An Economic Valuation and Cost Assessment Analysis of the Panama City Crayfish in Bay County

Prepared for:
Florida Fish and Wildlife Conservation Commission (FWC)

Center for Economic Forecasting and Analyses (CEFA)

Florida State University (FSU)
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Executive Summary

The Florida Fish and Wildlife Conservation Commission (FWC) requested that the Florida State University Center for Economic Forecasting and Analysis (FSU CEFA) conduct an economic analysis study of the Panama City Crayfish (PCC) habitat range. The FSU research team perceived the core of the assistance request to be one of value and/or cost allocation of scarce resources (i.e. available land), land value, proportional land allocation shares (e.g. zoning) and associated economic impact.

The results of the analysis pertain to this study site, and should be tested and replicated at other sites under variable conditions. Re-allocation or re-zoning results in an economic value determination, thus, the study team applied an economic valuation approach to the potential re-allocation of land to PCC habitat. The essence of the methodology examines the reallocation of urban land acres for PCC habitat use. Re-allocation or re-zoning is in essence viewed either as an elimination, or cost/loss of urban land (or conversely, a benefit in valuation of habitat restoration). The re-allocation reduces further use of the same land for urban economic purposes. A further breakout of alternative uses within the realm of non-urban, or rural land uses, was not included in this study. The analysis uses the valuation of urban land acres (with the caveat that land and building improvements and structures are included).

Regarding the analysis results, the minimum total integral cost, or re-allocation at the optimal point of one urban acre to one of non-urban or rural use is estimated at approximately $140,000 in indirect economic benefit/loss, and/or $140,000 in direct total parcel purchase costs (i.e., the out of pocket costs) when an urban acre is bought for re-allocation purposes. In addition, the research team found about 1,000 acres around the optimal cost point.

In the western portion of the PCC habitat range, about 129 parcels were found that fit the FWC criteria or conditions on acreage, while there were 670 parcels found in the eastern range. A further selection based on just values of parcels shows that agricultural lands are the least expensive parcels, of the total land use codes/types. A large number of soils on the agricultural parcels are listed as "Albany Sand, 0-2° Slopes", which has a 15.65% PCC presence (or less than a third of the PCC found on Plummer Sand).

The research team found the mean value per agricultural acre in the eastern area to be $8,310 per acre, and $9,978 per acre on the western section of the PCC habitat range. Based on the decision criteria (see FWC PCC mitigation calculator in Appendix 1) of expanding the PCC habitat an additional 2,000 acres; if a purchase was made of a total of 500 acres in the western section and 1,500 acres in the eastern section, the expected price is estimated to be a total of $19,122,000 (based on just values). The potential purchase or reallocation of acres for PCC habitat use will have economic benefits/loss consequences. The purchase of parcels will preclude any future planned or perceived other uses and activities in perpetuity, but for PCC habitat, restoration and maintenance.

To the perception of the research team, it would depend highly on additional available data concerning the real estate market conditions to further refine the economic valuation analysis. In conclusion, the research team found that the further selection and purchase of agricultural parcels on the eastern side for PCC preservation would result in an average price of $8,310 an acre, compared to about $140,000 for an urban acre (on the western side). There is an added benefit of a reduction in restoration costs of the agricultural parcels in order to be designated, or transformed, to suitable PCC habitat.

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Background and Perspective

The Florida Fish and Wildlife Conservation Commission (FWC) requested the Florida State University Center for Economic Forecasting and Analysis (FSU CEFA) to conduct an economic analysis study of the Panama City Crayfish (PCC) habitat range (Figure 1). The boundary of the PCC habitat range is marked by the thick grey line. The Transmitter Road serves as a dividing line between the East and Western portion of the PCC habitat range.

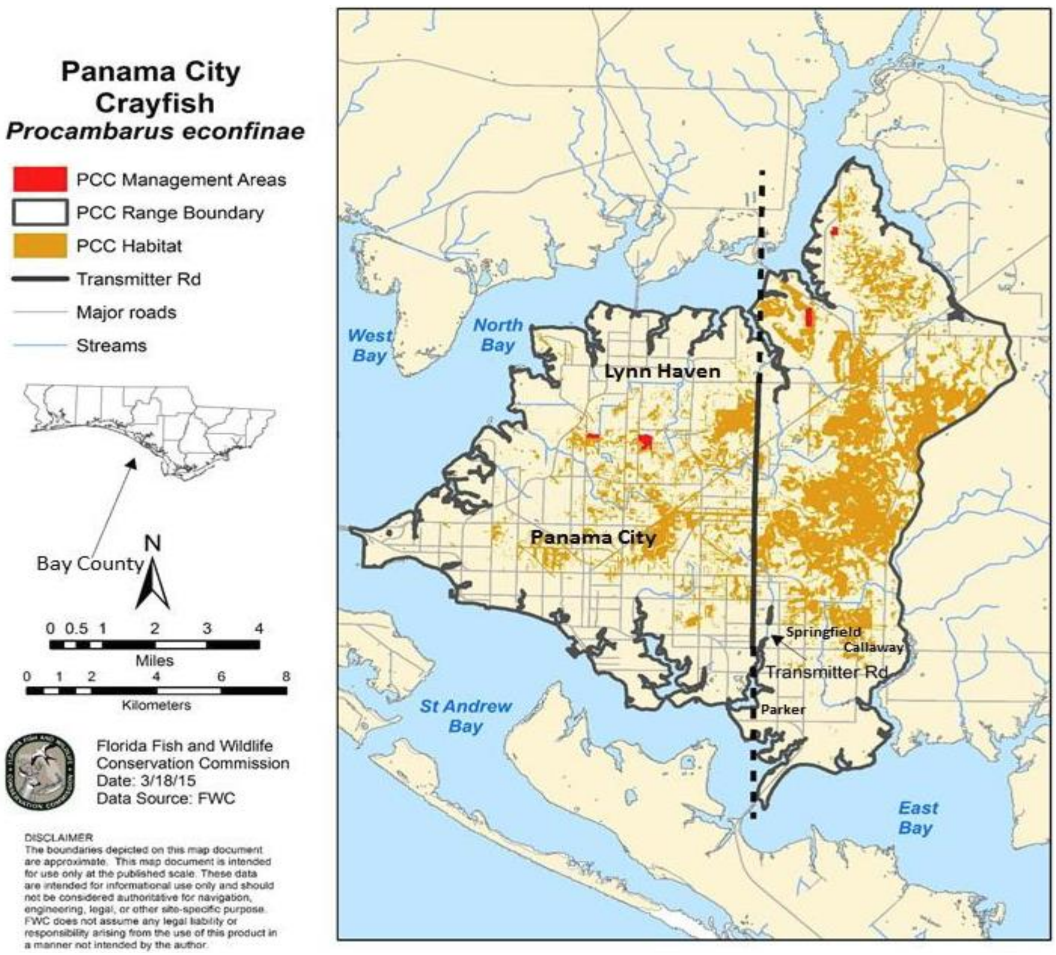

Figure 1. The PCC Habitat Range

The Species Conservation Measures and Permitting Guidelines for the Panama City Crayfish were produced by the Florida Fish and Wildlife Conservation Commission (FWC) with input from stakeholders. The guidelines were developed as a means to assist in supporting the goal and objectives of the FWC's Panama City Crayfish Management Plan, a separate document, with an anticipated April 2016 release date. The overall goal of the management plan is to ensure the long-term conservation of the Panama City Crayfish (*Procambarus econfinae*, PCC) throughout its range so that it no longer warrants listing by the State of Florida[1]. The objective under the goal areas is described below:

1) Increase the total area of occupied PCC habitat by 2,000 acres: 1,500 acres in the eastern portion of its range consisting of parcels that are each ≥ 25 acres and at least 5 parcels in the western portion of its range that are each ≥ 5 acres. These management areas will be secure in long-term easements and managed in perpetuity. The Transmitter Road serves as the dividing line between the East and Western portions of the PCC range.
2) Develop and evaluate methods to accurately determine PCC densities and assess population status (age structure and sex ratios) to determine a minimum viable population size and to develop translocation guidelines.

The FWC is requesting assistance in order to compile a series of cost mitigation strategies or scenarios for the PCC which exists in a very limited range in Bay County, Florida. The species is proposed for listing as a state-designated threatened species.

The Panama City Crayfish (PCC) occurs within a very limited range in Bay County, Florida. The species is proposed for listing as a state-designated threatened species. Take,[2] under

[1] Extracted from the Draft Species Conservation Measures and Permitting Guidelines for the Panama City Crayfish, Dec. 10, 2015.

[2] (4) Take – to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in such conduct. The term "harm" in the definition of take means an act which actually kills or injures fish or

this listing status, is defined by Rule 68A-27, F.A.C., and the conditions under which permits can be issued are outlined in Rule 68A-27.007, F.A.C. Permits for take are issued if they have a scientific or conservation benefit and the permitted activity cannot have a negative impact on the survival potential of the species.

In many cases, to achieve a conservation benefit while allowing take necessitates mitigation to offset the take and provide the additional benefit. Stakeholders in Bay County have asked for a streamlined approach for permitting and determining mitigation. FWC staff developed an impact assessment tool for this purpose, but need assistance in determining the appropriate final cost of using this (or a similar tool). Additionally, stakeholders in Bay County have asked that FWC continue to explore additional options to develop appropriate mitigation.[3] FWC is seeking economic input on the use of the impact assessment tool as well as other mitigation strategies:

1. Impact assessment tool: ideas to explore for determining the contribution structure

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wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. The term "harass" in the definition of take means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering.
Florida Administrative Code (F.A.C.), Chapter 68A-27: Rules Relating to Endangered or Threatened Species; retrieved at https://www.flrules.org/gateway/ChapterHome.asp?Chapter=68A-27

[3] Environmental mitigation, compensatory mitigation, or mitigation banking, are terms used primarily by the United States government and the related environmental industry to describe projects or programs intended to offset known impacts to an existing historic or natural resource such as a stream, wetland, endangered species, archeological site or historic structure. To "mitigate" means to make less harsh or hostile. Environmental mitigation is typically a part of an environmental crediting system established by governing bodies which involves allocating debits and credits. Debits occur in situations where a natural resource has been destroyed or severely impaired and credits are given in situations where a natural resource has been deemed to be improved or preserved. Therefore, when an entity such as a business or individual has a "debit" they are required to purchase a "credit". In some cases, credits are bought from "mitigation banks" which are large mitigation projects established to provide credit to multiple parties in advance of development when such compensation cannot be achieved at the development site or is not seen as beneficial to the environment. Taken from-https://en.wikipedia.org/wiki/Environmental_mitigation

   a. Cost of implementing conservation actions
      i. Land management
      ii. Habitat acquisition
      iii. Habitat easements
   b. Vacant land value – average based on lots with existing potential habitat
   c. Loss of value of on-site mitigation – if sites opt for on-site mitigation, what economic benefit do they give up by not developing? Can this be used as a basis for financial mitigation?
2. Proportionate fair share: stakeholders asked that we look at concepts similar to how counties have assessed impacts of large businesses on infrastructure needs.
   a. Contributions are spread out over many (all?) entities in the range – collected by county/municipality for implementing conservation actions.
3. Focus on commercial development over single family homes or modifications on residential lots:
   a. Consider existing zoning and habitat found within each zone.
   b. Is 2,000 acres in conservation achievable if small lots aren't considered?
   c. Does excluding single family home zoned areas change the economic impact to the county?
4. Estimated cost of implementing permitting strategy on a yearly basis?
   a. Based on options above, and analysis of development patterns in the range of the PCC.

