florida Turnpike and US-1, where most of the major employment concentrations are located. This speaks to the high level of dispersal of both people and jobs in Palm Beach County, and the fact that substantial population and employment growth has taken place at low densities in outlying portions of the service area.

The proportion of people who have access to the most useful tier of Palm Tran service is also quite limited, with fewer than 10% of County jobs or population located within 1/2 mile of a transit stop, still fewer within 1/4 mile. The reach of the more frequent elements of the transit network is a good indicator of the degree of orientation of the network towards a high-ridership goal, since a higher degree of frequent reach means that more people are near the most convenient transit service, which is most competitive with other modes of travel.

For Palm Tran to improve either the reach of its frequent services or its total network coverage without increasing its budget would imply redirecting resources from one to the other. For instance, cutting an hourly service and increasing frequency on a 30 minute route would reduce the level of total coverage, but increase the extent of frequent network reach. On the other hand, total coverage could be increased by extending routes to serve new areas, but only by reducing the service level (and reach of useful service) on a 20 minute or 30 minute route.

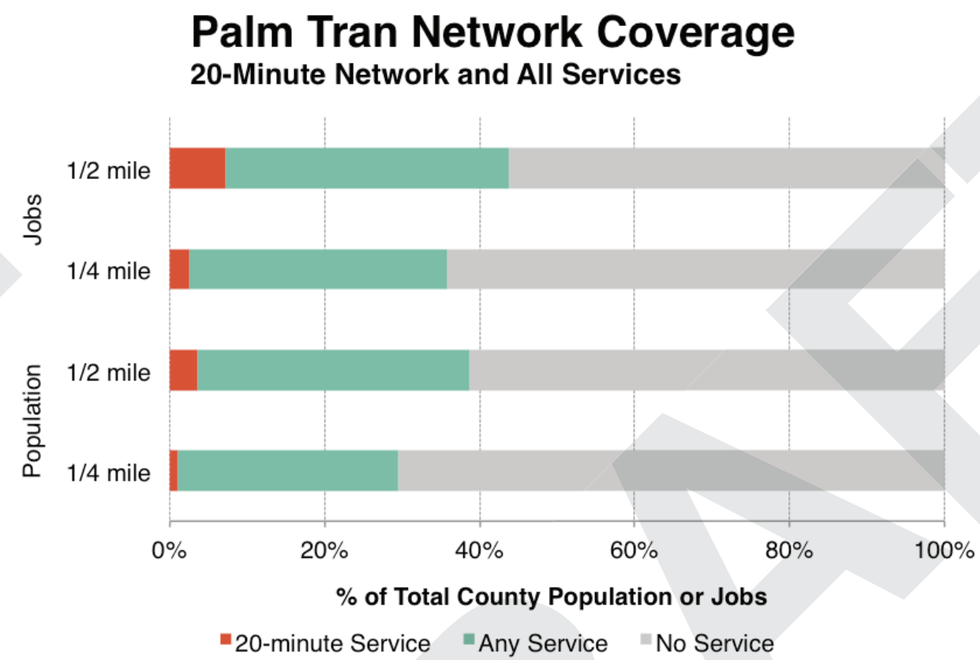


Figure 40: Palm Tran Coverage and 20-minute Network Reach

Reliability

Service reliability, also known as on-time performance (OTP) is typically measured as the percentage of trips that arrive less than 2 minutes early and less than 5 minutes late. That is the current standard used by Palm Tran, and based on that, overall system reliability is currently around 72%. Prior to September 2016, Palm Tran used a different, less rigid standard, that counted trips as on time if they arrived less than 3 minutes early or less than 7 minutes late.

The figure to the right shows the on-time percentage for each route individually, color-coded by the frequency of the route. Most routes achieve an OTP of between 70 and 80%. There is no clear connection between the frequency of a route and its reliability.

A key pattern from this figure is that Routes 70, 80 and 81 are three of the five least reliable routes and all three serve the Delray Beach area. Routes 80 and 81, in particular, have numerous deviations and circuitous routing. In general, the more turns in a route, the more opportunities there are for delay. But many Palm Tran routes in other parts of the county have circuitous patterns and numerous turns. There may be traffic signal, congestion or other issues specific to the Delray Beach area causing the reliability of these routes to be so low.

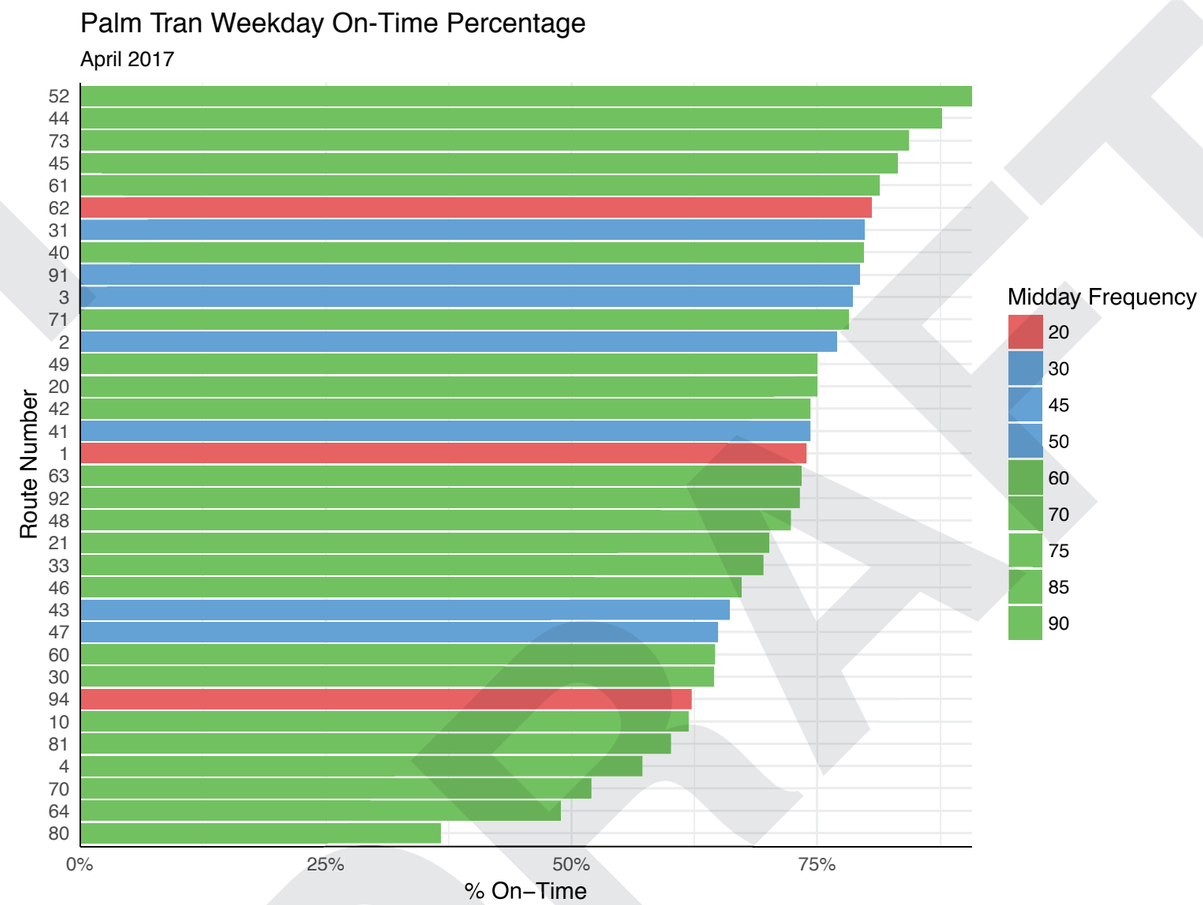


Figure 41: Palm Tran Weekday On-Time Percentage by Route and Midday Frequency

The maps to the right show reliability by timepoint location using arrival time delay and on-time percentage.

The maps clearly show that Delray Beach has significant reliability issues, as discussed above. Other areas that appear to have reliability problems include:

- Jupiter where OTP is consistently below 40% and arrival times are consistently 5-10 minutes late.
- The 6th Ave/Melaleuca Ln Corridor, where OTP is below 60% along most of the corridor but the main problem appears to be buses that arrive too early most of the time.
- The Lantana Corridor where multiple locations have OTP of less than 40% and late arrivals of more than 5 minutes.
- The eastern parts of Boca Raton where OTP is often less than 40% and arrivals are regularly more than 5 minutes late.

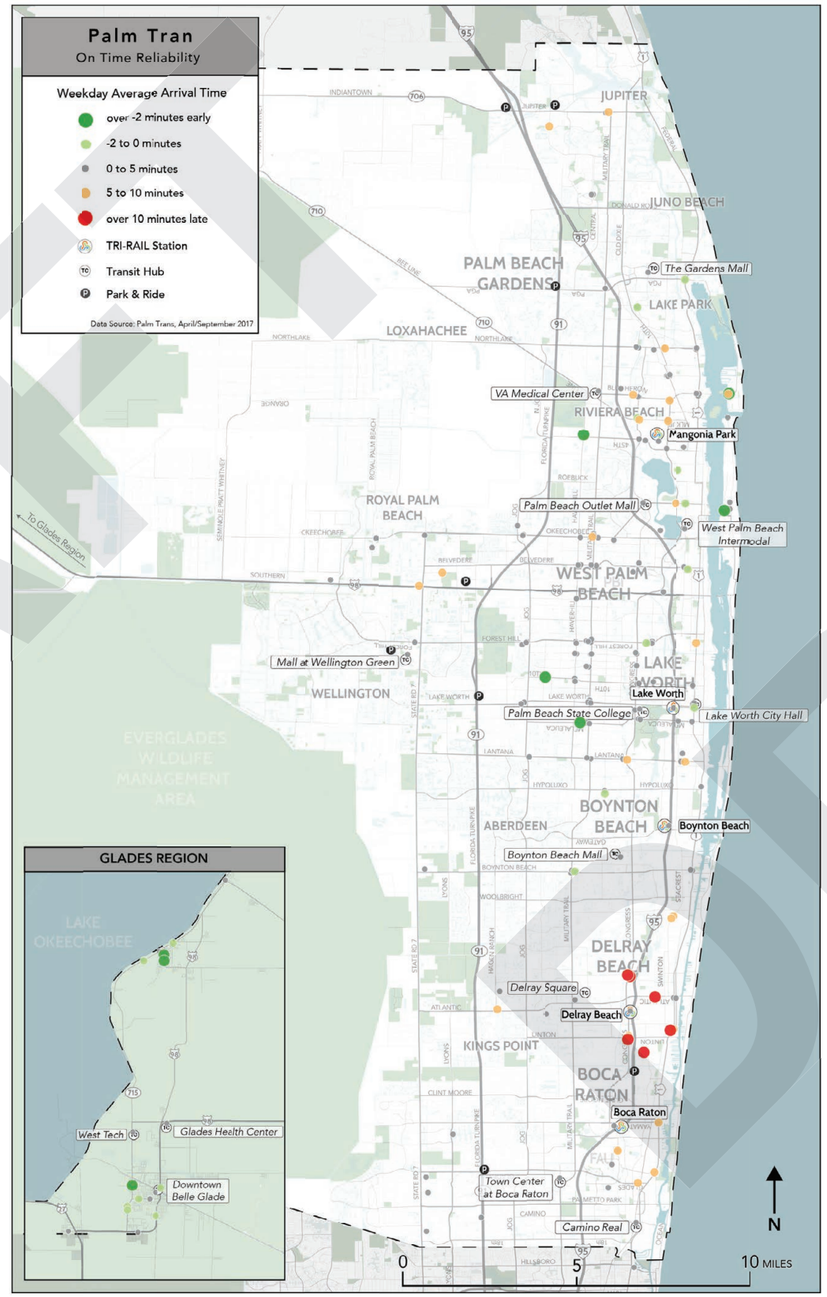


Figure 42: Palm Tran Average Schedule Deviation by Stop

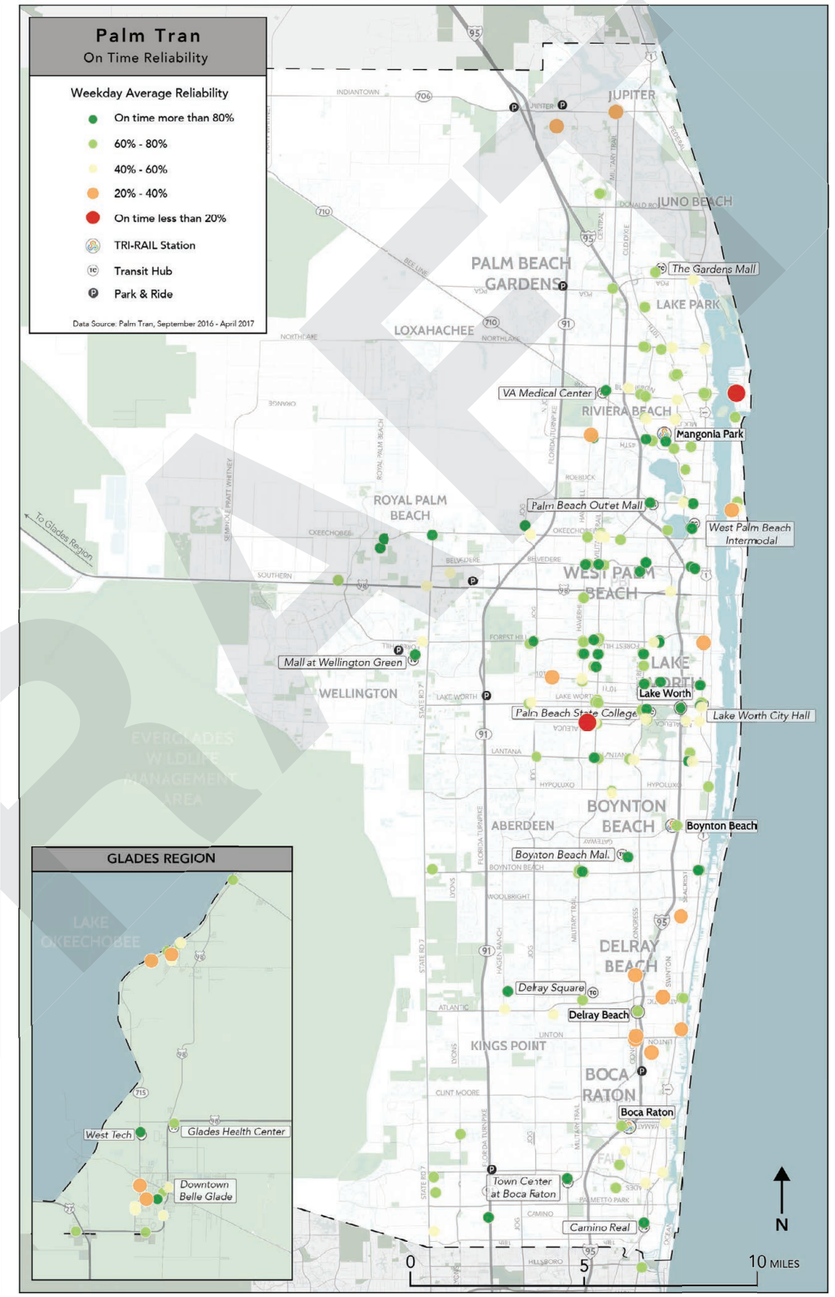


Figure 43: Palm Tran On-Time Performance by Stop

The following sections explore major subareas of the network, and their performance, in greater detail.

Network Design: Lake Worth and West Palm Beach

The area of the County encompassing Lake Worth and southern West Palm Beach east of Jog Road is the area of the most continuous residential density within Palm Tran's service area.

In Lake Worth and West Palm Beach, the most effective routes form a clear and simple grid pattern. These routes are generally quite productive in terms of ridership per revenue hour, relative to other elements of the network, even those that only run every 60 minutes. High boardings appear wherever these grid routes cross. This indicates that some people are transferring between routes, although this is much hampered by low frequencies. This area has a grid road network offering straightforward transit paths, and substantial density providing a ready market.

East-West Corridors

Most of the routes in this area traveling east-to-west display a consistent ridership pattern: strong ridership in both directions between US-1 and Jog Road, then a lower-ridership section from Jog to Wellington Green. Wellington Green itself is a powerful anchor that offsets the short low-ridership segment required to reach it from Jog. On the next page, Figure 46 and Figure 47 display the average daily weekday ridership by stop for routes 43, on Okeechobee, Boulevard and 62, on Lake Worth.

In both cases, the importance of Wellington Green as an anchoring destination is immediately apparent from examination of the eastbound boardings. Route 43 serves a secondary major destination (the Wal-Mart located near Belvedere Road and SR-7) before entering the more consistent development pattern from Jog Road to the east, while a smaller Wal-Mart near SR-7 and Lake Worth Road plays a similar role for Route 62.

Routes 43 and 62 provide a critical connection between major commercial centers in the western portion of the service area, the core dense residential area of Lake Worth, and the dense diversity of uses found along the shoreline of the Intracoastal Waterway. As a result, they (and to a lesser extent the infrequent routes in this area) generate ridership very efficiently, a fact Palm Tran's TDP capitalizes upon through its recommendation to increase the frequency of Route 43 to 20 minutes in the future.

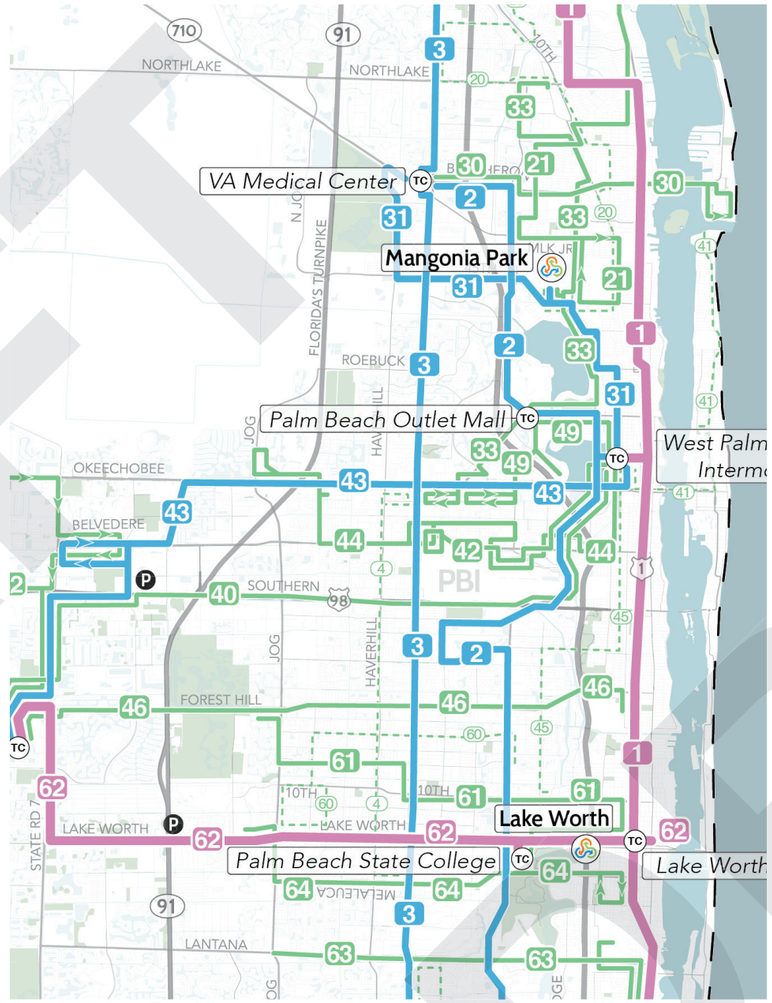


Figure 44: Palm Tran Midday Network Frequency: Lake Worth and West Palm Beach

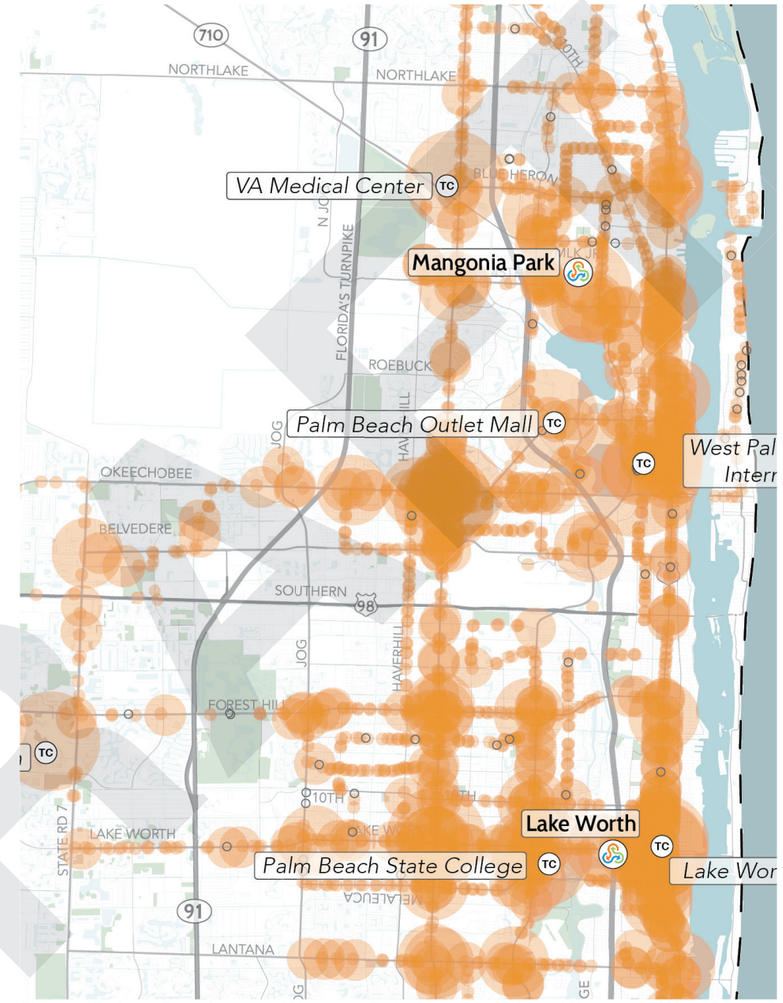


Figure 45: Palm Tran Average Weekday Daily Boardings: Lake Worth and West Palm Beach

Route 43 Average Weekday Boardings by Stop

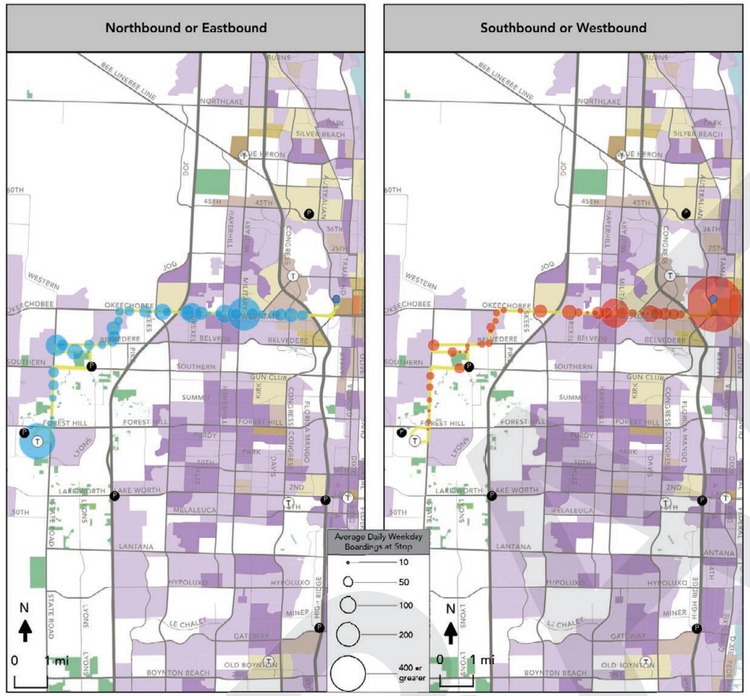


Figure 46: Average Weekday Ridership by Stop: Route 43

Route 62 Average Weekday Boardings by Stop

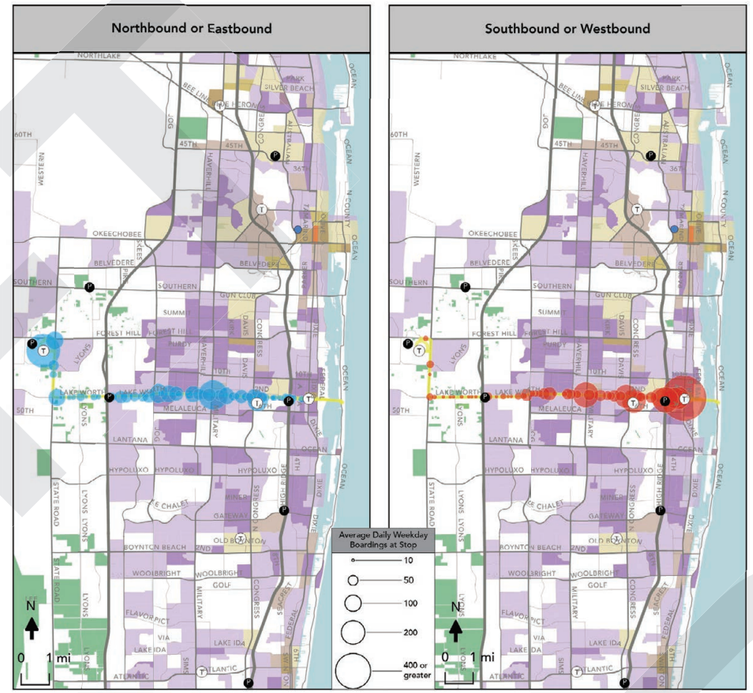


Figure 47: Average Weekday Ridership by Stop: Route 62

Route 3 Average Weekday Boardings by Stop

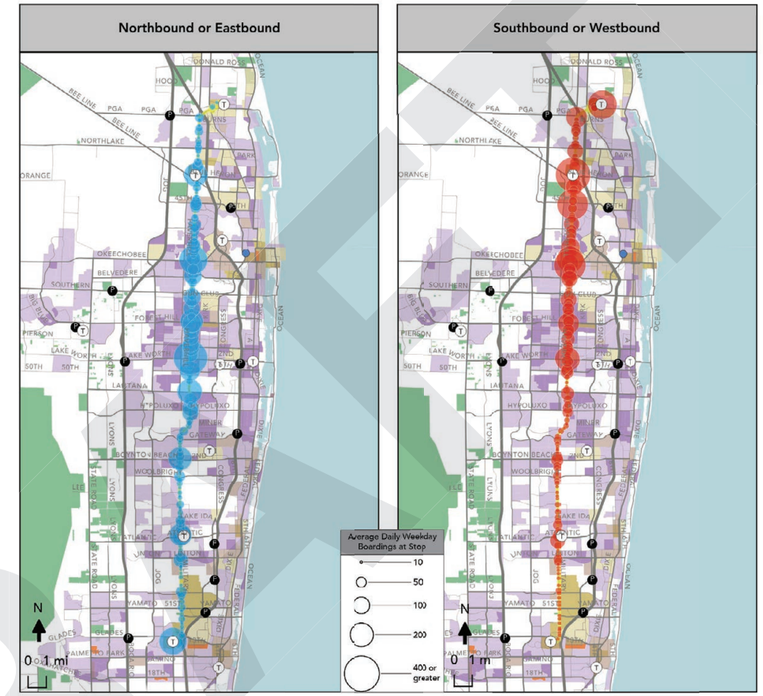


Figure 48: Average Weekday Ridership by Stop: Route 3

North-South Grid Elements

Part of the strong utility of transit in the Lake Worth area is the multidirectional travel enabled by its grid network. While transit grids are most effective when operated at high frequency, even at lower frequencies, grids enable single-transfer travel anywhere within their extent, so long as routes are spaced at a walkable distance from each other.

Route 3, shown in Figure 48, is an example of a route serving this function in the dense corridor from Lantana Road north to the Gardens Mall. From this map, we can see large ridership dots at transfer points at Lake Worth Road, Forest Hills Boulevard, Lantana Road, Melaleuca Lane, and Okeechobee Boulevard. Between these transfer points, lower, but still-substantial ridership results from the strong transit market surrounding the route. The relatively walkable, grid development pattern ensures that accessing transit is possible for most people, and the higher densities provide a substantial quantity of people who may choose to do so, provided transit is sufficiently useful for their purposes.

As that pattern of density diminishes south of Lantana, the transfer points stand out more dramatically as ridership generators. In general, the imbalance of ridership north vs. south of Lantana suggests that the right service level may not be constant along the full length of this route.

Riviera Beach Complexity

North of downtown West Palm Beach, and including Riviera Beach, residential densities are more fragmented (though there are still areas of substantial concentration), but the area is still home to important commercial and service destinations like the Mangonia Park Tri-Rail station, St. Mary's hospital at 45th Street & Greenwood Avenue, and the VA Medical Center at Blue Heron Boulevard & Military Trail.

However, service in this area much more complex than it is further south. In the area north of Mangonia Park, routes 20, 21 and 33 each wind through different sections, providing service that in some areas duplicates longer, more frequent routes like routes 1, 2 or 3. These routes are quite a bit more mixed in terms of productivity: none of the three are currently achieving better than 15 boardings per revenue hour. In large part, this is a result of a geography that is rich with obstacles both for buses and for pedestrians trying to access them.

From Mangonia Park Station to Northlake Boulevard, Old Dixie Highway (10th) is the only continuous path available to transit through this area. Unfortunately, this street has very little residential or employment activity oriented towards it, few safe crossing points, and incomplete sidewalk infrastructure. As such, Palm Tran's network must traverse these neighborhoods using other roads, resulting in the complex route shapes like routes 20 or 21.

While these routes succeed at serving the area despite the challenging road network, their ridership potential may be limited due to a few key attributes. Firstly, the longer travel times such transit paths require make them less competitive with other modes, an issue compounded by their low frequencies (and long wait times). In quite a large portion of this area, routes 1 and 3 are likely a sufficiently short walk away that their higher frequencies may draw people able or willing to walk a longer distance for a shorter wait.

Finally, routes 20, 21, and 33 are both quite short compared to other elements of Palm Tran's network (ending at The Gardens Mall in the north and Mangonia Park or Okeechobee Boulevard in the south). The shorter a trip transit aims to serve, the less tolerant customers typically area of long waits, because walking is more competitive. Additionally, none of the three reach West Palm Beach Intermodal Transit Center, where a very reliable timed connection is available enabling travel throughout the entire county.