Report Overview

The section "Economic Analyses Framework" of this analyses report will reflect on available literature and economic thought regarding the place and role of nature from an environmental economics perspective. The focus in the section "Building Blocks for Mitigation Analyses" will be on the necessary building blocks or components for the analyses regarding the PCC habitat mitigation. In the section "Combination of Economic Benefits/Loss and Total Parcel Purchase Cost" the various elements or components will be put together in a coherent methodological framework for analyses. The final section provides some discussion pertaining to the study results and conclusions. In the sections "Assessment and Mitigation Tool, and Assessment Calculator" an attempt is made by the research team to fill in some of the blanks in the Assessment and Mitigation Tool (Appendix 1) and the Assessment Calculator (Appendix 2). Appendix 3 describes a discussion of an alternative analysis done (for validation purposes) in the section "Combination of Economic Benefits/Loss and Total Parcel Purchase Cost".

Economic Analyses Framework

The concept and/or role of nature are still very much debated in economics; though important advances have been made. Usually, the disclaimer is that the Gross National Product (GNP) doesn't provide an adequate index of social welfare,[4] yet no widely accepted alternative is available.

The term "external economies" is important to the concept of nature in economics (externalities), and was first coined by A. Marshall in 1890.[5] Currently, "externalities" are defined by benefits or setbacks received by third parties not involved in the production or consumption of a product or service. The notion is important, in terms of recognizing the existence or occurrence of benefits and costs outside a market that (may) influence decisions made by third parties. The concept of externalities was elaborated upon by A.C. Pigou in 1920,[6] in perceiving externalities to cross social and private sector use. The real enhancement and broader acceptance of social costs of production in literature came only in the sixties, with the works of K.W. Kapp and E.J. Mishan.[7] Kapp defines social costs (including environmental pollution; deterioration, depletion and destruction of natural resources) as the direct and indirect losses by third parties or by society as the consequence of unbridled economic activities.[8] Mishans' work *The Cost of Economic Growth* was the first analyses emphasizing the disadvantages (external effects) of economic growth, stressing the need for increased regulation. In case of an external effect the market price of a good is not a good indicator for its social marginal value. The social value, i.e. the value which results after deducting the estimated damages to third parties may even be

[4] Welfare for economists is a psychic entity (or experience) and thus immaterial.
[5] A. Marshall, (1969) p. 221 e.v.
[6] A.C. Pigou (1962) pp. 131-135, and pp. 183-196
[7] K.W. Kapp (1950 and 1963) and E.J. Mishan (1967)
[8] K.W. Kapp (1963) p. 13.

negative. To achieve an optimal situation in case of a negative effect, production should be reduced (lowering adverse effects) until the social value has risen to its marginal social costs. As known, the optimal allocation of production factors occurs there where marginal cost is equal to the price of a product. This may be accomplished via compensation payments to victims or by adopting policies aimed at eliminating/preventing damages. Private marginal cost will therefore be transformed into the social marginal cost, which will cause prices of goods to be equal to their social marginal costs in all sectors of production. In order to achieve a better living environment, according to Mishan, "amenity rights" should be set. Mishans' approach of deterioration of nature is mainly an allocation and fairness problem. On a side note, K.E. Boulding perceived economic science as too limited, describing only production- and consumption (or 'throughput'). Instead, his system approach (or spaceship-economy) includes limited resources ('input') and limited absorption capacity of the earth as reservoir for waste ('output'). In his perception, Gross National Product should be perceived as a Gross National Cost, leading only to increased entropy, while using the capital assets of the earth. The former is to be minimized while the latter is to be preserved.

In addition to Kapp and Mishan, are J.W. Forrester and D.L. Meadows, both economic modelers.[9] Their models include variables such as: population, capital assets, unrenewable natural resources, available land, and pollution, in which land and capital are broken down to specific uses (e.g., agriculture, industry, services, etc.,) and proxy variables (e.g. industrial production, food, life span multipliers due to pollution, pollution absorption ratios, and capital being spent on remaining shrinking reserves, etc.).

[9] E.g. in J.W. Forrester, World Dynamics, Cambridge (Mass.), 1971 and;
D.H. Meadows e.o. The Limits to Growth, New York, 1972.

Finally, the study team reviewed the work of R. Hueting.[10] In his work, he describes nature as providing useful functions per nature component. A function is defined as usefulness of an environmental asset. Deterioration of nature is defined as reduced availability hence increased scarcity of a function. Due to production and population growth, functions are increasingly subject to competition; e.g. use of one function may preclude or reduce alternative uses. Competing functions reflect the limitation of potential uses of the environment.

Pertaining to the top portion of the following Figure, Hueting includes the elimination measures cost-curve (E) with a compensation/financial loss measures cost-curve (C+S). Nature function loss(es) may be described by elimination. Restoration may come at different levels. On the horizontal axis, Hueting measures purity of a natural component. The measure of purity will increase if emissions are eliminated or “onerous” use decreases, or in other words the rate of purity goes hand in hand with function availability, hence a positive slope (i.e., the E-curve). On the other hand, compensation and financial loss ((C+S) -curve) is expected to be higher, via indirect costs, with a lower rate of purity (hence negative slope). Societal cost will be the combined costs of both (i.e., the T-curve). In effect, an optimal rate of purity may be determined (at purity level L). The bottom of Figure 2 depicts the same analyses but from the perspective of marginal analyses. Marginal elimination cost (e) is likewise sloping upwards while compensation and financial loss cost ((c+s)-curve) is sloping downwards, with the optimal situation being reached where marginal elimination equals marginal compensation/financial loss (c+s=e or c+s+e=t=0; marginal total cost is zero), this at a purity rate of C corresponding to level L in the top portion of Figure 2.

[10] Hueting, R.: New Scarcity and Economic Growth, Agon Elsevier Amsterdam/Brussels 1974)

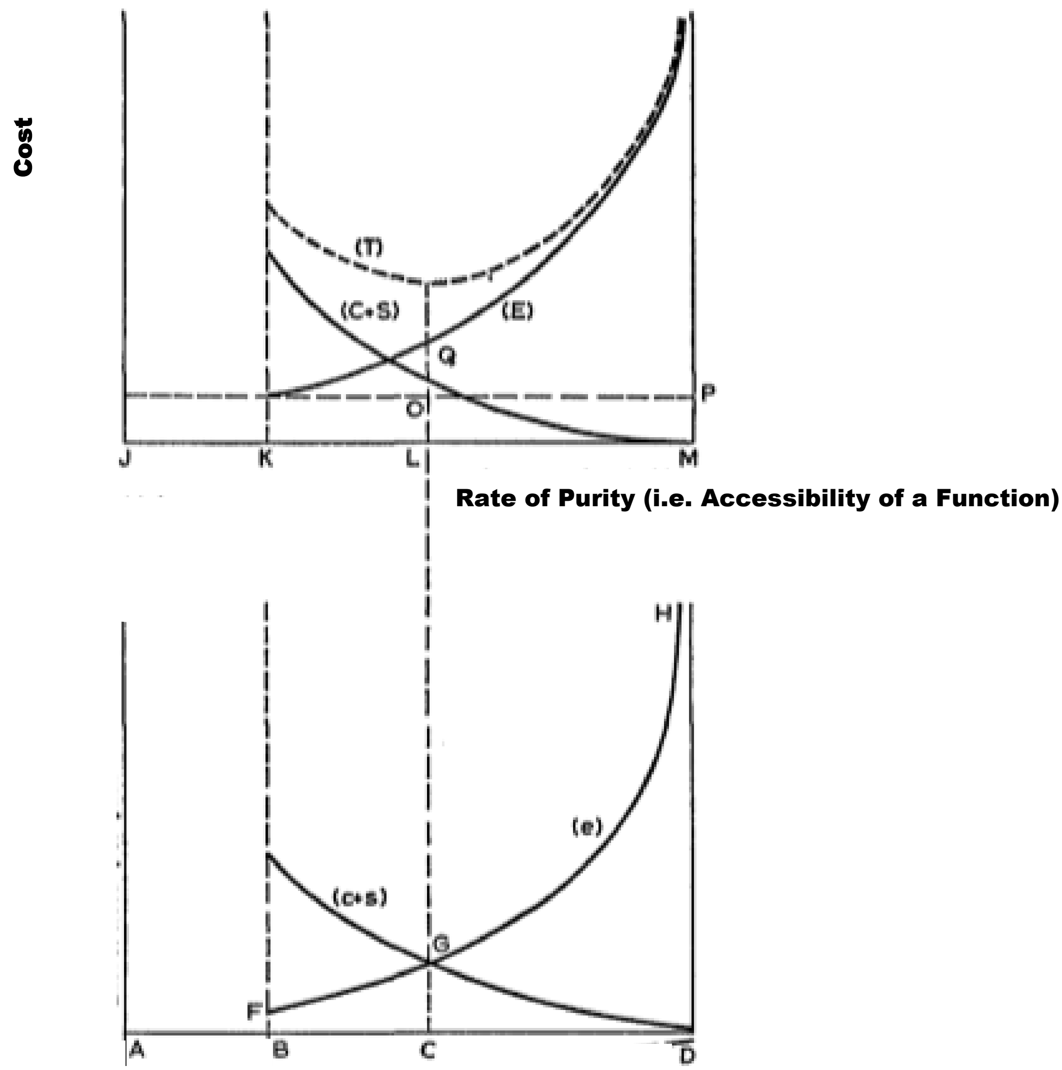

Figure 2. Elimination Cost-Curve (E), Compensation/Financial Loss (C+S) Cost-Curve, and Total Cost-Curve (T)[11]

The mitigation of wildlife species is not (yet) routinely incorporated in economics, given that economic value is difficult to assign. With the above approach, it is the allocation of functions and not the final user (human or wild species) that is key to the analysis. The

[11] Figure taken from Hueting (1974), p. 111.

analysis concerns competition between alternative and competing uses. For example, land among other uses: e.g., construction, infrastructure, agriculture, natural habitat preservation and restoration (including habitat competition between species X, Y and Z). Therefore, functions in, or of, nature are subject to the same allocation problem in economics as allocation involving factors of production.

Since the mid-seventies, numerous studies have used either a nature function-related approach or by economic valuation (e.g., measuring willingness to pay, ecosystem services, etc.). The challenge for economists is that only a few functions relating to economic values (for threatened and/or endangered species) are priced in markets.

The FSU CEFA research team will utilize a similar aforementioned approach as Hueting, albeit with some modifications. The focus for this study will be on land use (given scarce availability), and not on water allocation, which is equally necessary for the same PCC habitat.[12] The horizontal axes of Figure 2 therefore will correspond to the available land area in the designated PCC habitat range (as per Figure 1). Second, the focus will be on scarce land resource allocation, in terms of Urban versus Non-Urban or Rural allocation (not between different Non-Urban or Rural uses). A necessary assumption is that PCC habitat (re)allocation falls into the land-use category Non-Urban or Rural (again precluding competition between different Non-Urban or Rural allocations). Thus, the issue at hand is a re-assignment or a re-allocation of land to PCC habitat, whereby the same land is no longer available for Urban uses and/or Urban development. This is similar to the elimination measures cost curve in Hueting's approach. The next step is to determine a relationship between Urban land acres and economic benefit/loss. This relationship serves in

[12] Note: Data on water allocation in the Bay area is far from sufficient to include water volume in the analyses as a second scarce resource, though flow (not inventory) in terms of water production (extraction) and natural rainfall may provide a start for a slightly different and more comprehensive analyses.

estimating the economic benefit/loss of not developing (i.e. eliminating) a parcel of land for Urban use purposes. Land value assessment, or estimation, using "Just Value"[13] NAL[14] data by the Department of Revenue (DOR), will be used as "sales price" for transferred property. In principle, values are determined in the market, but many sales data points in the NAL database proved fiduciary or otherwise value constrained. The "Just Values" will be used as indicator for mitigation cost and/or purchase (i.e., the out-of-pocket cost similar to Hueting's compensation/financial loss measure cost curve). In addition, the latest NETS[15] data available is for the year 2013, while the available DOR NAL data used is from 2014. No attempt is made to bridge the one year, as the research team believes it wouldn't impact the analyses significantly. It should also be noted that the analyses will be static, thus will hinge on the assumption of ceteris paribus; i.e. other things being equal or remaining the same. Finally, the analysis is based on the input data used. Additional data (i.e., including assessment and mitigation tool data, among other data) will lead to more comprehensive economic analyses.

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[13] "Just Value" is the Department of Revenue property appraiser's opinion of market value after an adjustment for criteria defined in F.S. section 190.011.

[14] Name, Address, Legal (NAL)

[15] National Establishment Time Series (NETS)

Building Blocks for Mitigation Analyses

The estimation of the benefit or cost in land allocation for PCC habitat involves various elements, or building blocks. An operational description of the area is depicted in Figure 1. The research team found five zip codes; 32401, 32402, 32404, 32405 and 32444,[16] which, in whole, or in part, match and overlap, the PCC habitat range. Given that the area of zip code 32404 stretches beyond the PCC habitat range, both to the North-East, East and South-East, an algorithm was developed by the research team in order to define the East boundary. This was done based on Latitude and Longitude approximations[17] of eighteen nodal points as depicted in Figure 3; the Applied East-boundary of the PCC Habitat Range.

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[16] 32401: Cities: Panama City, FL (82.17%), Springfield, FL (10.99%), and Cedar Grove, FL (3.70%)
32402: contained within ZIP code 32401
32404: Cities: Callaway, FL (6.50%), Panama City, FL (4.91%), Parker, FL (1.65%), Springfield, FL (1.25%), Lynn Haven, FL (1.01%)
32405: Cities: Panama City, FL (39.98%), Cedar Grove, FL (8.88%), Lynn Haven, FL (8.52%), Pretty Bayou, FL (7.86%), Springfield, FL (3.81%)
32444: Cities: Lynn Haven, FL (57.83%), Panama City, FL (0.10%)

[17] Using Figure 1 and data retrieved from http://www.findlatitudeandlongitude.com

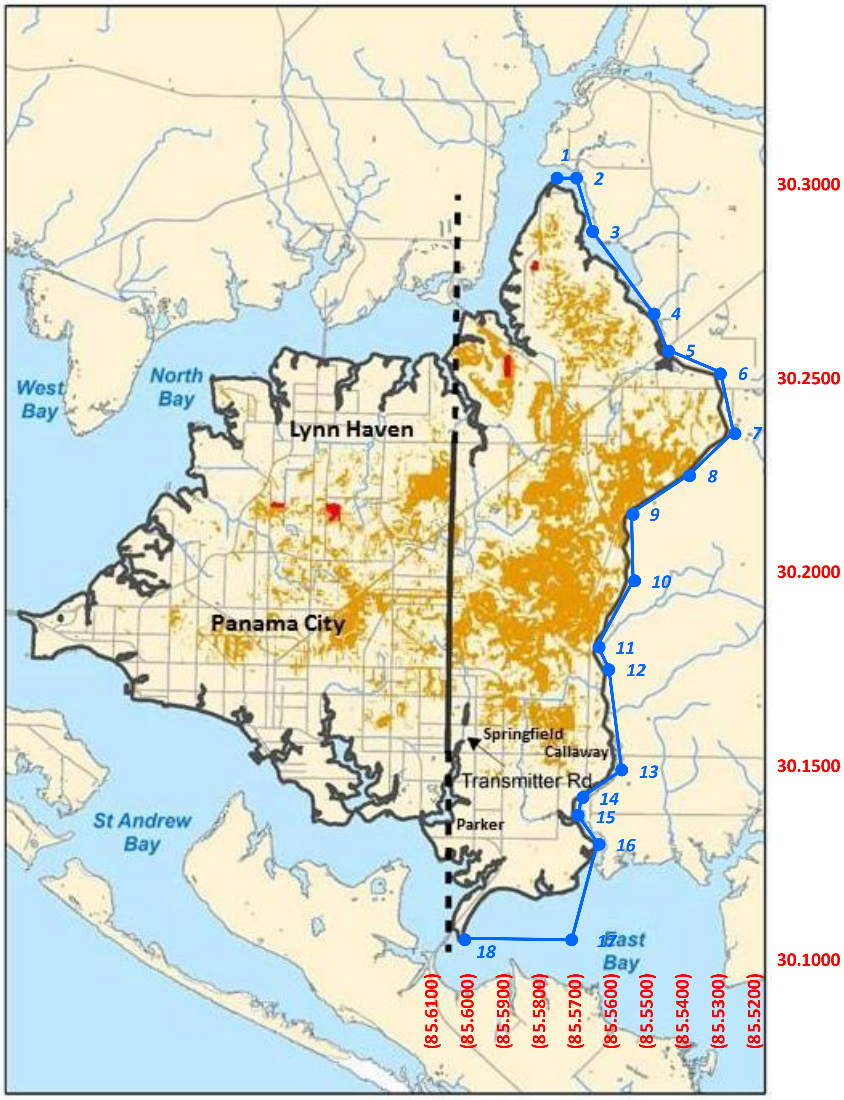

Figure 3. Applied East-Boundary of the PCC Habitat Range

The zip code selection and subsequently the algorithm on demarcation of the East-boundary was applied to data from the Department of Revenue (DOR) NAL13F20 database,[18] containing parcel ID's, "just value" (appraiser's value) and other variables, such as square footage, and sales price ("Sale-PRC1" and "Sale-PRC2") (if owner transferred), combined with Latitude-Longitude data, in order to establish a working database for the analyses.

The working database reveals some 45,736 Parcel ID's within the defined PCC habitat range. Converted to acres, the database contains about 60,022 acres.[19] Concerning the property valuation, in the last two years, 5,974 parcels (13.1%), changed hands, at least once (not always valued[20]). For the purpose of this study, the research team opted to use the "just values" (rather than "market values") on sold properties.[21] The average "just value" in the working database is $157,719 (standard deviation $635,916), with a median value of $94,500.

Parcels found in the database are depicted in Figure 4, based on the latitude-longitude information.[22] The East-Boundary of the PCC habitat range is denoted by the red line.

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[18] Department of Revenue, Tax Rolls, Tax (Assessment) Roll Data Files - the real and personal property files submitted to the Department of Revenue by property appraisers. Data retrieved from: http://dor.myflorida.com/dor/property/resources/data.html

[19] The land mass is slightly (approximately 3 percent) over the total zip codes area square miles' data available (excluding zip code 32404), with the main differences being in part due to comparative square miles information being available in one decimal only, the East-boundary estimation (as per Figure 3), rounding and reporting issues. For the purpose of this analysis, the research team will work with the aforementioned area of 60,022 acres.

[20] For the first sale, blanks showed in 355 rows, while e.g. 1,535 rows show a reported sales price of $100 only. In addition, it is noted that at least a small subset of parcels has been sold under unfavorable conditions as well, this based on over six hundred local Real Estate sales data collected from the internet using Zillow Real Estate, and other real estate agents' internet websites.

[21] A decision was made by the research team to use "just value", because the market values provided in the NAL database were either incomplete or inaccurate values.

[22] The figure is overlaid on Figure 1.

In addition, variables from the Department of Revenue NAL13F20 database are included that represent a function of the environment. The NAL data provides some coding on appraised land/parcels, namely: DOR_UC 000 through 009 is used for Residential, 010-039 for Commercial, 040-049 for Industrial, 050-069 for Agriculture, 070-079 for Institutional, 080-089 for Governmental, while the remainder codes up to 099 is used for three miscellaneous groups. In particular, codes 050 through 069, pertaining to Agricultural parcels, total about 21,942 acres, or 36.6 percent, of the total of 60,022 acres. About 95.5 percent of agricultural acres fall into four categories of timberland.[23]

[23] DOR_UC codes 054, 055, 056, and 059.

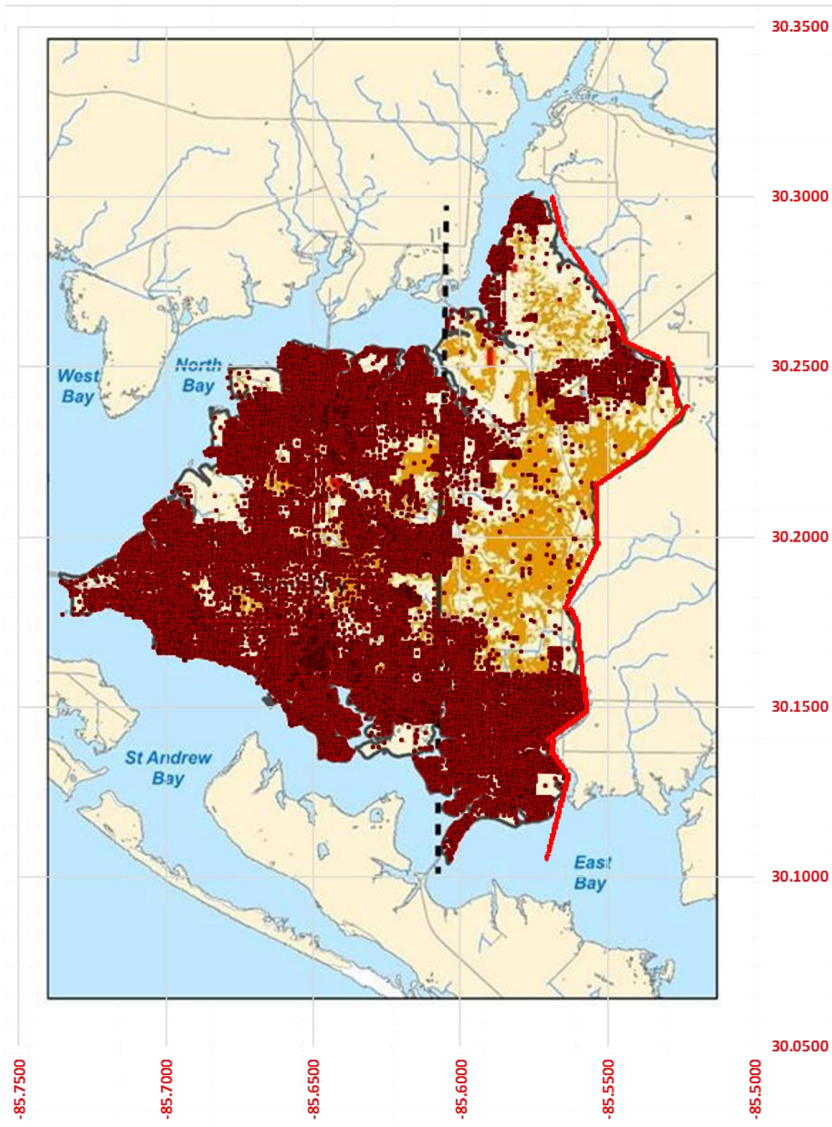

Figure 4. Overlay of Parcels on the PCC Habitat Range

For analyses purposes, a demarcation is set in the working database on transferred, or sold, parcels (first sale only during 2014). Using all data points from the database would be equivalent to flooding the market with all available real estate at the same time, which would introduce a huge distortion to the analyses. The sold Agricultural parcel information (using the aforementioned codes) is set aside for now, based on the assumption that these are already assigned to Non-Urban or Rural zoning. The subset of sold parcels in the working data base showed only six or seven available data points for Agricultural properties.[24] Hence, the remaining Urban lands or acres were used for further analyses. This is based on the assumption that only Urban lands may be in for a potential re-allocation or re-zoning to Non-Urban or Rural, for PCC habitat uses. The examination of Agricultural parcels sold therefore falls outside the scope of study, since a different analysis would be necessary (measuring different or even competing Non-Urban and/or Rural uses). Re-zoning is seen by the research team as key to allocate land to the PCC habitat range.[25]

In addition to parcel sales, the construction of an Economic Benefits/Loss function is necessary in order to analyze the reduced economic benefits (i.e. economic loss or cost) by not developing parcels for Urban use.[26] This analysis will be conducted using the NETS database.[27] The same zip codes and East Boundary demarcation defined earlier in this report (i.e., the DOR parcel id's) were used to extract available data on Sales (for years 1999 through 2013) from the NETS database. The NETS reveals data on some 11,528 local, or area, establishments in 2013.[28] Figure 5 shows all establishments in the East and West Boundaries of Bay County (with the PCC habitat range in red).