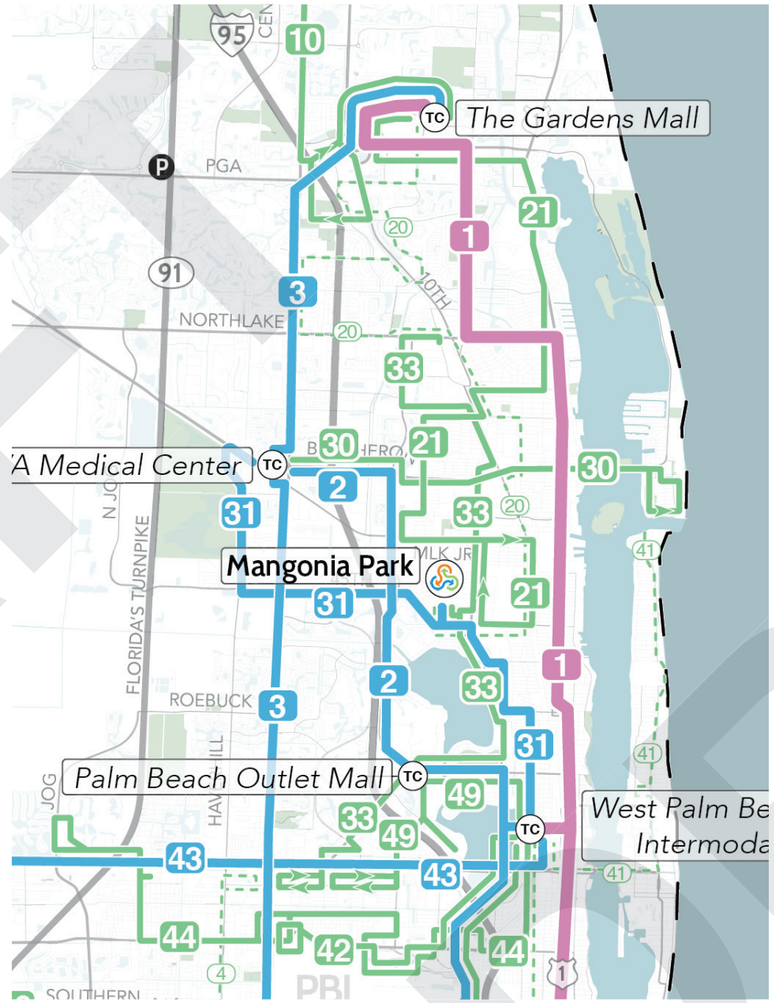


Figure 49: Palm Tran Midday Network Frequency: West Palm Beach to the Gardens Mall

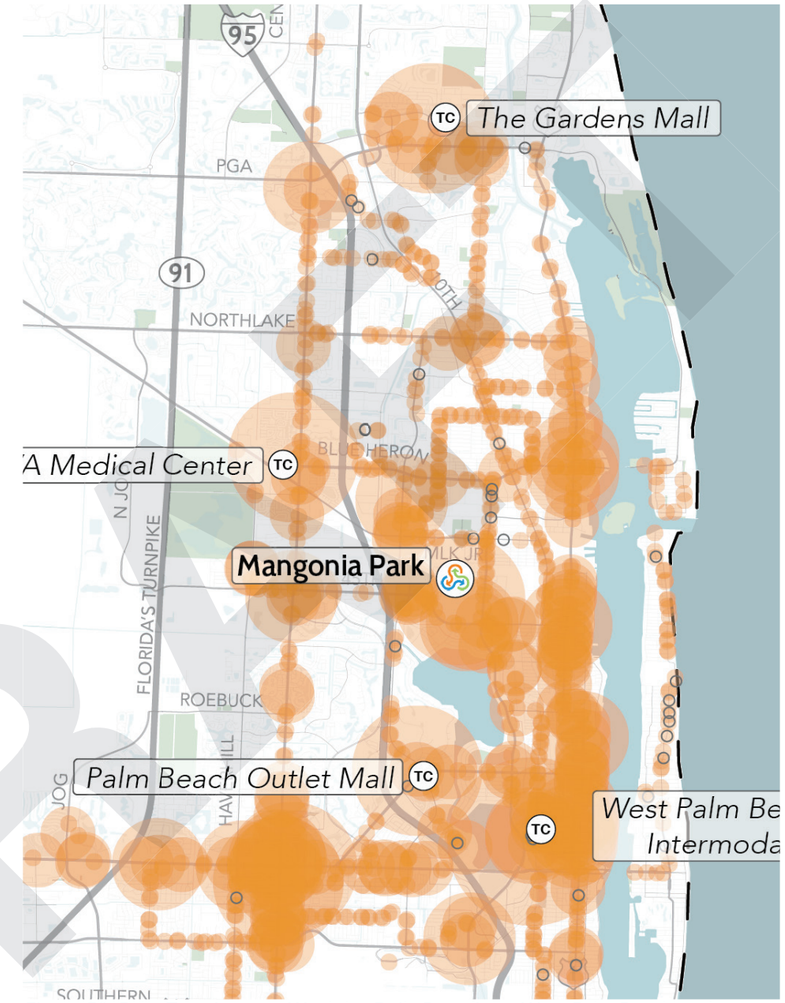


Figure 50: Palm Tran Average Weekday Daily Boardings: West Palm Beach to the Gardens Mall

Boynton Beach, Delray Beach and Boca Raton

In the southern part of the county, the major north-south corridors (routes 1, 2, and 3) continue, ending in Boca Raton. Hourly local routes mostly form local networks built around one or two nodes.

Boynton Beach

In Boynton Beach, the primary available transit routes are routes 1, 70 and 73. Boynton Beach is densely developed along US-1, and ridership on Route 1 is quite strong in this segment, though it drops off to the south before the route reaches the town center of Delray Beach.

Route 70 is a good example of a route that is weakened by a stronger route nearby.

The route runs through the dense, walkable shoreline area of Boynton Beach, before continuing on via Swinton Avenue towards Delray Beach. For most of its extent in this area, Route 70 is between 1/2 and 3/4 of a mile from Route 1 (which operates at substantially higher frequency). While Route 70 provides unique coverage from Seacrest Boulevard west to I-95, in the zone between it and Route 1, its market is likely sapped by the short walk to the much more convenient service available on US-1.

Route 73 on Boynton Beach Boulevard faces a challenging environment for transit, because many of the neighborhoods along its length are physically separated by walls or water from transit stops.

Nevertheless, the route is moderately productive in the context of Palm Tran's network (at approximately 18 boardings per revenue hour of service), below the level of the Lake Worth east-west grid routes, but comparable with routes such as Route 81 in Delray Beach, or 33 in West Palm Beach.

Its pattern of ridership (shown in Figure 53 on page 38) is highly focused on destinations located at the major intersections from SR-7 east, include Bethesda Hospital at SR-7, shopping centers at Lyons Road, Hagen Ranch Road, Military Trail, and Boynton Beach Mall, and then on the denser, more walkable portion of its market from I-95 to the transfer point with Route 1 as US-1. Route 73 serves commercial centers and transfer points similar to the corridors in Lake Worth to the north, but its lower density and difficult street network limit its ridership potential between those nodes.

Boynton Beach and the southern portion of the service area are also served by routes 2 and 3 on Congress Avenue and Military Trail. From

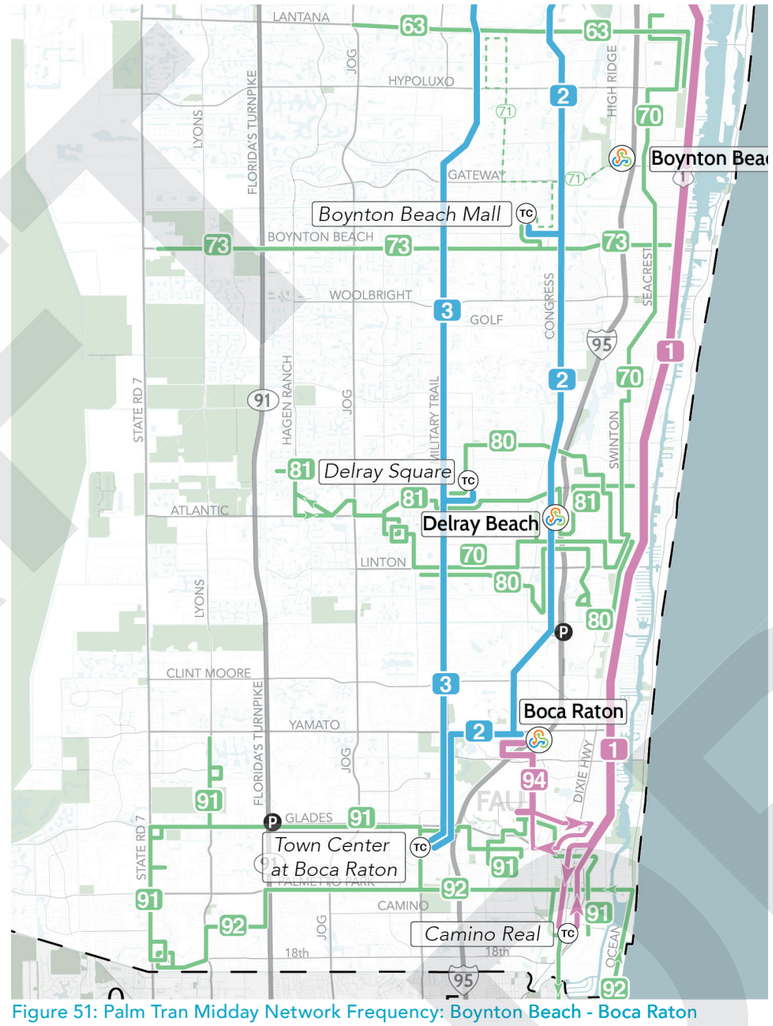


Figure 51: Palm Tran Midday Network Frequency: Boynton Beach - Boca Raton

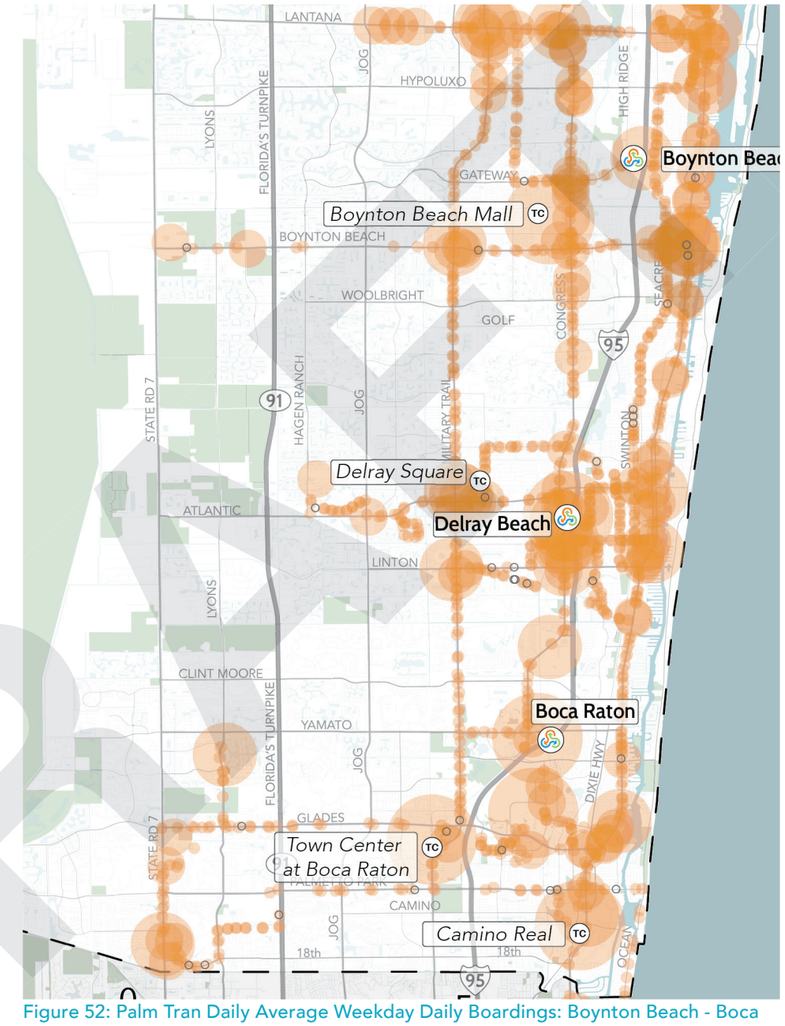


Figure 52: Palm Tran Daily Average Weekday Daily Boardings: Boynton Beach - Boca Raton

the slice of the ridership dot map shown in Figure 52, we can observe strong ridership at the transfer points, and generally low ridership on other segments away from the core town centers or commercial nodes (such as Delray Square).

Figure 53: Route 73 Average Weekday Boardings by Stop and Direction

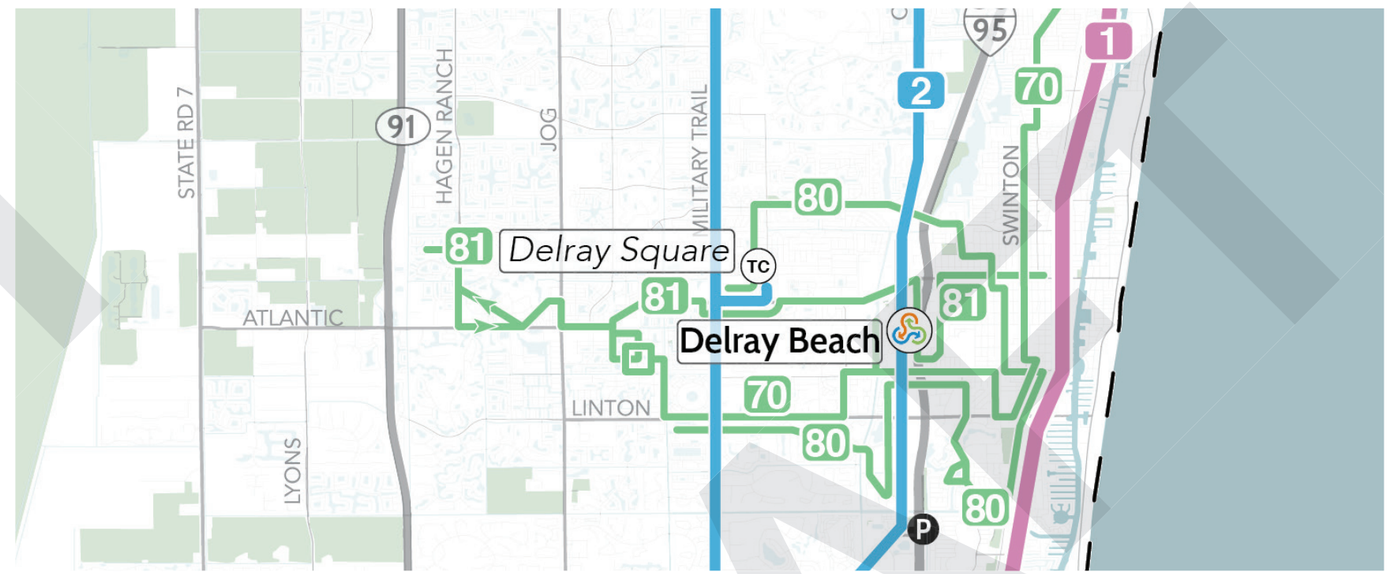


Figure 54: Palm Tran Midday Network Frequency: Delray Beach

Delray Beach

Between Boynton Beach Boulevard and Boca Raton, Delray Beach is the main place Palm Tran provides feeder service to the major north-south corridors. Routes 70, 80 and 81 connect the portions of Delray Beach between the corridors of Military Trail, Congress and US-1. All three of these routes circulate through different areas of Delray Beach, and provide a transfer both to Tri-Rail and to Route 1 on US-1.

Delray Beach is less dense than Boynton Beach to the north, and its concentrated residential areas are clustered around the Kings Point area between Linton Boulevard and Atlantic Avenue east of Jog Road. This is another area with a very substantial concentration of senior citizens and zero-vehicle households, two indicators of potential strong transit ridership. Employment density in this part of Delray Beach is quite low, outside of the shopping centers and hospital at the intersections of Atlantic and Linton with Military Trail. As a result, one of the key tasks for transit in this area is facilitating connections to commercial, employment, and services destinations elsewhere, whether in Delray Beach (where they are clustered around I-95), or another community in the county.

Routes 70, 80, and 81 provide the best example in Palm Tran's network of a local feeder network that provides a one-seat ride between most major destinations, but at the cost of substantial duplication throughout much of the area.

Route 70 coming from the north is very close to Route 1, a much more frequent service. Once it reaches Delray Beach, it proceeds west along 10th St to the Tri-Rail Station, which is also served by routes 3, 80 and 81, before continuing on Linton past the Delray Medical Center and Wal-Mart Supercenter at Linton & Military Trail (also served by Route 80), before terminating at Lakes of Delray southeast of Atlantic Avenue and Jog Road (a point also served by Route 81).

Route 80 runs in a "U" shape from Delray Medical Center on Linton east to the Plaza at Delray shopping center and transfer point on US-1, and then west to Delray Square shopping mall near the intersection of Atlantic and Military Trail. Along the way, it makes several long deviations away from the most direct route between these destinations; these are also the main unique portions of the route. The segment of the route along Linton west of I-95 includes a jog south through the Delray Oaks retirement community. Most of this area is within walking distance to Route 2 on Congress, but actual walk paths in the area are quite limited and Route 2 does not directly connect to the important local destinations described above.

This is also largely true of the segment of Route 80 just east of I-95, where the route again deviates from a direct path to its major destination in order to provide access to the Lake Delray Apartments and surrounding dense housing, which is a long walk from either Linton US-1.

Route 81 provides relatively direct service from Hagen Ranch Road in the west to US-1 in the east, mainly along Atlantic. It too has several deviations, including to the transfer point at Delray Square and the Tri-Rail Station.

Delray Beach is a challenging environment for transit, because many of the dense residential concentrations are located far from major corridors, requiring costly and inconvenient deviations for the transit routes that serve them others. In a network optimized to generate more ridership, an important design question would concern the manner in which feeder service in this area was organized, in order to connect as many of the pockets of density and destinations as possible, while reducing the degree of duplication from the current arrangement.

Boca Raton

All three of Palm Tran's major north-south axes have their southern terminii in Boca Raton, with routes 2 and 3 ending at the Town Center at Boca Raton mall, and Route 1 ending at Camino Real Transit Center. This area is also served by three local routes: Route 94, the Tri-Rail feeder to FAU, and routes 91 and 92, which provide local circulation through Boca Raton and west to SR-7.

Connections to Broward County Transit are available at Camino Real, where BCT's 30 minute Route 30 ends, and at 18th and SR-7, where the 20 minute BCT Route 19 ends.

Palm Tran service in the southern part of the service area is oriented towards two main purposes: local circulation via routes 91 and 92, and connections to and from destinations to the north provided by routes 1, 2 and 3. At Town Center at Boca Raton, Routes 91 and 92 are timed to arrive within the arrival and departure window of the 2 and 3, ensuring that even though these routes operate infrequently, the connection to travel to or from the northern area of County does not require an extensive wait. This is also true between routes 1 and 91 at Camino Real, where each arrival of the 1 is timed to coincide with a northbound departure of Route 1.

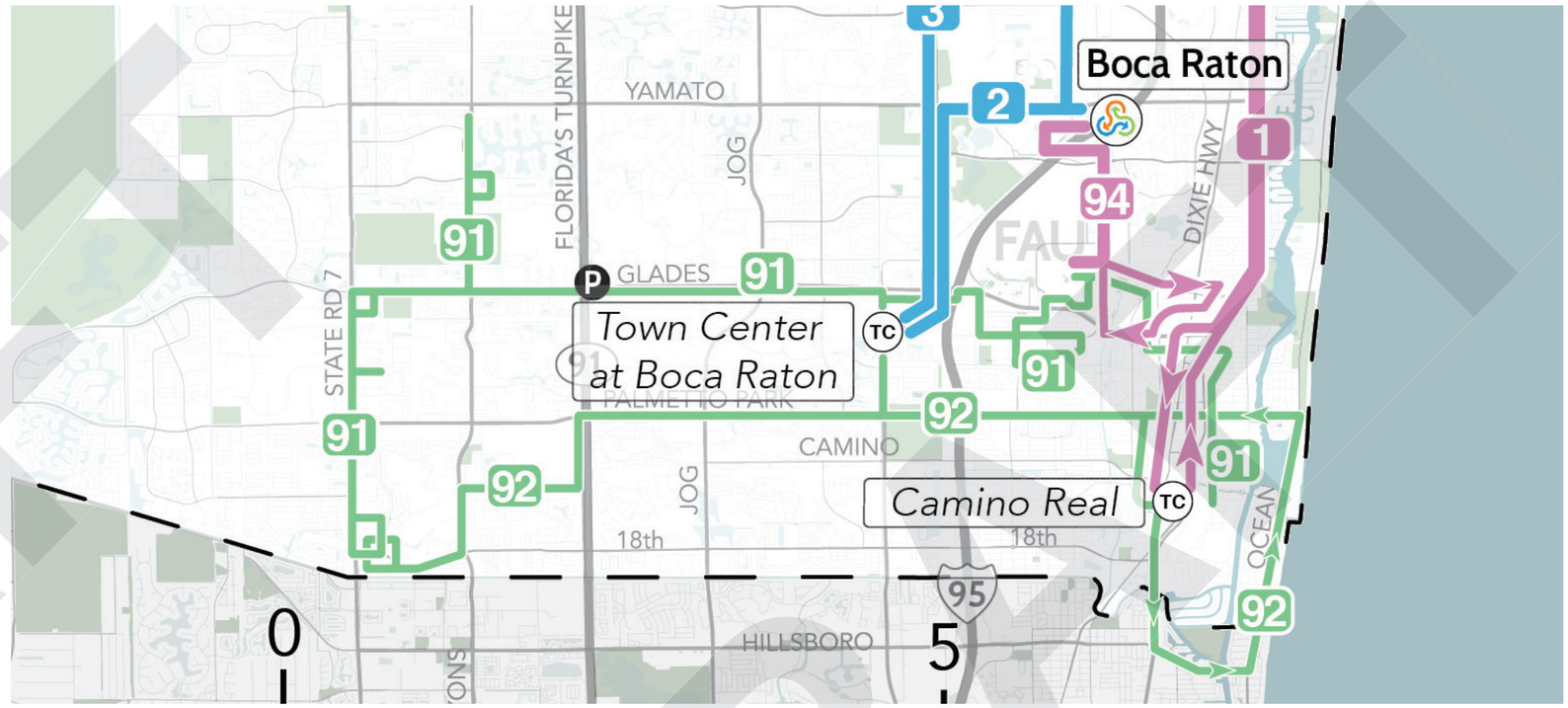


Figure 55: Palm Tran Midday Network Frequency: Boca Raton

Downtown Routing

Figure 56 shows the frequency map zoomed in to the downtown area of West Palm Beach. Many routes converge here at the Intermodal Transit Center, where a timed connection is organized to reduce transfer time and increase the ease of multi-route travel throughout the region. In general, the transit paths used to access ITC are quite simple, with minimal one-way routing on couple streets except on the blocks immediately surrounding the station.

Late in 2017, Brightline's West Palm Beach station will open near the intersection of Evernia and Quadrille, three blocks south of Banyan. This station will open with Palm Tran service via Route 1 available to passengers directly across the street, enabling connections to many important destinations in Palm Beach County.

Because many routes are converging downtown, there is inevitably going to be some duplication of service, with multiple routes using the same shortest path to the transit center. Examples of this sort of case include the duplicative service between ITC and the airport provided by routes 42 and 44 discussed earlier in this report, or the multiple routes that approach the transit center on Australian Avenue.

Another example of this issue is with Route 49 along Congress. This is a more complex problem, because Route 49 has a unique segment between Palm Beach Lakes Boulevard and Okeechobee Boulevard serving dense and hard to reach residential areas, particularly the mid-rise residential buildings immediately north of the interchange between I-95 and Okeechobee. This is a cul-de-sac that can only be accessed from Congress, but this segment of Congress can only be reached from Palm Beach Lakes or Okeechobee, two roads with more useful 30 minute service already in place. This limits the potential market of this service to people traveling to or from the small unique area. As a result, the daily ridership of the route is quite low, just over 200 boardings on the average weekday.

The segment of Route 33 on Palm Beach Lakes Boulevard is another short segment with continuous commercial development, but located in a place that would require a deviation from the shortest path for an incoming route such as Route 43 or Route 2 to serve on the way to ITC. Route 33 is actually serving an even more difficult market than Route 43 due to the roadway design of Palm Beach Lakes Boulevard, which has few safe crossing points, and is surrounded by frontage roads on either side.

Network redesign efforts focused on maximizing ridership would likely seek to streamline routing in the core of West Palm Beach, attempting to serve these hard to reach, close in areas without negatively impacting travel times for passengers traveling longer distances on routes converging at ITC.

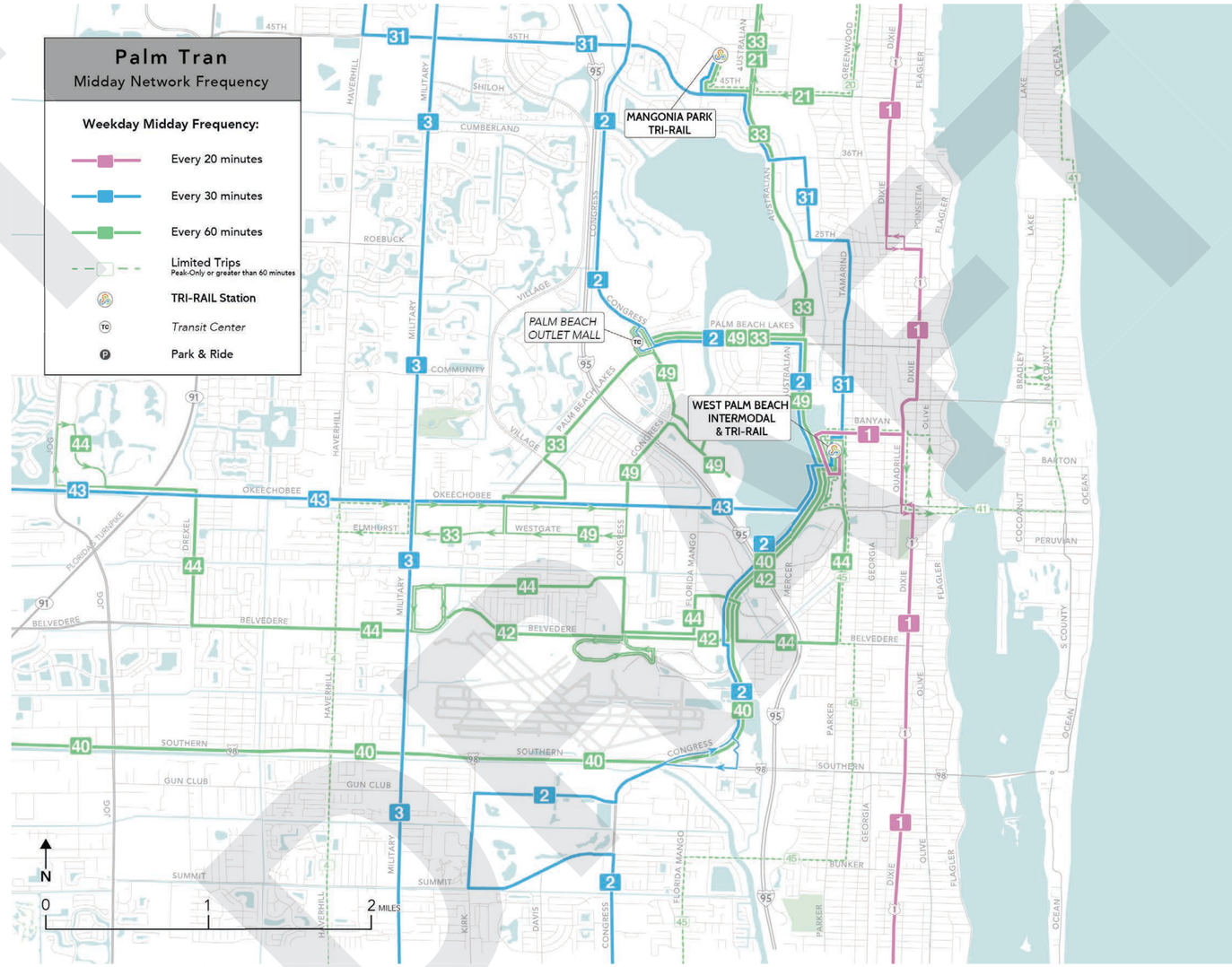


Figure 56: Palm Tran Midday Network Frequency: Downtown West Palm Beach

Timed Transfer

At many points in Palm Tran's network where routes converge, their schedules are coordinated to provide a shorter wait. This technique is referred to as a "timed transfer", and in its most classic form, it looks like the diagram shown in Figure 58, where vehicles serving different routes arrive and depart together from transfer hubs, greatly reducing wait times. When timed transfers happen reliably each hour, it is sometimes referred to as a "pulse".

Anyone who has been near downtown West Palm Beach's Intermodal Transit Center around the top of the hour will have observed a lot of buses arriving and departing over a short period: this is the main hourly pulse. This is Palm Tran's largest time transfer. When a subset of routes in a pulse come more often then every hour, a secondary pulse can take place in between the major hourly pulses.

A pulse is an excellent way to create a network out of a set of routes, because it makes transfers less onerous and risky than they would be if they happened at random. This is especially important for low-frequency routes. If two 60 minute routes cross someplace in the city, and someone wants to transfer between them, their average wait will be 1/2 of the frequency, i.e. 30 minutes.

Instead, if the transit agency designs the network so that those two 60 minute routes meet together at a timed transfer point, people's wait at the connection will be reliably shorter. Many more people will be willing to transfer between low-frequency routes if the connection is quick and reliable.

There is a cost to timed transfer, however. First, the routes must be designed so that they can make a round trip in the right amount of time to get back to the pulse with all of the other routes.

Second, the routes must be given enough spare time to protect them against all of the predictable or unpredictable delays that happen on the roads. If two 60 minute routes are meant to pulse together, and one of them is often late and misses the rendezvous, then the transferring passengers face waits even worse than if the routes were connecting at random – they may often be waiting 55 minutes!

Timed Transfer in Palm Tran's Network

Figure 57 displays the locations of all the places Palm Tran's which system map identifies as timed transfer points. Some of these locations are true pulses, where very short or immediate transfers are possible between near all routes involved. Other timed connections shorten the typical wait for the key directions of travel, but don't involve vehicles actually arriving and pausing to exchange passengers.

This map differentiates between two types of timed transfers: major pulses, where connections between routes are available in nearly all directions with no or minimal waiting, and less structured timed transfers that reduce transfer waiting in one or both directions, but not to the extent of a true pulse where all routes are coming and going in tandem.