[24] For statistical results pertaining to all the available PCC rural or Agriculture (use codes 50-69) land parcels for 2014: N=98 parcels, Average=$6,419 per acre, Median-$2,328 per acre. Average number of acres per parcel=223.9 acres, Median number of acres per parcel=184 acres.

[25] The potential land purchase and re-allocation is similar to Hueting's compensation/financial loss measure cost curve (C+S) in Figure 2.

[26] Similar to Hueting's elimination measure cost curve (E-curve) in Figure 2.

[27] The National Establishment Time-Series (NETS) Database is a time-series database on establishment information. NETS provides longitudinal data on various dynamics of the U.S. economy that include establishment job creation and destruction, sales growth performance, survivability of business startups, mobility patterns, changes in primary markets, corporate affiliations that highlight M&A, and historical D&B credit and payment ratings. It contains information on some 4.5 million unique establishments in Florida, businesses, non-profit and government, between 1990 and 2013.

[28] NETS reporting may vary from year to year. Clearly a database is subject to the usual dynamics and "no data reported" on a given establishment doesn't necessarily mean that it is out of business.

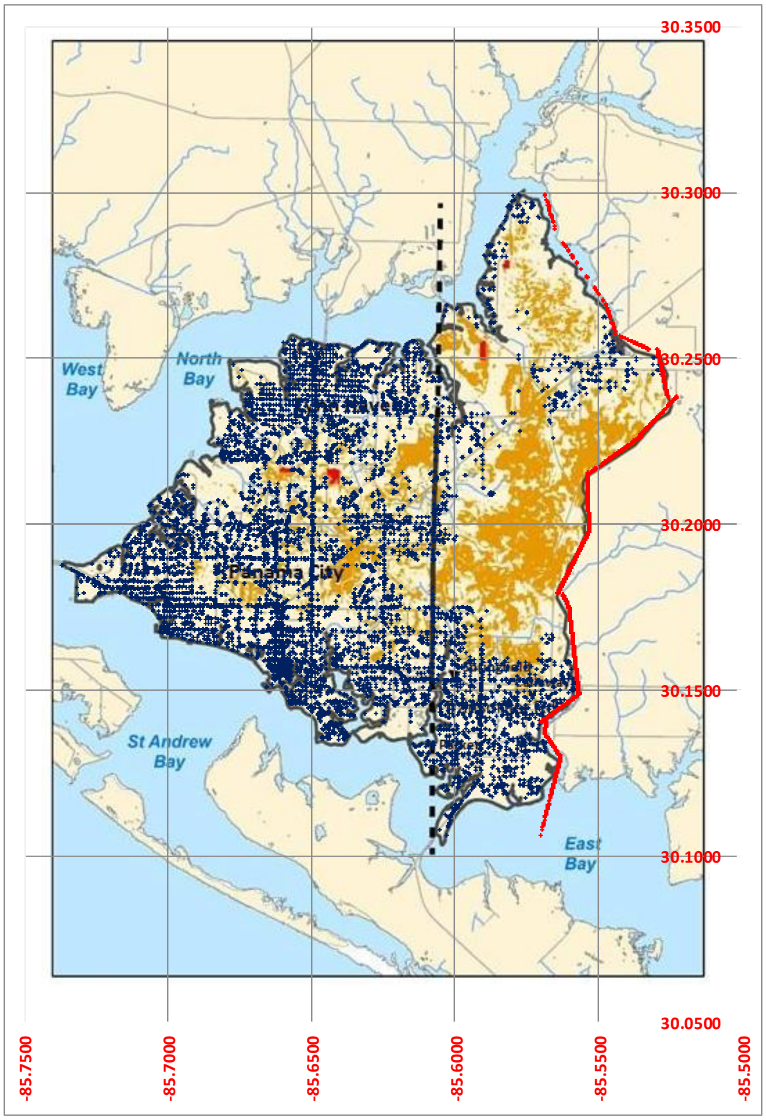

Figure 5. Overlay of Establishments on the PCC Habitat Range

Combination of Economic Benefits/Loss and Total Parcel Purchase Cost

In this section, the economic benefits foregone by not developing land for Urban uses, and the total parcel purchase cost are combined. First, a determination is made for the relationship between economic benefits/loss, defined as Sales, and Urban land acres' allocation.[29] The principle used here is similar in nature to a two function, two variable solution. In the case of Urban Sales and land acres, the following two conditions must hold:

$\text{Sales} = \alpha \text{ Urban Land Acres}^{\beta}$ (Integral Approach) Eq. 1

$\text{Sales} = \int_0^{56,157} \alpha\beta \text{ Urban Land Acres}^{\beta-1}$ (Marginal Approach) Eq. 2

Where: α and β are parameters determining the curvature of the relationship.
In addition, the limit on Urban land acres and the total sales for 2013 i.e. (56,157, $5,347,504,002) is used.[30] The resulting coefficients are:

α = 441.7907 and;
β = 1.4913

resulting in the relationship:

$\text{Sales} = 441.7907 \text{ Urban Land Acres}^{1.4913}$

Figure 6 shows the derived function between Sales and Urban land uses (both X and Y axis are truncated). The horizontal axis represents the total PCC habitat range area (estimated

[29] An alternative, more roundabout, approach is provided in Appendix 3. The alternative approach uses a production function, which under Ceteris Paribus is used to calculate the relation between Economic benefits/costs and urban land acres' allocation.
[30] The difference between the two set sales conditions (from Eq. 1 and Eq. 2) on average is $3,778 or 0.000071% of total Sales. This marginal difference may in part be attributable to rounding (esp. digit limitations).

at 60,022 acres). The dotted vertical line represents the demarcation of Urban land to the left hand side of the axis and Non-Urban or Rural to the remainder, reaching a total of 60,022 acres, on the right hand side of the axis. The vertical axis reflects local Sales (in million dollars), from the NETS database.

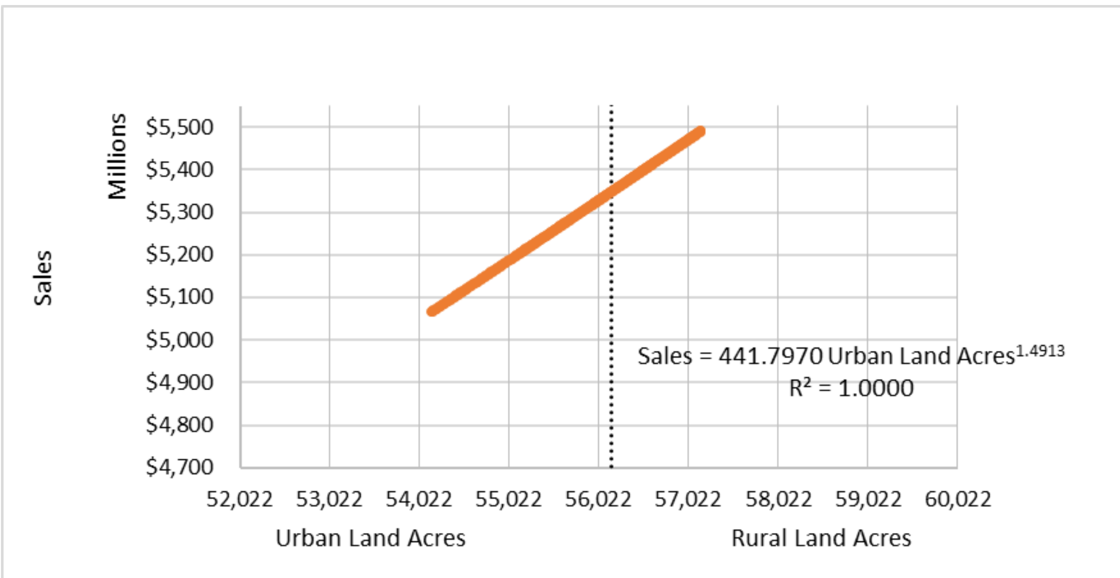

Figure 6. Functional Relation between Economic Benefits/Loss and Urban Land Acres Allocation

Clearly, the slope of the relation between Urban land acres and Sales is positive (i.e. the elimination, or reduction, of Urban land for further economic development translates to a loss of Sales (and vice versa). Figure 7 depicts the total parcel purchase cost curve of Urban land acres (or "just values") sold in 2014. As stated earlier, an assumption is that Agricultural land (codes 050 through 069 in the DOR NAL database) is already assigned to the category Rural land. No analysis is conducted on competing allocation or land uses within the realm of Non-Urban, or Rural lands. Properties sold are sorted to the acre or unit price, analyzed, and depicted in Figure 7. The parcel cost curve starts at the marked Urban land acres, and at the Sales level. The data reflect a static equilibrium.[31] The curve shown depicts the total Urban parcel purchase costs, since Urban acres may be bought to re-allocate or re-zone for PCC habitat use.