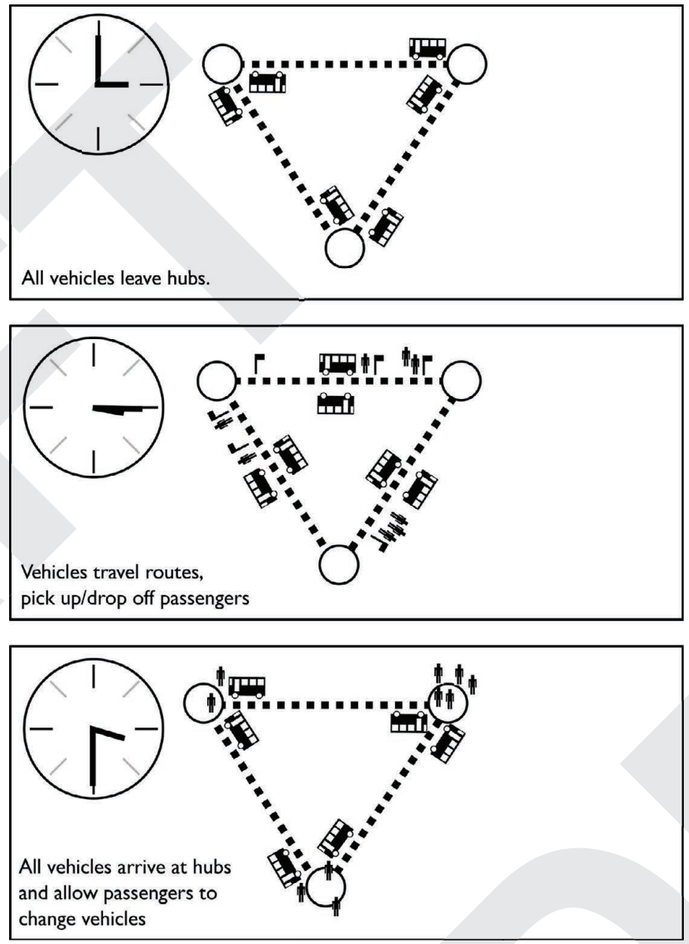


Figure 58: Timed Transfer

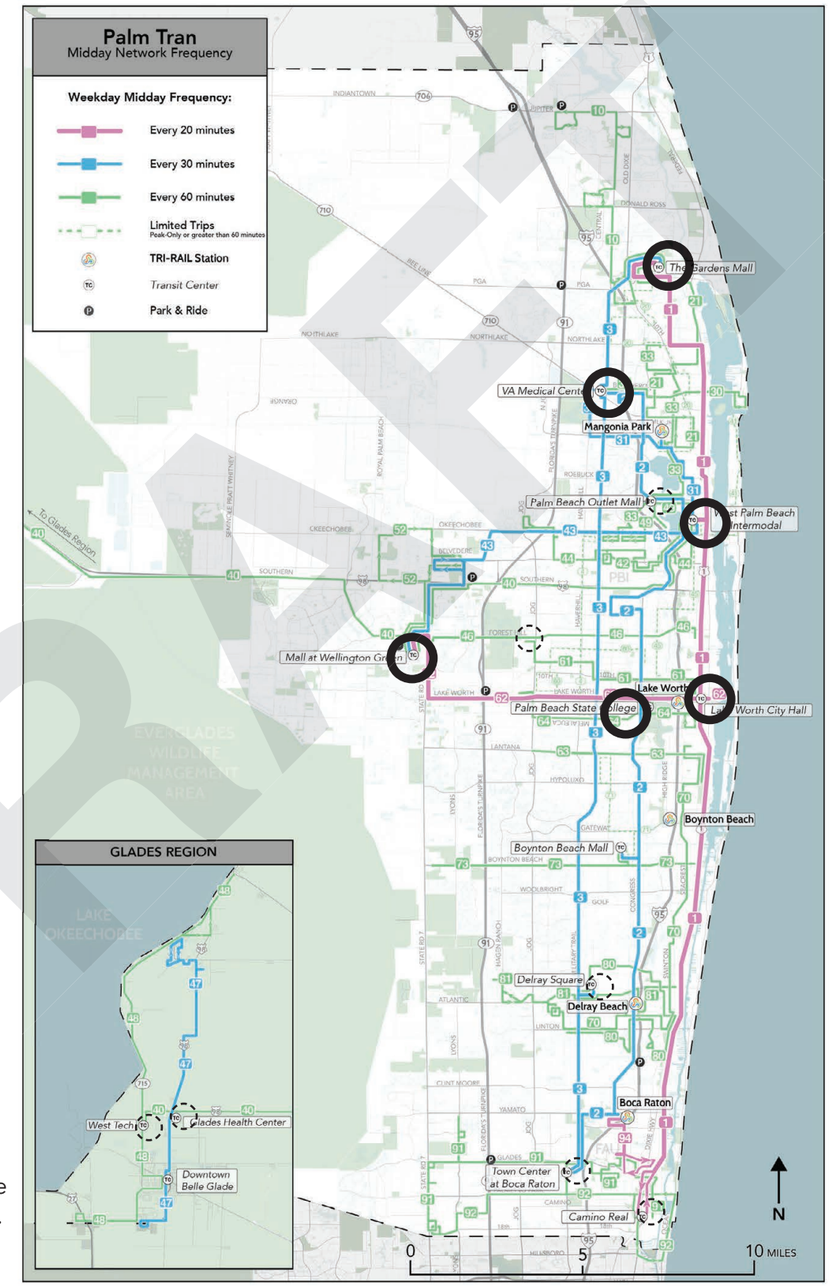


Figure 57: Palm Tran Timed Transfer Locations

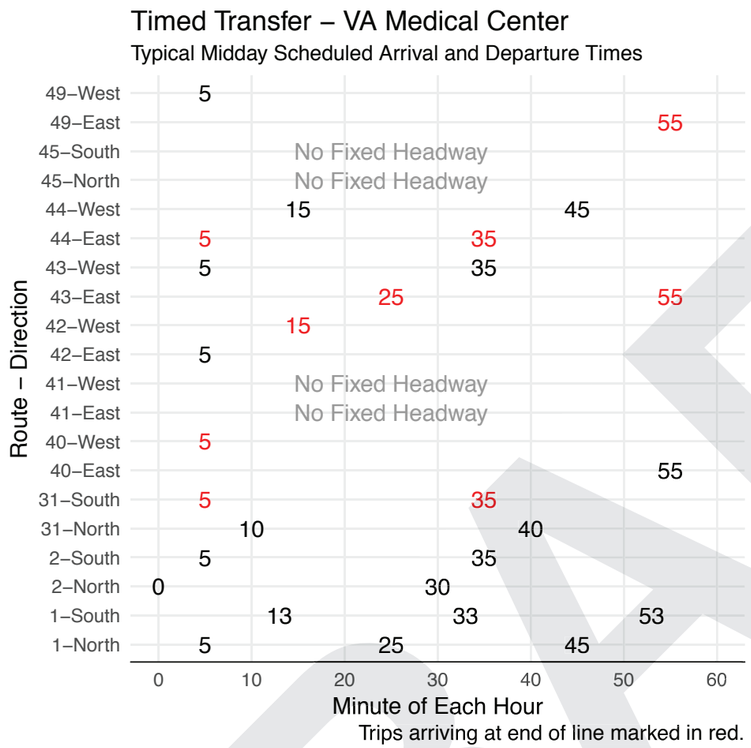


Figure 61: Timed Transfer - Intermodal Transit Center

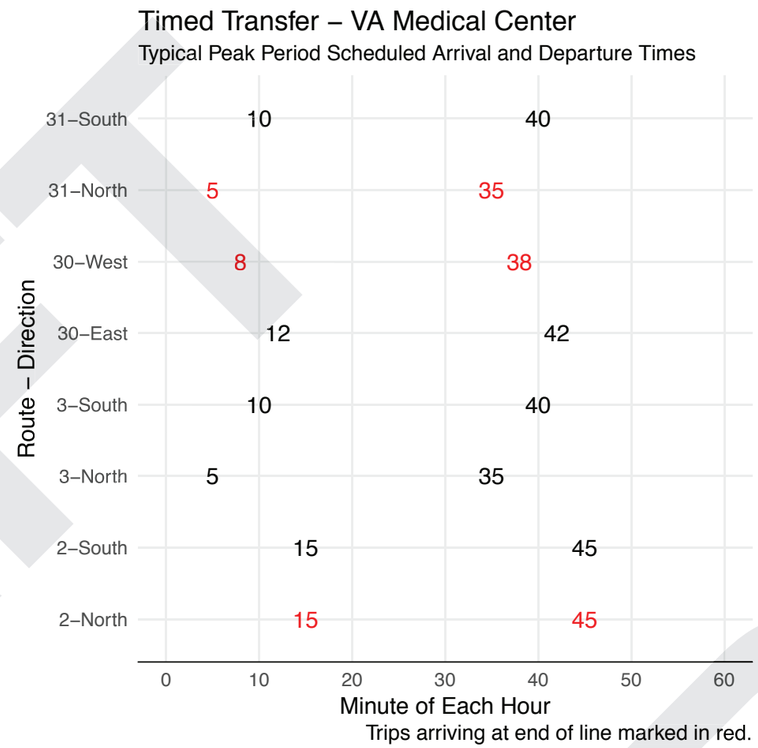


Figure 59: Timed Transfer - VA Medical Center

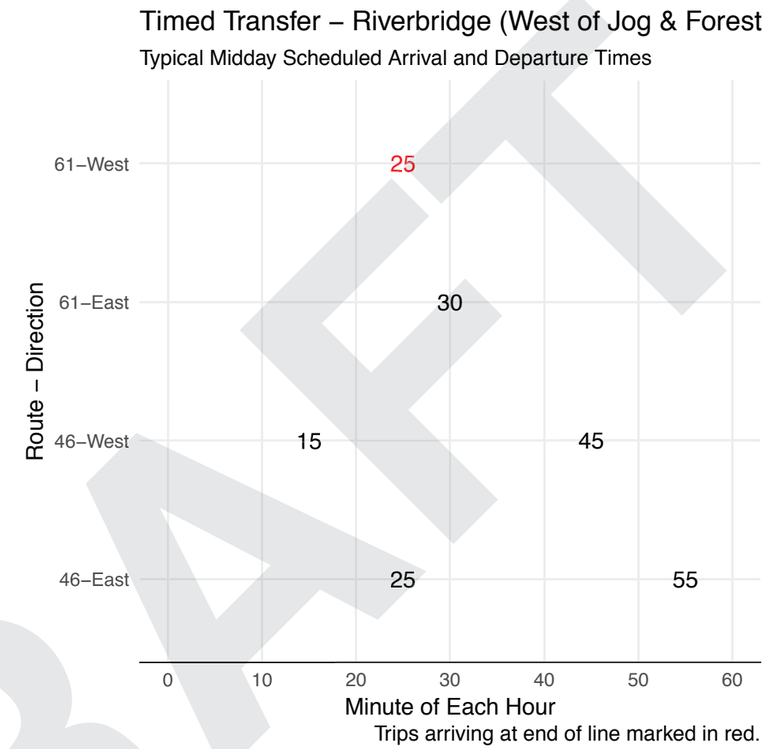


Figure 60: Timed Transfer - VA Medical Center

Timed Transfer: Intermodal Transit Center

The Intermodal Transit Center hosts the largest timed transfer in Palm Tran's network, a fairly structured pulse between :05 and 0:15, with a secondary pulse excluding most of the hourly routes at :25 to :45 each hour. While every route does not depart at precisely the same time, for those that do not, a short wait is generally available. The scheduled times for each route at this pulse are shown in Figure 61. On each line of the chart, the typical arrival time for each direction of the converging routes is shown. In this case, each route terminates at this transfer point, so transfers with a minimal wait are possible between each route and direction except for passengers incoming on the northbound Route 2.

At the earlier pulse, transfers are possible between each direction of each route with the longest wait being 20 minutes (between the eastbound Route 43 and westbound Route 44, which is likely not a well-used connection due to the closeness of the two routes' corridors). For arrivals as part of this early pulse, a connection to the northbound Route 2 is not particularly convenient, since it departs the transit center 5 minutes at the top of the hour, before most of the other pulsing routes arrive.

The later pulse allows an easy connection between routes 41 and 44, and easy connections from routes 1 and 2 the 41 and 44. Routes 1 and 2 come through the transit center before the 41 and 44, so the connection doesn't work as well in the reverse direction.

Timed Transfer: VA Medical Center

An example of one of Palm Tran's simpler and more structured timed transfers outside of the ITC can be found at the VA Medical Center at Blue Heron and Military Trail, shown (for the AM and PM peak periods) in Figure 59.

For example, imagine a passenger is traveling from their home along Route 30 to a job located on Route 31. They arrive on the westbound trip of Route 30, 8 minutes past the top of the hour, and transfer to the southbound trip of Route 31 leaving 2 minutes later. This reduces their potential wait time tremendously from the average 15 minute wait to board a 30 minute route. Within 7 minutes of their arrival, this person could be on their way to any of the destinations served by any of the other routes at the VA hospital.

The timed transfer at the VA works very well for anyone arriving via routes 3, 30 or 31, and less so for someone arriving via Route 2. Since Route 2 arrives northbound at 00:15 and 00:45, it reaches the transfer after the outbound departures of each of the other routes. Passengers who just arrived on those routes can easily transfer to Route 2, but a person who needed to travel from somewhere along Route 2 and arrived at a quarter past the hour would need to wait until 00:35 at the earliest, a h wait, for the next departure (Route 3 northbound).

Timed Transfer: Riverbridge

Another timed transfer identified on Palm Tran's system map takes place between routes 46 and 61 at the Riverbridge shopping center just east of Jog & Forest Hills, Route 61's terminus. Transfers at this site improve

the most important connection - from one route to the other in the same direction. A person traveling from Wellington Green could get to somewhere along 10th, served by Route 61, by transferring from the eastbound Route 46 to the eastbound Route 61 with just a 5 minute wait.

However, the same is not true in the opposite direction; a person traveling west from 10th would get to Riverbridge at 25 past the hour, but would have to wait 20 minutes until Route 46 arrives at :45 of the hour to continue the trip. This wait is an improvement from the native average wait time of a 60 minute route (30 minutes), but still fairly substantial given the short 15 minute run time from Riverbridge to the end of the line at Wellington Green.

Glades Region

In the western part of Palm Tran's service area, the Glades Region is made up of the small towns along the shore of Lake Okeechobee: Belle Glade, Pahokee, South Bay and Canal Point. Belle Glade is the largest of the four. Palm Tran's current service in the area is shown in Figure 62.

Outside of Belle Glade, the towns in this region are quite small, and the developed area is very limited. This means that the potential market for high ridership transit is quite low. Belle Glade itself is an area of concentrated poverty, and throughout this area median household incomes are low. As such, this area presents a potential coverage need relevant to services whose goal is to extend access to the transit system to more people, particularly those with few other options.

In this region, the design of the network is oriented towards two major objectives: facilitating travel between within and between the four towns, and enabling transit travel between the Glades area and the eastern part of Palm Beach County. Ridership volume in this area is low (around 1300 total average daily boardings across the area shown in the two maps on this page), but there are some hotspots where ridership is relatively high:

- Transfer points between Route 40 and routes 47 and 48 at West Tech and the Glades Health Center, both important destinations in their own right.
- The transfer point between Route 47 and Route 48 in the center of Belle Glade, which is also the main stop serving the commercial area of downtown Belle Glade.
- Stops serving commercial destinations, particularly the Winn-Dixie store at the south end of Belle Glade and the Pahokee shopping center.

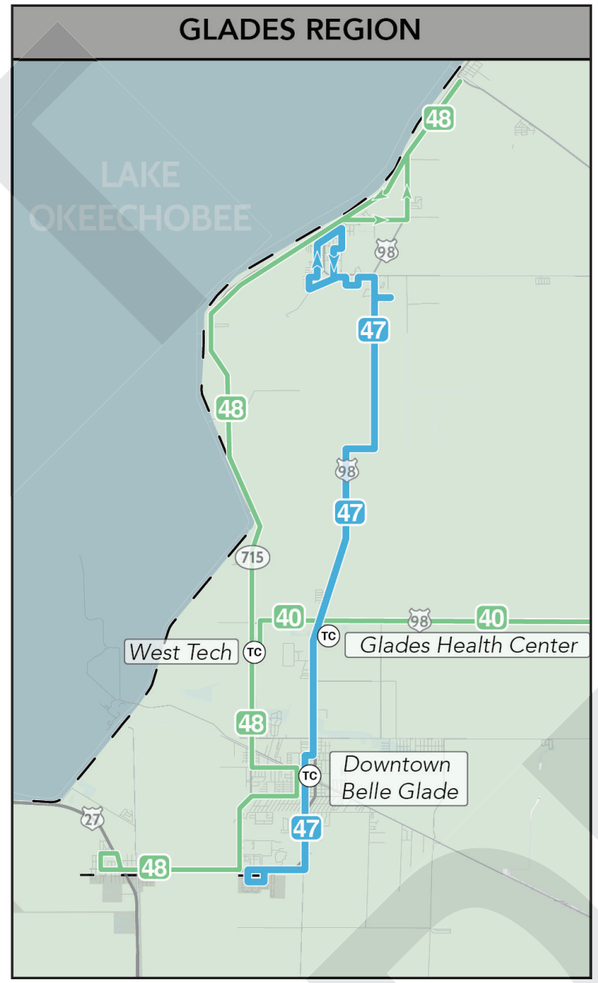


Figure 62: Palm Tran Midday Network Frequency: Glades Region

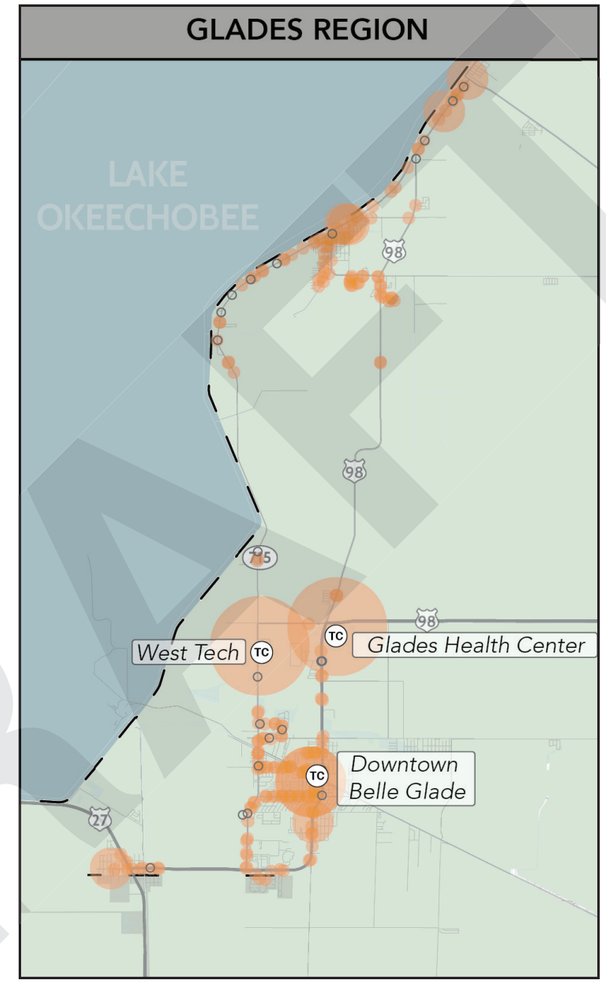


Figure 63: Palm Tran Average Daily Weekday Boardings by Stop: Glades Region

Glades Timed Connections

Route 40 is the route connecting the Glades to the main urbanized area of County. It operates hourly between West Palm Beach Intermodal Transit Center and Wellington Green in the east, and transfer points at Glades Health Center and West Tech. To reduce waiting times for people traveling between the Glades and the rest of the service area, timed transfers are available at these locations.

At Glades Health Center, Route 40 arrives traveling westbound at 00:45 each hour, while the southbound and northbound trips of Route 47 arrive at 00:55 and 00:00, respectively. This means that a person coming from the eastern part of Palm Beach County will rarely need to wait more than 10 to 15 minutes to transfer to the route that will take them on to their final destination. The eastbound Route 40 then arrives at 00:15, a 15 to 20 minute wait for a person arriving on Route 47 traveling east. In both directions, this arrangement ensures a shorter waiting time than the average wait time of a route operating at 60 minute headways (30 minutes), although the two routes' arrivals do not coincide to reduce waiting entirely.

The transfer arrangement at West Tech is a bit tighter, at least during rush hour. The westbound Route 40 arrives at 00:55 each hour, and departs eastbound at 00:05. During the peak period, Route 48 runs every 30 minutes, and both directions reach West Tech at 00:00, allowing a transfer with a minimal wait to Route 40. This is a very useful service for anyone who needs to travel from the Glades to the eastern part of the service area during the rush hours.

However, during the midday (between 9:00 am and 2:00 pm), Route 48 runs hourly, so the short connection is only available between Route 40 and southbound trips of Route 48.

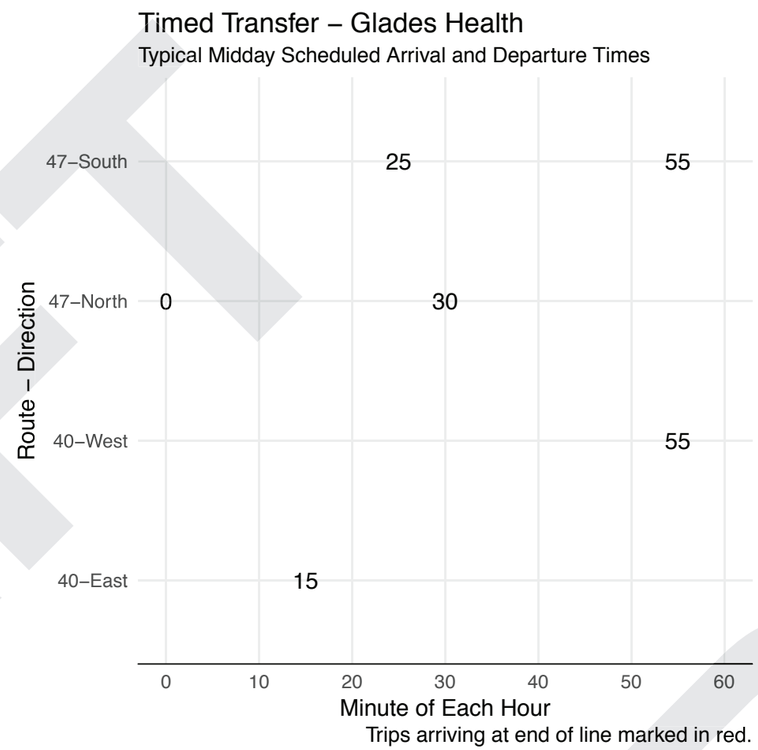


Figure 64: Timed Transfer - Glades Health

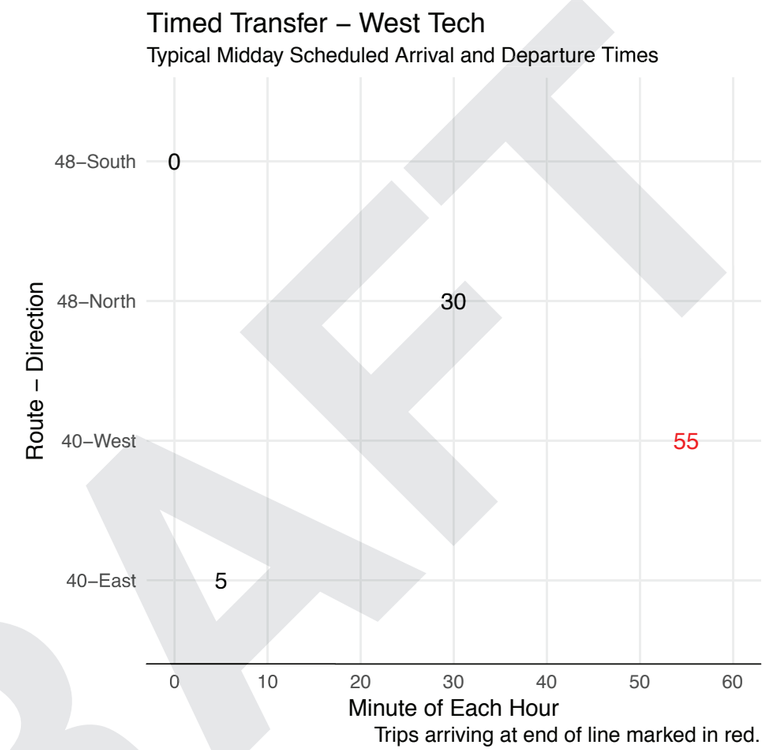


Figure 65: Timed Transfer - West Tech

Financial Overview

Palm Tran is funded by a combination of fare revenue, County general funds, gas tax revenues, and state and federal grant funding. The table below outlines revenues and expenditures by category for FY 2015 and FY 2016 from the Palm Beach County Budget. These figures represent total costs for all service, fixed route and paratransit.

Approximately 38% of revenues come from state and federal grant funding. Local funding provides about 48% of revenues, with 28% coming from local gas tax revenues and 20% from County general funds. The local gas tax revenues come from the County's local option gas tax of 12 cents per gallon. About half of the revenue from this local options gas tax goes to Palm Tran while the other half goes to roadway and other transportation projects. The local option gas tax is at the maximum level allowed under state law, so it would not be possible to tap this revenue source for additional revenues in the future.

Customer fares provide about 12% of total revenue in FY 2016, down slightly from FY 2015 due to declining ridership.

Personnel costs represent 39% of expenses while other operating costs (mostly fuel and maintenance) represent 43% of expenses. Capital outlays for bus replacement are about 18% of expenses.

The Palm Tran TDP provides planning level budget estimates for 2017 to 2026. The budget estimates from the TDP indicate that total operating expenses in 2017 will be about $100 million (excluding capital expenses) and 70% of those expense are for fixed route transit service and about 30% are for paratransit. The TDP estimates that inflation will increase costs for maintaining existing services by 3% per year for the 10-year planning period. This is consistent with the average over the period of 2005 to 2015, but there was also extensive variability in the cost increase for fixed route transit over that time.

Analysis of the National Transit Database data on Palm Tran fixed route services shows that overall operating costs have increased 53% from 2005 to 2015. From 2005 to 2013, service hours were generally flat, with less than 4% increase in any year from 2005 to 2013. Thus, during this time, the cost per service hour increased, from about $89 per hour in 2005 to about $120 per hour in 2011, a 36% increase. The largest increases came in the period from 2006 to 2009, where annual increases in per hour costs averaged 7%. The rapid increases in per hour costs during this time may be partially attributable to the rapid increase in fuel costs during the same period.

Since 2013 both revenue hours and expenses have increased, but expenses have increased at a slower pace. Thus, costs per revenue hour have declined to about $116 per hour, still 30% higher than 2005.

It is natural for costs to rise, irrespective of increases in revenue hours due to inflationary factors like labor expenses and fuel costs. Overall fuel costs have declined in the last few years, which may explain some of the recent improvement in operating cost per revenue hour.

Revenues	FY15 Budget	% of Revenues	FY16 Budget	% of Revenues
Fare Revenue	$14,697,723	13%	$13,714,917	12%
State/Federal Grants	$42,239,593	37%	$45,249,924	38%
County General Fund	$22,662,373	20%	$24,886,476	21%
Local Gas Tax	$32,197,000	28%	$33,045,000	28%
Other Revenues	$1,304,531	1%	$1,385,319	1%
Total Revenues	$113,101,220		$118,281,636	

Expenses	FY15 Budget	% of Expenses	FY16 Budget	% of Expenses
Personnel	$44,644,726	39%	$46,642,693	39%
Operating Costs	$46,353,815	41%	$50,650,775	43%
Capital Expenses	$22,015,132	19%	$20,900,770	18%
Other	$87,547	0%	$87,398	0%
Total Expenses	$113,101,220		$118,281,636	

Figure 66: Palm Tran FY15 and FY16 Revenues and Expenses

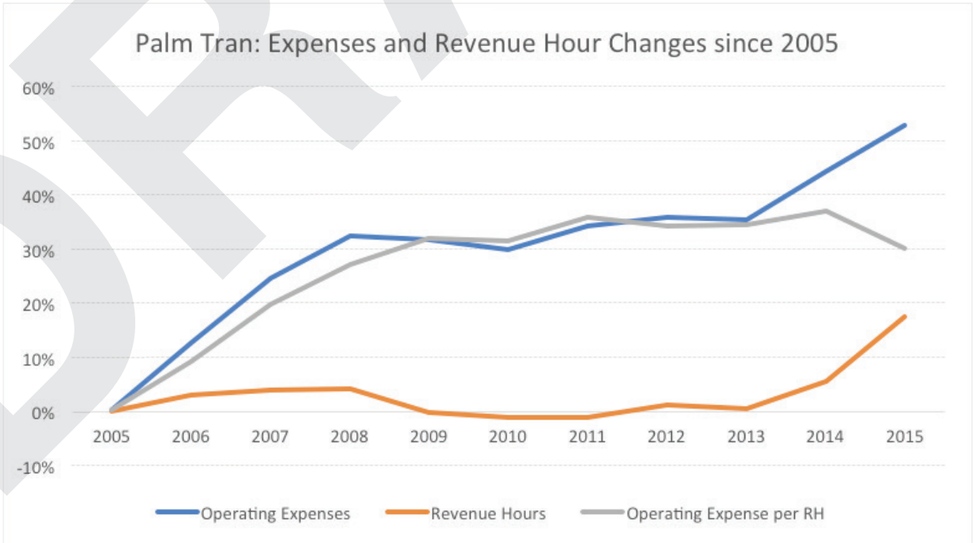


Figure 67: Palm Tran Expanses and Revenue Hour Changes since 2005

Paratransit

While the RPM is concerned with analyzing and developing strategies to improve the efficiency of Palm Tran's *fixed-route* network, it is worth considering some of the ways in which changes to the fixed-route system can impact a transit agency's paratransit service obligations or practices.

Current Paratransit Programs

Palm Tran currently operates three demand-response programs that can be collectively described as comprising its paratransit service offering, Palm Tran Connection:

- **Americans with Disabilities Act (ADA) Program.** All transit systems in the United States are required to comply with the provisions of the ADA concerning transportation for qualifying people. Agencies must offer a demand-response service within 3/4 miles of a fixed route during the time when it is in operation. Palm Tran exceeds this standard, offering ADA service east of the Florida Turnpike in Palm Beach County from the South County Line to Donald Ross Road in the north, and then within a 3/4 mile buffer outside of that area.
- **Transportation Disadvantaged Program (TD).** Sponsored by the State of Florida Transportation Disadvantaged Trust Fund, the TD program his provided anywhere in Palm Beach County during the same hours and days as Palm Tran fixed route bus service. Eligibility is based on income or disability. TD trips require a $3.50 per one-way trip fare for all trips.
- **Division of Senior Services (DOSS).** This program provides free transportation for any senior citizen (age 60 and older) to designated meal sites on weekdays from 8am to 5pm.

As of April 2016, about 80% of paratransit trips were ADA eligible riders, 15% were Transportation Disadvantaged riders and 5% were Senior Service riders. Average weekday ridership is about 3,100 riders and average monthly ridership is about 75,000.

Average revenue hours of service per month is about 50,000. Thus the average productivity for paratransit service is about 1.5 boardings per hour, far below the average for fixed route service. Paratransit, however, is not expected to achieve high productivity levels because it's purpose is not to achieve high ridership, but instead to provide essential coverage service to eligible residents.

Paratransit and Network Redesign Efforts

Major transit network redesigns can effect paratransit by changing the extent and hours of operation of service. Extending routes to new portions of the service area, or running service later into the evenings or during more of the weekends, can increase the period and area over which paratransit service must be provided.

On the other hand, reducing the coverage area of the fixed-route network has the potential to reduce the area an agency is obligated to provide complementary ADA service across. But, many agencies that remove an area from transit coverage where paratransit customers live will often provide continued eligibility for those customers for a set period of time.

Since Palm Tran already designates a large swath of the developed area of the county as a designated service area for paratransit (the area east of the Florida Turnpike and south of Donald Ross Road), service changes that reduce coverage within this area will not reduce the paratransit required coverage.

Palm Tran routes that reach outside the designated area (such as Routes 40, 43, 52, 62 and 91) cover key destinations and high concentrations of senior citizens. It might be possible to remove coverage for some, but not likely all of these areas. And, again, most transit agencies that make this kind of change provide grandfathered eligibility for existing paratransit customers.