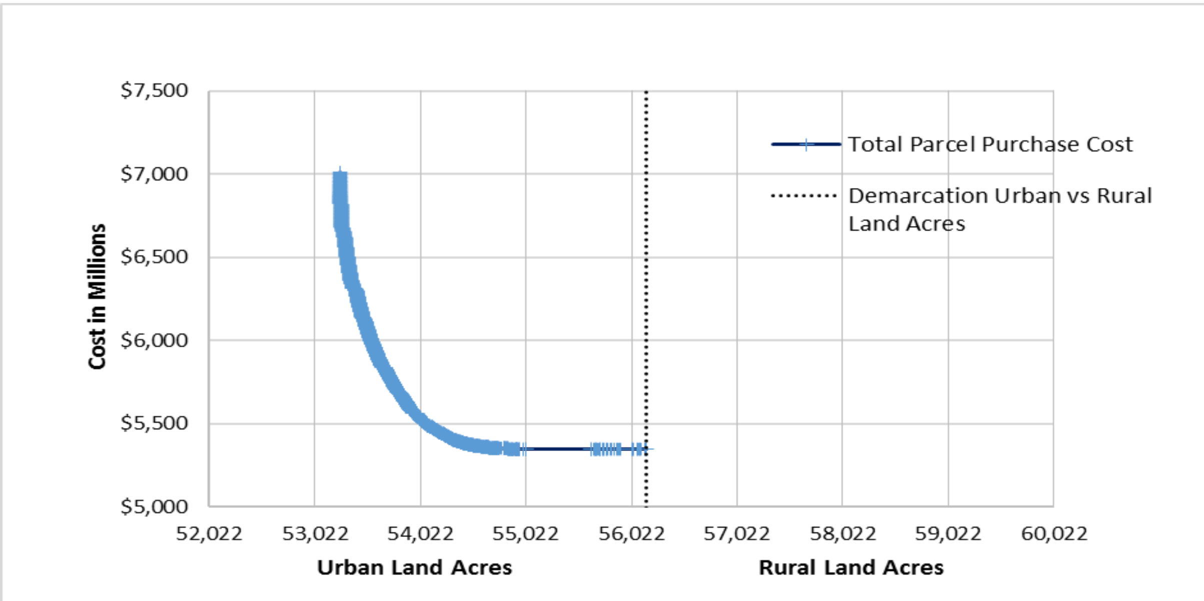

Figure 7. Total Parcel Purchase Cost Curve of Urban Land Acres Sold, at "Just Value", 2014

Figure 8 combines the economic benefit/loss curve of Figure 6 and the total parcel purchase cost curve of Figure 7, as well as depicting the total integral cost curve.[32]

[31] Including the one-year vintage difference between the two data sets (DOR and NETS).
[32] Similar to Hueting's T-curve or the addition of (C+S) and (E)

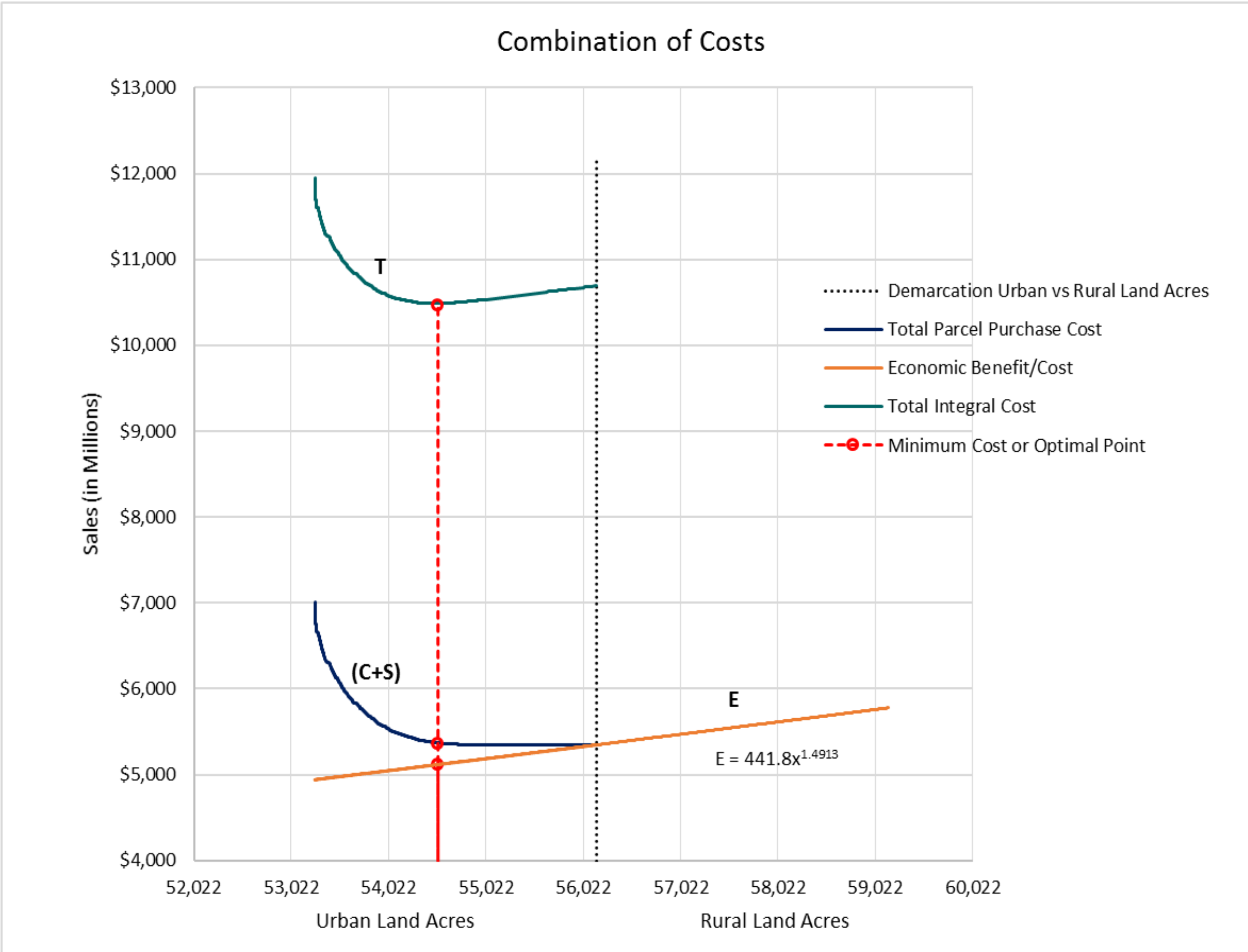

Figure 8. Combination of Economic Benefit/Loss, Total Parcel Purchase Cost, and Total Integral Cost Curves

The optimal total integral cost can be found at the minimum of the T-curve. It is observed though that there is a near horizontal segment on the T-curve around the optimum or minimum total integral cost, showing about 1,000 acres at similar or at near similar conditions, albeit at near minimal total integral cost.[33] The best fit polynomial, depicted on the left hand side of Figure 9, failed to capture the curvature at minimum or optimum

[33] The optimum is estimated by using a fourth degree polynomial over the bulk of data used (for curve T) leaving out the far right data-points (red) as depicted in the right hand side of Figure 10.

integral cost by almost 550 acres.[34] The minimal total integral cost, as per the right hand side of Figure 9, can be determined at 54,529 acres. The total costs shown include: the total integral costs; economic benefit/loss and total parcel purchase costs.

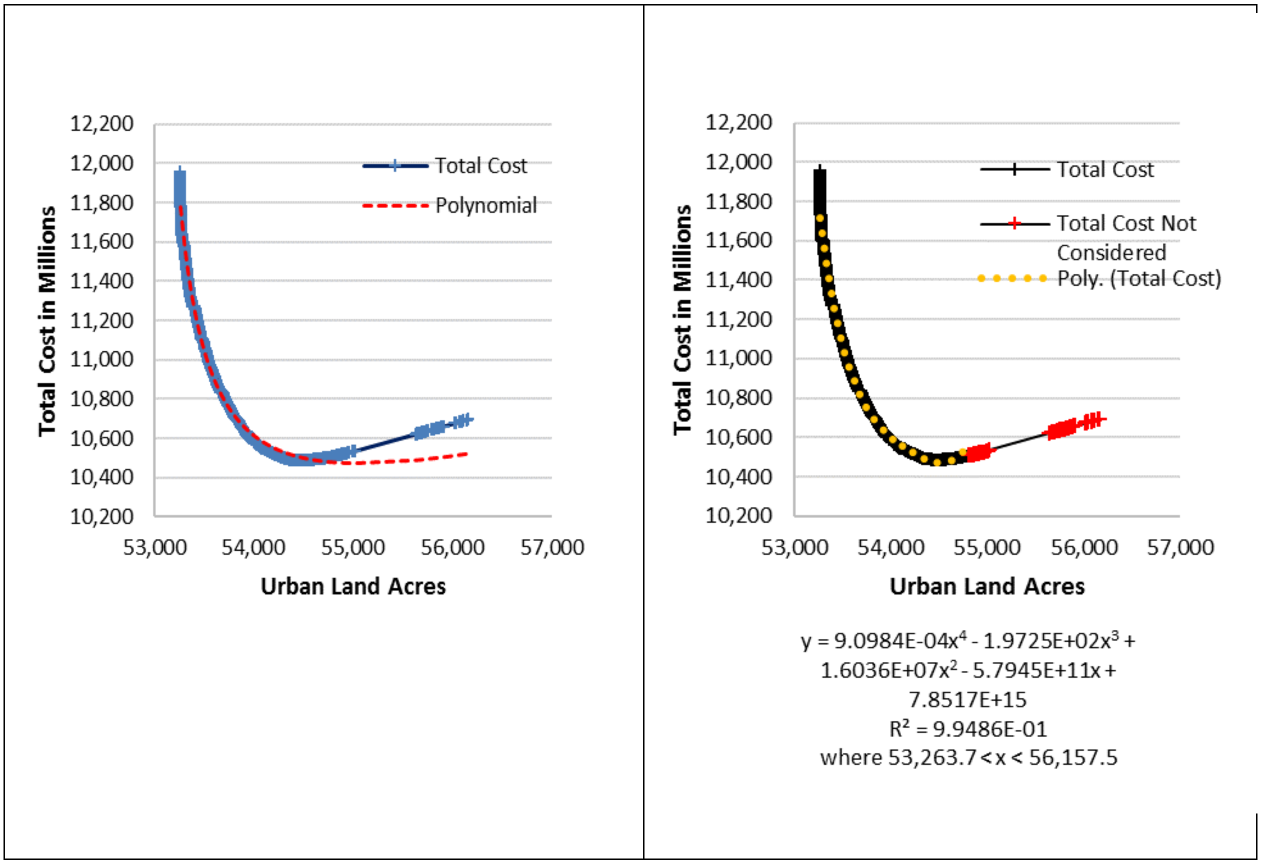

Figure 9. Total Integral Cost and Determination of Minimum or Optimal Point

Using the derived optimum, and the economic benefit/loss total parcel purchases costs curves, the following info as per Table 1 can be derived.

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[34] The cost polynomial is developed until:
$\text{Integral Cost} = (x^{0.7230} \times (3.8004 \times 10^6 x - 52{,}867.4710) + 9.9981 \times 10^8)/(x - 52{,}929.3673)$
where $53{,}263.7 < x < 56{,}157.5$ at $R^2 = 0.9921$

Table 1. Results on the Economic Benefit/Loss, Total Parcel Purchase Cost and Total Integral Costs at Optimum, 2014

Function	Total Integral Cost at 54,529.1 Acres	Marginal Cost of Change in one Acre Urban to Rural	Model Parcel Acreage	Price per Modal Parcel
Economic Benefit/Loss	$5,354,202,973	$139,966	0.34399	$48,147
Total Parcel Purchase Cost	$5,117,915,045	$139,970		
Total Integral Cost	$10,472,118,018	$279,936		

The total optimum or minimum integral cost is $10.5 billion. The re-allocation parcel purchase cost of one acre from Urban to Non-Urban or Rural is estimated at $139,970.[35] This is based on the “Just Value” of 3,691 parcels or properties transferred in ownership in 2014. Given that the same re-allocated acres are no longer available (are eliminated) for Urban use or development, the derived and indirect economic cost is also estimated at approximately $139,970.[36] When projected on a modal size parcel of 0.344 acres, the result is an approximate optimal purchase “Just Value” of $48,147. Projected to 2,000 acres (i.e., the estimated additional PCC habitat acres) this would result in about $280 million in purchase cost. A land purchase may be viewed as the ultimate form of mitigation. For the purpose of this study, the research team did not determine other levels of mitigation, but suggest that the value of about $140,000 per acre is used as a reference value for mitigation. Given that this is a one-point estimate only, the question arises as to whether the results of the analysis remain stable under varying circumstances, e.g., changing real estate sales, etc. The research team examined the 2015 real estate sales (at “Just Values”) from the DOR NAL working database, as depicted in Table 2.