On the other hand, expanding coverage to areas west of Florida Turnpike or north of Donald Ross Road, could increase paratransit ridership by expanding the pool of eligible customers or destinations served. However, Palm Tran already provides service to the most dense residential and employment centers in these areas, so additional coverage would be unlikely to dramatically increase paratransit demand, since the additional areas that could be covered have relatively low densities and a paucity of destinations to serve.

Finally, it is important to note that in most places paratransit demand is increasing faster than general population growth or transit ridership growth. This is primarily due to general increases in the average age of the population, which is exacerbated in Palm Beach County by the already high average age of the population in the county. Thus, one should expect that even if no changes were made to the Palm Tran fixed route network in the next 5-10 years, the paratransit eligible population and ridership would likely rise.

Survey of Relevant Transit Technology Upgrades

While potential transit technology upgrades do not pertain directly to the network design questions that are the focus of the RPM, as Palm Tran seeks to maximize the operational efficiency of its network, there are a number of key technologies that it could consider to aid in that process. Further study would be required to determine if and where to deploy any of these, but each can be used to address different issues common to many transit systems.

Transit Signal Priority

Transit signal priority (TSP) is the integration of transit with the a roadway's traffic signal system. Essentially, it allows transit vehicles to trigger a light cycle that lets them to pass through an intersection without waiting for the light to change on its own. This technology is particularly useful where congestions issues have a major negative impact on transit speed and reliability. It is most frequently found as a feature of different types of rail transit (many surface-running light rail lines feature transit signal priority at intersections), but some cities and transit agencies use the technique to improve bus speeds as well.

Transit signal priority is a very effective tool for improving transit speed and reliability without separating transit vehicles from regular traffic. TSP can be made even more effective when it is in place at an intersection in combination with a bus-only queue jump lane that allows the vehicle to immediately approach the intersection, rather than lining up behind other vehicles.

Palm Tran has undertaken bus transit signal priority project on its high-ridership Okeechobee and Lake Worth corridors served by routes 43 and 62, respectively.

Off-Board Fare Collection

One important factor in transit's speed is the time vehicles spend picking up passengers. Typically, a bus will reach a stop, passengers will board, pay fares or validate a pass, and then the vehicle will depart. This requires drivers to spend time handling these transactions, which increases the amount of dwell time at the stop and the overall travel time of the route.

One alternative to this process is to have passengers handle their own fare payment before they board the vehicle. This is called "off-board fare collection" or "proof-of-payment" fare validation. A passenger will use a ticket vending machine (or smartphone application, increasingly) to

purchase a ticket when they reach a transit stop or station. When the bus comes, they can board and find a seat without a need to interact with the driver to pay their fare. This also allows for faster boarding, since passengers can board through both doors.

While few agencies have instituted entirely off-board fare payment (most retain a cash option on board, but also provide an app or ticket vending machines at stations), many have shifted some portion of their fare payment off the bus. For example, a high-ridership route on a key regional corridor would be a good candidate for off-board fare collection, since more passengers means more delay, and more delay on a higher-ridership route inconveniences more passengers.

In 2012, San Francisco Muni implemented off-board fare collection, all-door boarding and proof-of-payment fare inspection throughout its network. As reported by NACTO, "Dwell times have fallen 37% and are 42% more consistent, with the 68th percentile boarding time (one standard deviation) now 3 seconds faster than before"[11].

While this is an example of the benefits of the practice implemented in a comprehensive manner in an extremely high-ridership network in a very dense city, a more limited rollout of off-board fare collection across key corridors or routes like Palm Tran's Route 1 could offer a way to reduce dwell times and improve speeds, and thus passenger travel times and the overall level of convenience. Further study would be needed to assess the need and develop a plan for the implementation of off-board fare collection in Palm Tran's network.

One overlooked aspect of off-board fare payment concerns the institution of a proof of payment validation system relying on fare inspectors. Fare inspectors are new personnel that will need to be hired, and in some cases, the agency will need to determine the legal framework under which they are granted authority to examine fares and issue tickets or exclusions.

Real-time Data and Trip Planning App Ecosystem

With the development of the General Transit Feed Specification (GTFS) over the past decade, it is easier than ever for transit agencies to share data on their schedule. A vibrant ecosystem of trip planning apps has sprung up around this type of data, including both major brands like Google Maps and more specialized services like the Transit App. These applications allow a user to query the GTFS representation of the schedule in order to receive transit directions between an origin and a destination. They also take advantage of real-time information when available to provide up-to-the minute trip arrival predictions, and display vehicle positions. These features help customers access more information about their trip, so that they know more precisely when to go to the stop, if their bus is late, and if it is late, how much longer they will have to wait.

The third-party trip planning app marketplace is a great opportunity for transit agencies, because competition within it is generating fast innovation in trip planning, prediction and interface design, important aspects of the trip planner user experience, but which are typically outside of the agency's core competency: running transit service. However, the agency is a vital partner in making this sort of utility possible, because all of these apps rely on the transit agency to produce accurate and complete data. This includes both the GTFS representation of the schedule, and real-time data feeds.

Real-time data have a key role in trip planning. It is not relevant when a customer is considering their options days in advance, or exploring hypothetical travel times, so the real time element of a trip planner needs to be user-enabled or disabled. But people also make travel decisions in the moment. Using real-time data, trip planners can help customers make good decisions right then. Just as motorists use the traffic layer of online maps to select a path that will be fastest in the current situation, transit directions and maps are stronger if they help the customer figure out how to travel based on actual, rather than scheduled, times.

This functionality is also useful to the agency in managing disruptions, which is why state transportation departments put so much effort into this information for motorists. If a disruption has shut down service on a key line, only real time trip planners will immediately tell customers to route their trip a different way, or to postpone their trip, etc., reducing pressure on the disruption.

Palm Tran produces a GTFS feed and trip planning mobile application called iGo. It also exposes its vehicle positions feed to third-party developers to improve the quality of their predictions and trip planning. Currently, Palm Tran is providing all the necessary conditions to enable its customers to take advantage of these tools. However, innovation in this space has happed and continues to proceed rapidly; like all transit agencies, it is important that Palm Tran stay abreast of developments in data standards around trip planning so that its customers continue to enjoy the convenience and utility they do today.

Mobile Ticketing

Over the past 4 years, a number of US transit agencies have begun to implement fare payment systems that allow passengers to use a smartphone application to purchase transit tickets. The first example of this, in Portland, Oregon, has the driver visually validate a ticket screen they are shown on the app. Other systems allow for RFID or QR code validation, and there are a number of different technologies and business models currently developing in the space. Many of the companies operating in this space seek to earn a percentage of fare revenue in exchange for providing the app and validation system, and handling transactions.

According to the Pew Research Center, by late 2016, 77% of US adults owned a smartphone, a share that has rapidly increased from just 35% in mid-2011[12]. More and more elements of people's commercial behavior now involve the smartphone, and they are increasingly integrated into travel behavior as well, from ride, car and bikesharing apps to airline boarding passes. Smartphone-based ticketing has the potential to make transit service more convenient for passengers, and offers the added benefit of reducing the need for drivers to handle cash or fare payment.

However, smartphone penetration is highly variable across income and age groups. The same Pew report indicates that seniors aged 65 or older are currently much less likely than the population as a whole to own a smartphone. Lower-income people (earning fewer than $30,000 dollars annually) are also less likely to own a smartphone, though to a lesser degree than seniors.

11 NACTO. "Better Buses; Practitioners' Paper #1". February, 2017. Retrieved from: https://nacto.org/wp-content/uploads/2017/02/NACTO_Better-Buses_Boarding.pdf

12 Pew Research Center. "Mobile Fact Sheet". January 12, 2017. Retrieved from: http://www.pewinternet.org/fact-sheet/mobile/.

4 Recent Plans

This section surveys several major ongoing on recently completed planning efforts and projects that have the potential to impact Palm Tran's network design decisions in the future.

Palm Tran Transit Development Plan

Palm Tran completed an update to its Transit Development Plan (TDP) in 2016, laying out a vision for improvements to the transit network from 2017 to 2026. The RPM Initiative is intended to maximize the efficiency of the network prior to the implementation of recommendations developed through the TDP process.

In terms of changes to the bus transit network, the TDP's recommendations can be broken down into two categories:

- Short-term interventions through 2022, mainly focused on frequency and span improvements to the existing transit network.
- Longer-term planning focused on new express services to be implemented after 2022. As noted in the TDP, new revenues would need to be identified to fund the back half of the plan.

Figure 68 reproduces the short-term implementation plan from the TDP. All short-term improvements are either span extensions or frequency improvements. The highest priority improvements (to be implemented by 2021) focus on improvements to routes like Route 43 and Route 62, which have been discussed throughout this report as among Palm Tran's highest ridership, most productive services. Further down the list, many of the key high-productivity services in Palm Tran's densest markets are slated for extended spans or higher frequencies on weekends.

The TDP also involved the consideration of several major questions by the Palm Tran Service Board. While transit plans are composed of specific recommendations about routing, frequency and span of service, effective plans articulate policy-level direction stemming from an agency's leadership.

The most important policy question the board members considered during the TDP process was whether Palm Tran's future service should focus on improving transit service coverage or frequency. Planning focused on frequency means directing resources towards improving the utility of the most efficient routes serving the strongest markets, while a focus on coverage means that resources are directed towards expanding the total portion of the County's population that has access to some transit, even if that service is very infrequent.

From the TDP and supporting documentation of the board workshop, it appears that the board's opinion was mixed on this topic. As described in the TDP:

Year	Days of Service	Type of Improvement	Routes
2018	Weekday	Frequency - 30 to 20 minutes	43
2018	Weekday	Span of service - one AM hour/two PM hours	62
2018	Saturday	Span of service - one AM hour/two PM hours	62
2019	Weekday	Span of service - three AM hours/three PM hours	Bolt 1
2021	Weekday	New service - Route 2 Limited Stop (Bolt)	New Bolt 2
2021	Weekday	New service - Route 3 Limited Stop (Bolt)	New Bolt 3
2021	Weekday	Span of service - one AM hour earlier	2, 31, 33, 46, 61, 63, 81
2021	Sunday	Frequency - 60 to 30 minutes	2, 3, 43, 62
2022	Weekday	Span of service - one AM hour/one PM hour	1, 3, 43, 52, 62, 71
2022	Weekday	Span of service - two PM hours	63
2022	Saturday	Span of service - one AM hour/one PM hour	1, 2, 3, 31, 43, 63
2022	Sunday	Span of service - one AM hour/one PM hour	1, 2, 3, 31, 43, 62
2022	Saturday	Frequency - 60 to 30 minutes	2, 43, 62

Figure 68: Palm Tran TDP Implementation Plan (2018 - 2022)

> *"Overall, Board members indicated more need for frequency over coverage, as higher frequency would likely bring more ridership and is more attractive to riders. There is still a need to balance transit coverage so that riders can access the system."*
> Palm Tran Transit Development Plan 2017-2026, p. 3-8

Choices between services pursuing the ridership goal and those extending coverage are fundamental to the transit planning process. The recommendations emerging from the TDP are consistent with a transit network focused on becoming more useful to more people, more of the time.

Brightline

Brightline is a private intercity rail system under construction between Miami and Orlando. Phase 1, from Miami to West Palm Beach, will go into operation later in 2017. Brightline is true intercity rail, stopping only in the downtown cores of Miami, Fort Lauderdale and West Palm Beach, as opposed to the Tri-Rail commuter system, whose stops are spaced much more closely.

The Brightline station in West Palm Beach, located at Evernia and Quadrille just north of Cityplace, is currently nearing completion. This site is immediately adjacent to stops in either direction of Route 1, Palm Tran's highest-ridership service, and is approximately 1/2 mile (walk distance) from Palm Tran's Intermodal Transit Center. Route 1 will provide an easy connection between the Brightline Station and the Palm Tran Intermodal Transit Center.

A key issue will be the timing of Brightline service relative to the schedule of Route 1. Brightline is expected to offer trains once per hour. If the timing of their schedule aligns closely to when Route 1 northbound buses pass the station, then it will be easy for riders to connect between Palm Tran and Brightline, and to continue on to other destinations via the timed connections between Route 1 and other routes at the Intermodal Transit Center.

US-1 Multimodal Corridor Study

US-1 is Palm Tran's highest-ridership corridor, served by the highly productive Route 1. It is also a critical corridor for the County as a whole, home to many of the densest residential and employment areas, cultural

institutions, and major destinations. This year, Palm Beach MPO began a study examining the roadway, intended to develop strategies to improve cycling, walking and transit in the corridor.

While still very early the process, thus far, the transit element of this plan is described as planning work for a "corridor-based BRT line" that would lay the groundwork for a future federal grant application. Features of such a project could include buses running in mixed-traffic, exclusive right-of-way, or a combination, and incorporation other technologies like transit signal priority, off-board fare collection, and level boarding station-style stops.

Glades Area Transit Master Plan

In 2014, the University of South Florida's Center for Urban Transportation Research (CUTR) completed work on a master plan for transit in the Glades region, focused on the development of alternatives responding to the proposed Inland Logistics Center that could be located just east of the town of Belle Glade.

CUTR developed two scenarios for transit in the Glades, mainly varying in terms of the location of the main transfer point between local routes and services connecting to the main urbanized area of Palm Beach County. In scenario one, the transfer point would continue to locate at West Tech, while in scenario two, the transfer point would be moved to the proposed Inland Logistics Center.

In both scenarios, the current Route 40 would be truncated at Wellington Green while raising the route to 20 minute frequency. Both scenarios propose increasing Route 43 to 20 minute frequency to facilitate connections to West Palm Beach at Wellington Green. A new express service between Belle Glade and West Palm Beach would be established, and both Glades local routes (routes 47 and 48) would be increased to 20 minute headways. The plan estimates approximately 30,000 and 59,000 new revenue hours would be required to operate each scenario.

5 Key Transit Choices

Ridership or Coverage?

The most fundamental choice before Palm Tran concerns ridership: *How important is maximizing ridership within the agency's fixed budget for transit?*

A goal of maximizing ridership serves several common intentions for transit, including:

- Reducing subsidy per ride (maximizing the number of people riding for every dollar invested into the service).
- Reducing vehicle trips, miles traveled or emissions.
- Support for denser urban development, where people are able to drive less and own fewer cars.

On the other hand, all sorts of other non-ridership transit goals also exist, and are also valid and important uses of transit resources. These include:

- Ensuring that everyone throughout the service area has access to some transit service.
- Providing lifeline access to critical services.
- Providing access for people with severe needs.

Figure 69 and Figure 70 provide a simple illustration of this principle for a fictional town. In each image, dots represent the distribution of the population and jobs. In the first, a ridership-oriented network focuses all of the agency's resources (represented by the cartoon buses) on just two routes, serving the two major dense corridors at high frequency, but abandoning all other segments. In the second, service is available on nearly every segment, but the two major corridors are served much less frequently.

No transit agency focuses solely on either of these goals. Most transit agencies have routes that generate a lot of ridership very efficiently, and others which don't draw as much ridership but which have an important social purpose. Throughout this report have observed routes meeting both of these descriptions within Palm Tran's current service offering. The challenge is to identify the appropriate balance between the two goals, and then to design services that are explicitly oriented towards either one, so that they can be evaluated relative to their purposes.