[35] Land sales constitute a so-called direct out of pocket cost (i.e., value or asset transfer).
[36] There is actually a $4 difference between the marginal economic benefit/loss (which is $139,966) and the marginal aggregate purchase cost ($139,970) which is due to rounding and digit limitations.

Table 2. Results on the Economic Benefit/Loss, Total Parcel Purchase Cost and Total Integral Costs at Optimum, 2015

Function	Total Integral Cost at 55,846.7 Acres	Marginal Cost of Change in one Acre Urban to Rural	Model Parcel Acreage	Price per Modal Parcel
Economic Benefit/Loss	$5,358,463,731	$141,622	0.34399	$48,176
Total Parcel Purchase Cost	$5,303,438,093	$141,622		
Total Integral Cost	$10,611,901,824	$283,244		

It is noted that different years are represented for the economic benefit/loss (2013) and the total parcel purchase cost (2015). However, the number of parcels sold (or transferred) totaled 2,068 in 2015 (excluding one agricultural property), which is significantly lower than the 3,691 parcels[37] sold in 2014. The results, as shown in Table 2, remain almost the same. Both the marginal economic benefit/loss and marginal total parcel purchase cost are $141,622. Thus, it may be expected that the outcomes will be rather stable provided a relative rise (or reduction) in real estate values, depending on overall market developments.

[37] Or a difference of 1,623 parcels, when comparing years 2013 to 2015.

Assessment and Mitigation Tool, and Assessment Calculator

The research team next examined the Impact Assessment and Mitigation Tool (Appendix 1) and the Assessment Calculator (Appendix 2) that were developed in late 2015 by the FWC research team. The baseline number of acres in the PCC Habitat range is estimated at 60,022 (first decision block). About 26,003 acres were found West, and 34,019 acres were found East, of the Transmitter Road, respectively. In terms of parcels, 33,451 parcels were found West and 12,285 parcels to the East of the road. Figure 10 reflects the parcels vector Latitude-Longitude data based on the DOR NAL database separated by the two areas (West and East of the transmitter road) of the PCC habitat range.

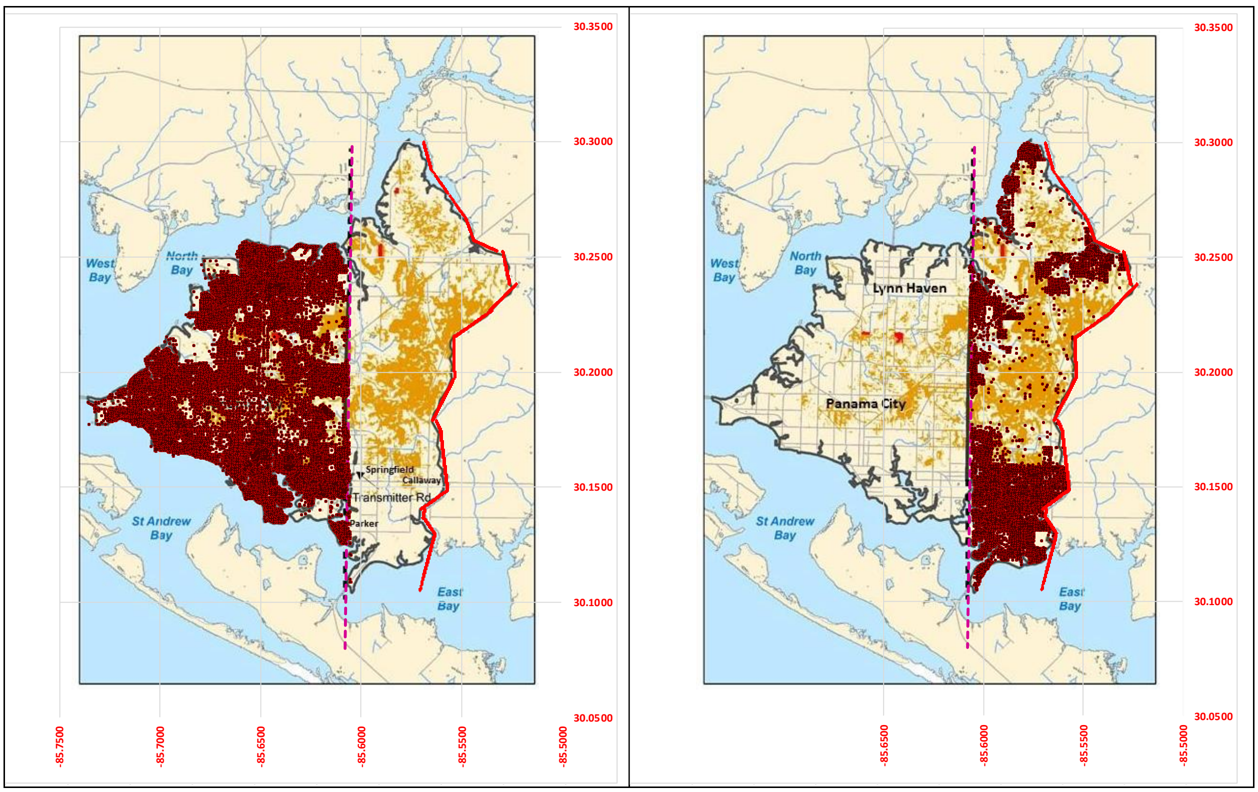

Figure 10. Overlay of Parcels on the East and Western Sections of the PCC Habitat Range

The following two figures: Figure 11 and Figure 12, were developed as a means for meeting the condition for the western range, namely; that parcels should be five acres or larger, and the condition for the eastern range; that parcels should be equal to or greater than 25 acres. It is noted that the criteria set are based on the FWC, in the Panama City Crayfish Management plan (2016), and may preclude combination opportunities of smaller parcels; both between parcels and contingencies at present PCC habitat areas.[38]

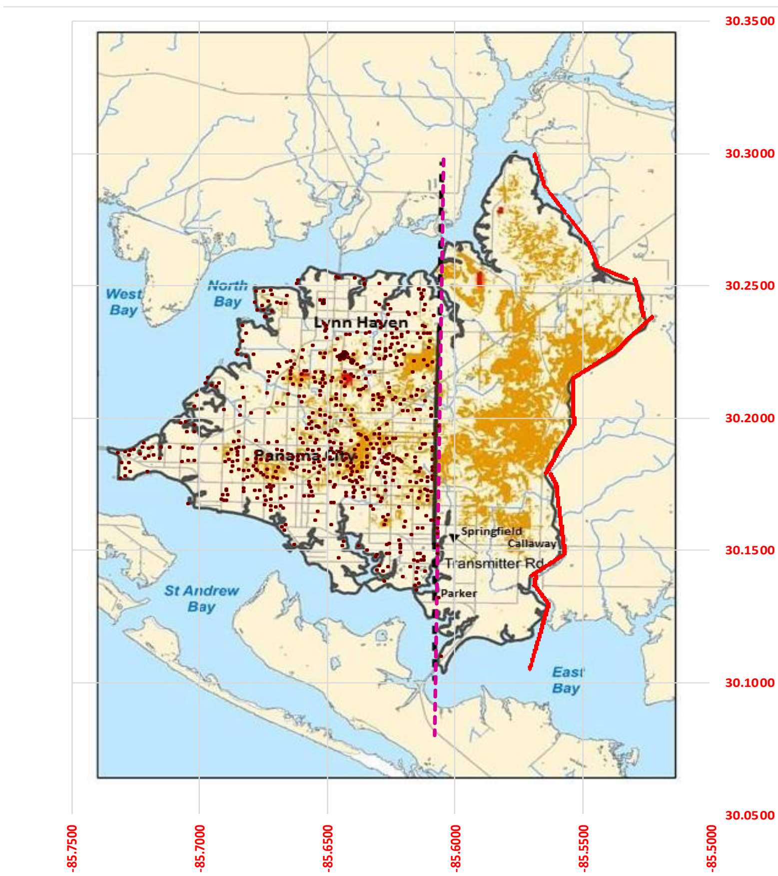

Figure 11. Overlay of Conditional Parcels on the East and Western Sections of the PCC Habitat Range

[38] In addition, the research team did not research contingency, stay, trees and/or other ground cover, as per the left hand part of the Assessment and Mitigation Tool (Appendix 1), due to currently unavailable data.

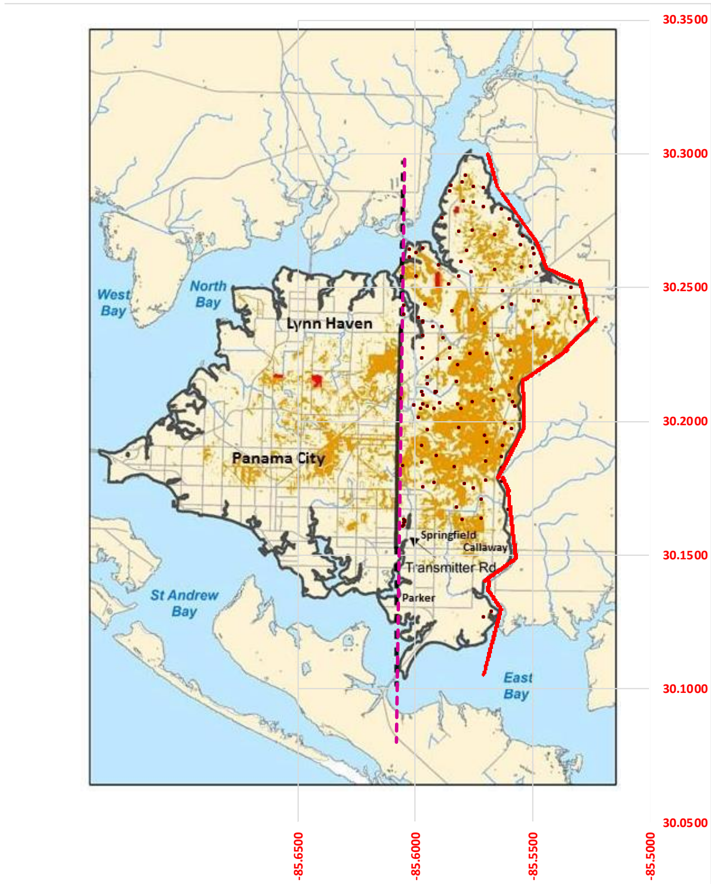

Figure 12. Overlay of Conditional Parcels on the East and Western Sections of the PCC Habitat Range

In comparing the two figures, it should be noted that the highlighted parcels do not reflect parcel size, but the location based on the Latitude-Longitude information. Table 3 provides some basic statistics on the same selection made.

Table 3. Number of Conditional Parcels and Acres in the East and Western Sections of the PCC Habitat Range

	WEST # parcels	EAST # parcels	WEST Acres	EAST Acres
Parcels < 5 Acres	12,156		8,615	
Parcels ≥ 5 Acres	**129**		25,403	
Parcels < 25 Acres		32,781		13,468
Parcels ≥ 25 Acres		**670**		12,535
	45,736		**60,022**	

Table 4 provides some further detail on the parcels and acres of Table 3 using the Department of Revenue (DOR) parcel use codes. As reflected in the table, most parcels in the western section of the PCC habitat range fall in the categories "Residential" (34.2 percent of parcels and 20.9 percent of the acreage), "Commercial" (20.4 percent of parcels and 21.4 percent of acreage), "Industrial" (10.6 percent of parcels and 15.1 percent of acreage), and "Government "(19.0 percent of parcels and 15.1 percent of acreage). However, the majority of available parcels and acres to the East are found in the use category "Agriculture" (primarily timberland; 54.3 percent of parcels and 78.3 percent in acreage) and "Residential" (18.6 percent of parcels and 14.0 percent of acreage).

Table 4. Selective FWC Parcels and Acreage in the PCC Habitat Range, East and Western Sections of the PCC Habitat Range, by Department of Revenue Use Codes

Use Code	Use Description	WEST # parcels	WEST tot. acres by use	EAST # parcels	EAST tot. acres by use
	Residential				
000	Vacant Residential – with/without extra features	76	834	14	2,959
001	Single Family	81	859	7	496
002	Mobile Homes	4	20	-	-
003	Multi-family - 10 units or more	29	338	-	-
008	Multi-family - fewer than 10 units	4	55	-	-
009	Residential Common Elements/Areas	35	512	3	94
	Commercial				
010	Vacant Commercial - with/without extra features	54	959	-	-
011	Stores, one story	9	109	-	-
012	Mixed use - store and office or store and residential combination	5	45	-	-
013	Department Stores	6	59	-	-
014	Supermarkets	1	5	-	-
015	Regional Shopping Centers	2	642	-	-
016	Community Shopping Centers	7	89	-	-
017	Office buildings, non-professional service buildings, one story	13	137	-	-
019	Professional service buildings	5	48	-	-
023	Financial institutions (banks, saving and loan companies, mortgage companies, credit services)	1	6	-	-
025	Repair service shops (excluding automotive), radio and T.V. repair, refrigeration service, electric repair, laundries, Laundromats	2	15	1	62
027	Auto sales, auto repair and storage, auto service shops, body and fender shops, commercial garages, farm and machinery sales and services, auto rental, marine equipment, trailers and related equipment, mobile home sales, motorcycles, construction vehicle sales	7	67	-	-
028	Parking lots (commercial or patron), mobile home parks	14	146	6	210
032	Enclosed theaters, enclosed auditoriums	2	16	-	-
038	Golf courses, driving ranges	7	318	-	-
039	Hotels, motels	2	18	-	-
	Industrial				
040	Vacant Industrial -with/without extra features	22	278	-	-
041	Light manufacturing, small equipment manufacturing plants, small machine shops, instrument manufacturing, printing plants	15	165	-	-
042	Heavy industrial, heavy equipment manufacturing, large machine shops, foundries, steel fabricating plants, auto or aircraft plants	13	1,253	-	-
043	Lumber yards, sawmills, planing mills	1	9	-	-
045	Canneries, fruit and vegetable, bottlers and brewers, distilleries, wineries	1	10	-	-
046	Other food processing, candy factories, bakeries, potato chip factories	1	9	-	-
047	Mineral processing, phosphate processing, cement plants, refineries, clay plants, rock and gravel plants	1	10	-	-
048	Warehousing, distribution terminals, trucking terminals, van and storage warehousing	15	128	-	-

Use Code	Use Description	WEST # parcels	WEST tot. acres by use	EAST # parcels	EAST tot. acres by use
	Agricultural				
050	Improved agricultural	5	418	5	462
054	Timberland - site index 90 and above	-	-	2	103
055	Timberland - site index 80 to 89	11	1,293	53	17,314
056	Timberland - site index 70 to 79	1	216	9	1,932
060	Grazing land soil capability Class I	-	-	1	70
	Institutional				
070	Vacant Institutional, with or without extra features	4	82	-	-
071	Churches	21	231	-	-
072	Private schools and colleges	1	6	-	-
073	Privately owned hospitals	2	57	-	-
074	Homes for the aged	2	29	-	-
075	Orphanages, other non-profit or charitable services	3	28	-	-
076	Mortuaries, cemeteries, crematoriums	11	116	-	-
077	Clubs, lodges, union halls	2	11	-	-
	Governmental				
080	Vacant Governmental - with/without extra features for municipal, counties, state, federal properties and water management district (including DOT/State of Florida retention and/or detention areas)	31	295	6	829
081	Military	4	140	-	-
083	Public county schools - including all property of Board of Public Instruction	35	540	1	36
084	Colleges (non-private)	4	169	-	-
085	Hospitals (non-private)	1	12	-	-
086	Counties (other than public schools, colleges, hospitals) including non-municipal government	8	77	1	38
087	State, other than military, forests, parks, recreational areas, colleges, hospitals	8	83	-	-
088	Federal, other than military, forests, parks, recreational areas, hospitals, colleges	2	30	-	-
089	Municipal, other than parks, recreational areas, colleges, hospitals	34	552	-	-
	Miscellaneous				
090	Leasehold interests (government-owned property leased by a non-governmental lessee)	4	58	-	-
091	Utility, gas and electricity, telephone and telegraph, locally assessed railroads, water and sewer	11	131	-	-
094	Right-of-way, streets, roads, irrigation channel, ditch, etc.	7	52	12	471
095	Rivers and lakes, submerged lands	2	25	-	-
097	Outdoor recreational or parkland, or high-water recharge subject to classified use assessment	3	46	-	-
	Non-Agricultural Acreage				
099	Acreage not zoned agricultural - with/without extra features	16	655	8	327
		670	**12,535**	**129**	**25,403**

Figure 13 depicts shapes of parcels of main categories (from Table 4), based on the DOR use codes. Both the East-boundary and the Transmitter Road are marked by thick black lines.

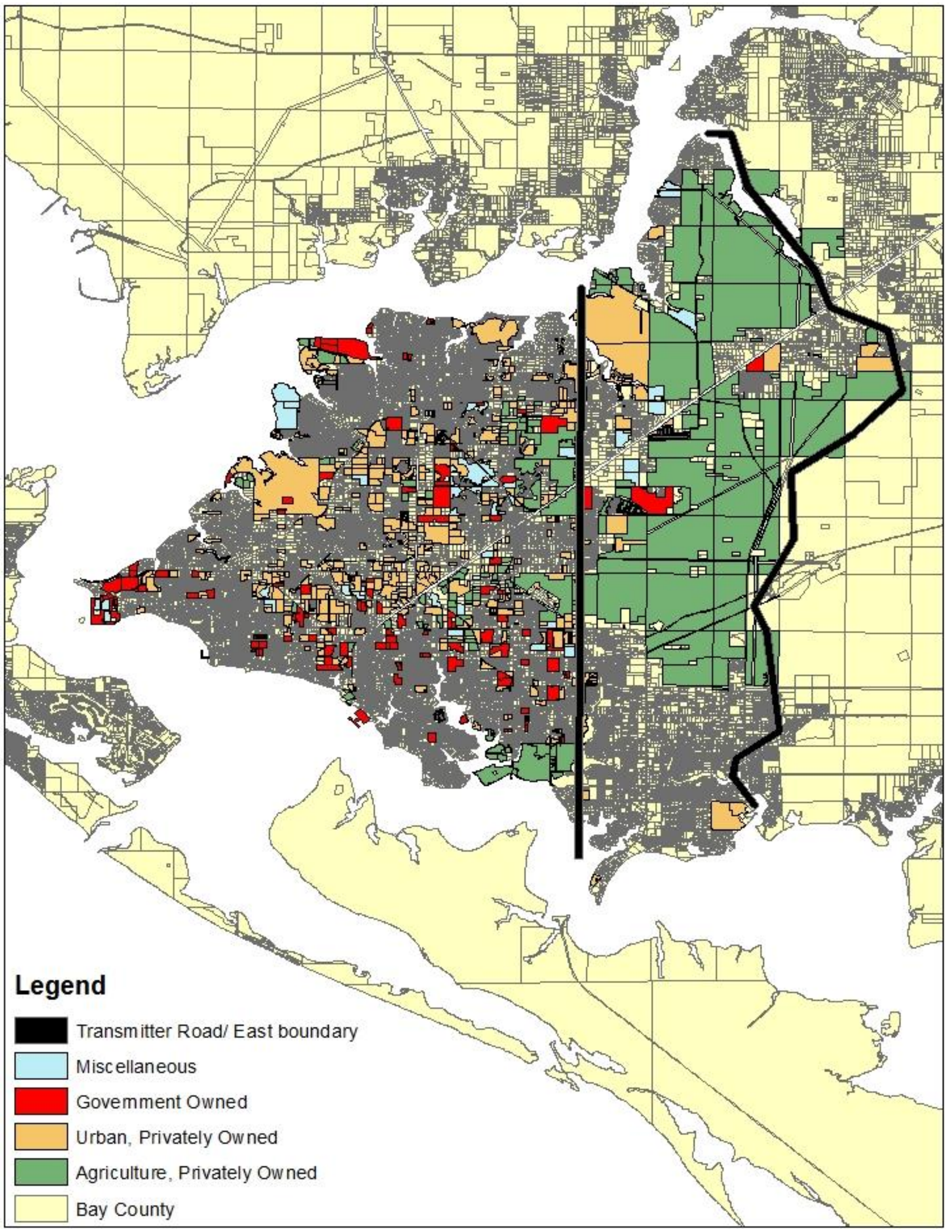

Figure 13. Selective FWC Parcels and Acreages in the PCC Habitat Range, East and Western sections, by Department of Revenue Use Codes

Further Selection Based on Valuation of Parcels

The analysis so far is based on the assumption of homogeneity of the Bay County east and western PCC region parcels and structures. However, there is a large disparity between parcel just values, use, use values and economic impact across acres. Regarding a further refinement in the search criteria, the following ten categories with the lowest average just-values per acre are shown in Table 5.[39] In addition to average just-values, the median just-values per acre and the geometric mean[40] just-values per acre are provided.

Concerning the western section, vacant lots with/without extra features appear to have lower per acre just-values. Of the vacant parcels, institutional vacant lots (use code 070) may be an outlier, since all four parcels have an equal $200 value per acre. The subset vacant residential parcels (use code 000) contain twenty-one (almost a third) of just values below $1,000, of which twelve parcels show less than $100.[41] Excluding the aforementioned lower valued vacant residential parcels in the average calculations would result in an increase in the residential average to a just-value of $21,009. In this case, the median vacant residential just value per acre would be $16,570 and the geometric mean per acre would be $15,239. The subset vacant commercial parcels (use code 010) show

[39] not considering Use Category 009 with an average just-value of zero, not considering the category Miscellaneous (090 through 097) and Non-Agricultural Acreage (099), including all Agricultural codes (050 through 060), and adding Vacant Governmental (080).

[40] The geometric mean of a set of n positive numbers is obtained by taking the n^{th} root of the product of the same numbers: the geometric mean of 2, 4, and 1 is $\sqrt[3]{8} = 2$. The geometric mean tends to dampen the effect of very high or low values, which might bias the straight average or arithmetic mean.

[41] Regarding the initial research analysis for this study, it was observed that sales prices in the DOR NAL database show some extreme low or fiduciary pricing. The same, though to a substantial lesser extent, may be said about appraisers' just values. Instead of using a confidence interval, with the removal of both lower and higher just values, the research team opted to exclude per acre values of about $1,000 and lower from further analyses since they were not likely representative of the current market values.