In its latest TDP update, completed in 2016, Palm Tran's service board considered the appropriate balance between ridership (there described as "frequency") and coverage goals. Many of the high-priority

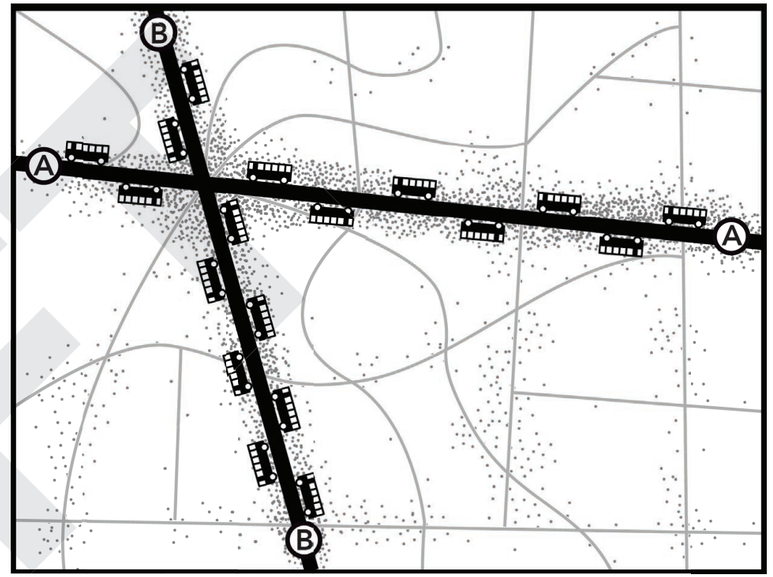


Figure 69: Ridership-Focused Network Diagram

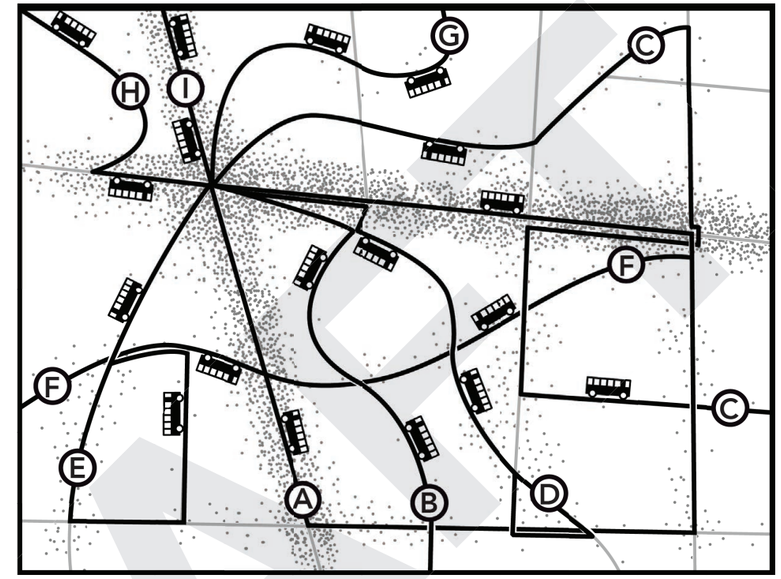


Figure 70: Coverage-Focused Network Diagram

recommendations emerging from TDP are consistent with a ridership goal (increased frequency and extended spans on key high-ridership routes), but records of discussion among the board suggest a continuing appreciation for the importance of transit's various social aims fulfilled by coverage services..

There is a danger, with conflicting goals, that an agency will be accused of failing no matter what they do, because their adopted goals are in conflict. If a high-ridership bus line is crowded, they are scolded for not offering enough frequency there; yet if they remove buses from a low-ridership line to reallocate them to the high-ridership line, they are scolded for cutting access that some people rely on. Only by acknowledging the conflict between these goals, and explicitly deciding how much effort to use pursuing each, can a transit agency succeed at both.

It is often said about public and private organizations alike that if you want to know what really matters, look at their budgets. High-level policies are valuable, but when they are vague or in conflict, the real evidence of what a community values is in the budget.

This first phase of the RPM will not develop an answer to what Palm Tran's position on the spectrum between ridership and coverage should be. However, it will develop Service Concepts to be integrated into a board and public conversation around this tradeoff. Ultimately, the aspiration to maximize the performance of the network first requires an answer to this question: to what extent should Palm Tran optimize for either of these values? Or more simply, what percentage of Palm Tran's service resources should be spent on the most convenient services in markets with high ridership potential, and what percentage should be spent on the goal of expanding access to the transit system to more people?

Walking or Waiting?

One aspect of a move towards a greater service design focus on ridership is the extent to which people are asked to walk to reach transit. Because of the many gated communities and challenge walk environments throughout the County, and particularly west of I-95, this issue is most relevant to the portion of the service area where grid development patterns and street connectivity permit longer walks, especially the older urban fabric of much of the area east of I-95.

Several routes in Palm Tran's network in these places provide service that is substantially duplicative for much of its length, in order to reach limited areas that are difficult to access from other routes.

For example, Route 70 from Lake Worth south to Boynton Beach duplicates the western side of Route 1's coverage area for much of its extent, in order to provide service very close to people living between Swinton

or Seacrest Boulevard and I-95. If it were decided that longer walks to Route 1 were tolerable in this area, Route 70 could be discontinued, and its resources used to increase frequency on that segment of Route 1 or elsewhere, increasing the convenience and reducing waiting times. This would improve the usefulness of the route, potentially drawing more ridership, but requiring people in the unique coverage area of Route 70 to walk farther.

Weekend Service Level

As was observed earlier in this report, Palm Tran's weekend level of service is much lower than during the weekdays. Only Route 1 operates at 30 minute frequency, with all other routes coming every hour. Service starts later in the morning and ends earlier in the evening, and on Sundays, many routes are withdrawn from service entirely. Figure 71 and Figure 72 compare each of Palm Tran's peer agencies weekday and weekend service levels[13]. Like Palm Tran, most peer agencies weekend service level is substantially lower than on weekdays, particularly on Sundays. Among its peers, Palm Tran has the third lowest Sunday service level relative to weekday, and the lowest among Florida peers.

Where possible, operating a comparable weekend service level to weekdays, at least on key high ridership routes, has a number of powerful benefits. Many people work on weekends, particularly in the retail, tourism and service sectors, and transit is much more useful to access those jobs when it runs as often and as extensively as on weekdays. Even among those who do not work during weekends, very few people cease the activities of their lives on weekends. Running a more comparable level of weekend service sends the message that transit can be useful not just to get to work during weekdays, but for all sorts of purposes, including weekday errands and leisure trips.

There is no correct answer to how a city should balance weekday frequency and coverage with daily and weekly long spans of service. Within a fixed budget, however, they do trade-off against one another, because expanding weekend service with a fixed resource base implies reducing weekday service.. Whether Palm Tran has struck the right balance for Palm Beach County, and for 2017, is a question that can be explored through the RPM.

A choice about weekend service can be considered separately from the choice about how to balance ridership and coverage goals. All-day, all-week transit is key to achieving high total ridership, and yet all-day, all-week transit also serves some important social goals that do not depend on high transit ridership.

13 Based on National Transit Database data for 2015.

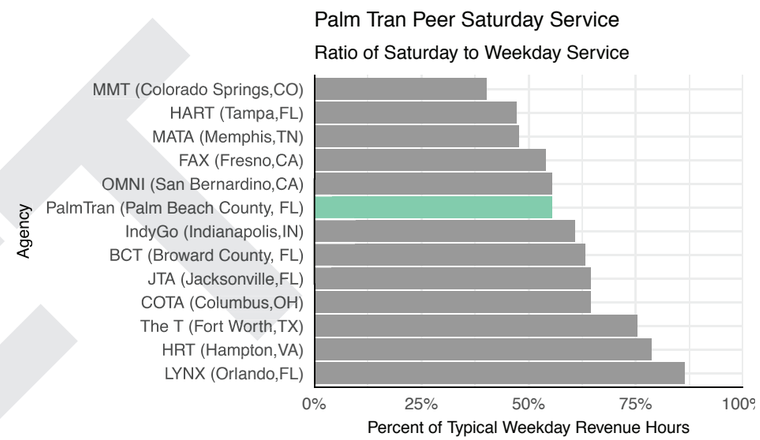


Figure 71: Palm Tran Peer Agency Ratio of Typical Saturday Revenue Hours as Percentage of Weekday Revenue Hours

Level of Service

One of the most striking observations one can make from comparing Palm Tran to its peers is just how little service it has, relative to other Florida agencies, or to similarly-sized service areas in other parts of the county. Palm Beach County is a fast-growing urban region of 1.4 million people, whose transit system operates a base of service hours designed for a place with nearly half a million fewer residents.

The RPM offers an opportunity to thoroughly reconsider aspects of the allocation of the current fixed route transit resources, and holds to potential to substantially grow ridership, depending upon the level to which the final plan focuses on strategies intended to meet that goal. However, efficiency measures implemented at a relatively constant resource base require difficult choices about which low-productivity coverage services to discontinue.

Similarly, given the low overall degree of coverage transit offers across the county (less than half of the population and jobs are within 1/2 mile of a transit stop),expanding the area and number of people with access to the system would require substantial cuts to more frequent services, with potential impacts to overcrowding and capacity.

The ridership/coverage choice is a hard one, particularly in a large region with a small level of service. Both have valid and important supporting rationales, and groups of people who will be impacted positively or negatively by a choice in either direction. Sometimes, the extent to which transit service can be made more efficient at generating ridership is limited by coverage obligations, particularly when the resource level is

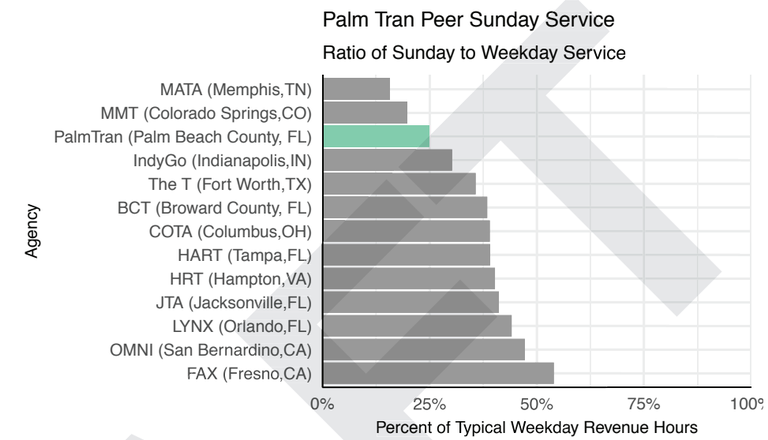


Figure 72: Palm Tran Peer Agency Ratio of Typical Sunday Revenue Hours as Percentage of Weekday Revenue Hours

low and needs are severe.

When frequency and overall coverage are both desired and limited, one way to achieve both goals is to seek additional funding.

Incremental Implementation or All-at-Once?

The answer to the question about the amount of service provided also has bearing on the question about how to implement a major service change. Any transit agency seeking to make major changes to its service must consider the timing to those changes: whether to implement them incrementally, or all at once.

This question must be considered in the context of the financial environment: is a flat level of service being redistributed based on changing priorities, or is new service being added?

By considering both questions there are four basic options:

- Incremental implementation with a fixed overall service hours.
- All-at-one implementation with a fixed overall service hours.
- Incremental implementation with expanded service hours.
- All-at-one implementation with expanded service hours.

The current TDP suggests that the County is interested in a ridership-focused network redesign. If the overall service hours are fixed, then

such a redesign implies the reduction of coverage service (either in the area covered, in the frequency of service, or both) and the use of those resources to improve or expand the most useful, most frequent elements of the network.

A ridership-focused network change is naturally disruptive and controversial, so when completed all-at-once, the community reaction can seem very negative during implementation because of the immediate disruption to so many people. When new resources are available for transit, ridership-focused improvements can be accomplished with few, if any, coverage cuts; without new resources, some degree of coverage loss is inevitable.

Incremental Implementation

Transit agencies often begin a process of redesign intending to implement changes incrementally, rather than forcing their customers to navigate a major disruption of travel patterns all at once. Over a number of service changes, system improvements are progressively brought into operation. When all service changes have been made, a new, redesigned network is then in place.

This method avoids a major "Day 1" disruptive event, and means that costs associated with implementation (infrastructure, bus stop facilities, etc.) can be borne over a longer period. However, without new resources, implementing ridership-focused improvements (requiring coverage reductions) over time also implies taking on a continuing public outreach effort responding to those people negatively impacted by such reductions.

Often, the smaller network changes made in phases under an incremental implementation process do not add significant frequency and can therefore seem like service cuts rather than reapportionment of service. Also, in an incremental implementation under fixed resources, any coverage cuts will inevitably focus on just a few routes at a time, making those neighborhoods and riders feel they are being punished or singled out for cuts.

It is challenging to communicate the positive benefits of the overall, longer-term plan when the public conversation around a single, small service change during its implementation focuses on the just one or two routes. Thus, in incremental implementation process, many compromises are often made over time to mitigate the impacts of coverage losses to each individual neighborhood and these compromises often undercut the ridership focus of the overall plan.

With new revenue and operational resources dedicated to the ridership goal, this problem is much less acute. Ridership-focused improvements can be incrementally implemented with few changes to the coverage network. But, if those additional resources are promised but never delivered, then the more ridership-focused network is never delivered.

All-at-Once Implementation

The main alternative to incremental implementation is to institute all changes to the transit network at one time. The most recent well-known example of this took place in 2015, when Houston METRO overhauled their transit network overnight, changing all routes, frequencies and numbering at once in order to implement a service design that reoriented the agency's resources towards high-ridership, high-frequency service.

There are a few key advantages to this implementation strategy. First, it allows all ridership/coverage tradeoff issues to be discussed at one time as part of a single, larger public conversation around the plan. This means that the agency can focus its outreach efforts on one large effort that is more likely to be of interested to media, diverse stakeholders and the public than a continuous sequence of small changes. The costs and benefits of changes aimed at generating higher ridership can be communicated on the network level, rather than service change-by-service change, and people who might be negatively impacted by one aspect of the plan have a greater opportunity to evaluate other aspects that might provide a positive benefit to their travel behavior.

All-at-Once implementation can also have a positive impact on the potential for expanding transit funding in the long-term. One key challenge for many transit providers is making clear how transit service is meeting the goals of the community. By embarking on a clear and transparent conversation with the community about the right balance between ridership and coverage service in the transit system, the transit agency can establish the most appropriate policy and balance between those goals. When the community can see that the transit agency is meeting the goals it has set, confidence in the transit agency increases and the willingness of the community to support transit service may increase.

All-at-Once Implementation also has some major challenges that an agency must prepare for when developing a redesign plan. Changing everything at once means writing new schedules, adding new bus stops or infrastructure, and even retraining drivers, throughout the organization, all during the same period of time. New customer informational materials must be designed, printed and distributed, and a substantial marketing campaign must be undertaken to ensure that the public is aware and informed about the changes coming to the network. All of these processes have costs in terms of staff time and materials.

Of course, the easiest path, if significant additional resources are available, is to implement a major shift in service all-at-once, but add enough resource so that existing coverage service is not cut. Typically, this approach is hard to implement because the additional resources are not available in the short-term.

Partial Implementation + New Resources

It is possible to implement in a manner incorporating aspects of both approaches, but only in the context of the addition of new service. Rather than making a dramatic move towards ridership, drastically shifting the balance of existing service, a more limited refocusing of service might first be implemented. This may allow a more limited degree of coverage reduction, while still freeing up revenue hours to put towards services seeking high ridership. Then, as new revenue became available in the future, more ridership-focused improvements would be progressively implemented.

For example, imagine a transit agency that spent approximately 50% of its current service resources on ridership-focused routes, and 50% on coverage. The public and its leadership could direct that agency to shift to an 80%/20% split between ridership and coverage, but feel that doing so at one time might be too disruptive, but also that slowly introducing those changes over a period of years could result in a continuing set of difficult public conversations around coverage loss.

One alternative, if additional resources are anticipated, would be to shift the balance of service to 70% ridership, 30% coverage in the short-term with an all-at-once implementation, and then to continue to introduce ridership-focused improvements over time. This hybrid approach would slowly shift the balance of service towards the original 80%/20% goal (and the various specific services included in the accompanying network design).