Table 5. Bottom Cost Parcel Categories, East and Western Sections, Based on Average Just-Value/Acre, Median Just-Value/Acre and Geometric Mean Just-Value/Acre

Use Code	Use Description	WEST # parcels	WEST tot. ac. by use	WEST Avg. Just-Value/ Acre	WEST Median Just-Value/ Acre	WEST GeoMean Just-Value/ Acre	EAST # parcels	EAST tot. ac. by use	EAST Avg. Just-Value/ Acre	EAST Median Just-Value/ Acre	EAST GeoMean Just-Value/ Acre
	Residential										
000	000 Vacant Residential – with/without extra features	76	834	$ 15,263	$ 11,153	$ 2,080	14	2,959	$ 16,010	$ 11,112	$ 11,713
001	001 Single Family	81	859	$ 35,111	$ 16,214	$ 22,106	7	496	$ 3,570	$ 3,626	$ 2,749
002	002 Mobile Homes	4	20	$ 31,033	$ 35,310	$ 29,501	-	-			
	Commercial										
010	010 Vacant Commercial - with/without extra features	54	959	$ 33,126	$ 20,722	$ 15,913	-	-			
	Industrial										
040	040 Vacant Industrial -with/without extra features	22	278	$ 14,577	$ 6,000	$ 9,777	-	-			
	Agricultural										
050	050 Improved agricultural	5	418	$ 22,049	$ 22,049	$ 22,049	5	462	$ 10,306	$ 12,205	$ 9,645
054	054 Timberland - site index 90 and above	-	-				2	103	$ 6,000	$ 6,000	$ 4,472
055	055 Timberland - site index 80 to 89	11	1,293	$ 8,202	$ 8,531	$ 6,992	53	17,314	$ 2,580	$ 1,000	$ 1,502
056	056 Timberland - site index 70 to 79	1	216	$ 1,000	$ 1,000	$ 1,000	9	1,932	$ 6,334	$ 3,000	$ 3,430
060	060 Grazing land soil capability Class I	-	-				1	70	$ 7,839	$ 7,839	$ 7,839
		17	1,927	$ 11,851	$ 10,000	$ 8,742	70	19,881	$ 3,787	$ 1,000	$ 2,015
	Institutional										
070	070 Vacant Institutional, with or without extra features	4	82	$ 200	$ 200	$ 200	-	-			
	Governmental										
080	080 Vacant Governmental - with/without extra features for municipal, counties, state, federal properties and	31	295	$ 167,548	$ 40,000	$ 6,255	6	829	$ 5,000	$ 5,000	$ 5,000

only one low outlier. The subset vacant industrial parcels (use code 040) show no obvious outliers. The subset of vacant governmental parcels (use code 080) show four parcels with just values over $1 million, and ten parcels with just values below $1,000. Excluding the aforementioned low valued parcels would result in a change of $44,297 to the average just-value, $40,087 to the median value, and the geometric mean to $36,631. Based on the recalculations, and not considering the vacant institutional parcels, would render the residential vacant parcels the least expensive, of the categories considered so far. Regarding vacant parcels in the east section, residential parcels show one low value, and all six governmental vacant parcels are priced at the same value per acre (same parcel numbers with six different object ID's). The single family parcels (use code 001) subset has only one low outlier in the east, while mobile home parcels (use code 002) have no outliers. Apart from the agricultural parcels, the vacant residential parcels in the east and western sections, and the single family parcels in the east appear to reflect relative lower just values per acre. Finally, agricultural parcels (use codes 050 through 060) show overall lower just values in the east. The five improved agricultural parcels (use code 050) in the west are valued the same (same parcel numbers with six different object ID's). The same holds for three of the five parcels in the east (same parcel numbers with six different object ID's). In summary, there are four unique just values in the use code category 050 in both the east and western sections. In addition, 40[42] out of the 53 timberland parcels (use code 055) in the east are valued at $1,000 or lower, while the same case holds for three out of the nine timberland parcels (use code 056). Excluding the 40 lower valued parcels in the east, (plus one in the west), leaves only nine unique just values within the use category 055 in the east and six parcels in the western section. Concerning the timberland parcels (use code 056), there are four just values equal to $1,000 or lower, both in the east and western sections. Excluding these four parcels, results in only six unique just values for timberland parcels (use code 056). There is only one just value for timberland (use code 060) in the east. In

[42] The 40 parcels are clustered in nineteen parcel id's.

summary, in addition to the aforementioned vacant residential parcels in both the east and western sections, and the single family parcels in the east, there are the lowest just value opportunities in agriculture (and timberlands). However, as mentioned earlier, placing a value on the latter (agricultural and timberland) categories is rather difficult given the available data. Figure 14 presents the just value distributions on agricultural parcels (use codes 050 through 060), with the average, median and geometric mean as provided in Table 5.

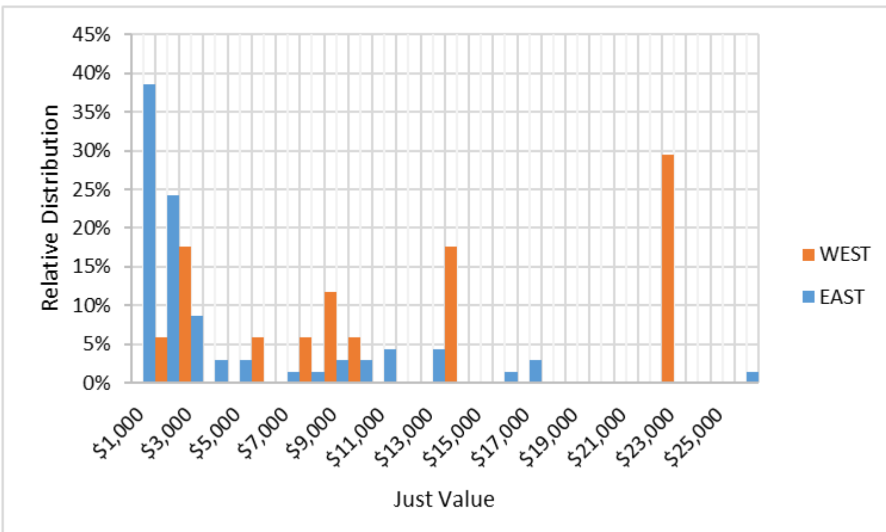

Figure 14. Relative Distribution on Agricultural Parcel Just Values (Use Codes 050 Through 060)

Further analysis reveals that by clustering object ID's and focusing on unique parcels ID's, the average agricultural just value in the east is $4,563 per acre, the median $1,000, and the geometric mean is $2,487. For the west, the average agricultural just values are $8,856, $7,925 and $6,418, respectively. The agricultural just values are the lowest for both east and west as compared to the vacant residential and single families. Thus, the following results will address only the agricultural use codes. It should be noted that the higher just values in the west pertain to improved agricultural parcels (use code 050) only.

Figure 15 uses the same baseline as Figure 14, but for unique parcels only using @Risk.[43] The two distributions on top represent the east, and the two distributions on the bottom represent the west. Likewise, the two distributions on the left hand side include all just

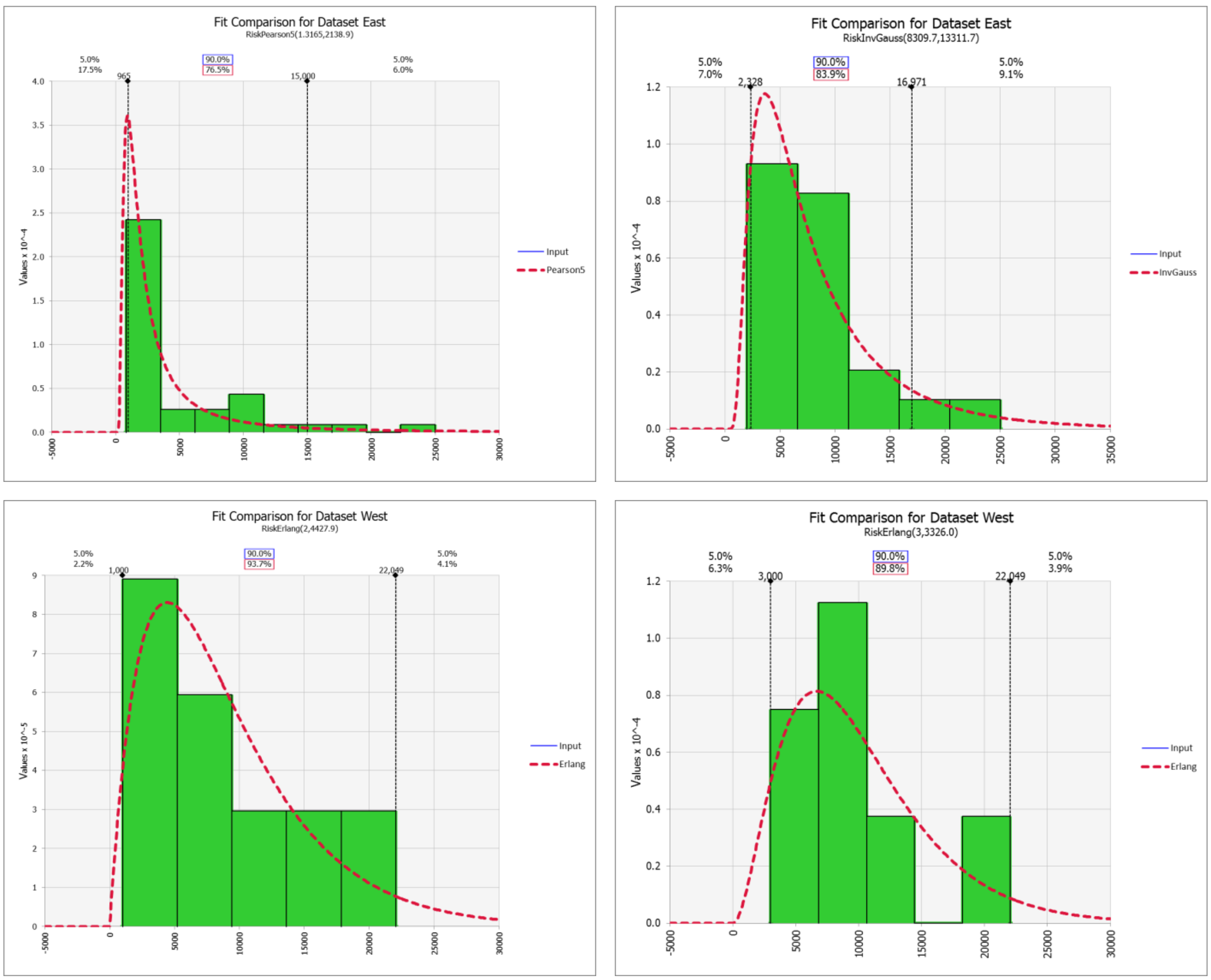

Figure 15. Relative Distribution on Unique Agricultural Parcel Just Values (use codes 050 through 060)

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[43] Palisade Corporation, maker of the world's leading risk and decision analysis software, @RISK and DecisionTools, http://www.palisade.com.

values, while the two distributions to the right hand side are exclusive of lower end just values below a rounded $1,000. The top two represent n=43 and n=21 values, respectively. The mean on the top-right hand (or east) side is $8,310.[44] The two distributions on the bottom represent n=8 and n=7 values. The mean of the distribution on the bottom right hand side (or west) is $9,978.[45]

The potential purchase or reallocation of acres for PCC habitat use will have economic benefits/loss consequences. The purchase of parcels will preclude any future planned or perceived other uses and activities in perpetuity, but for PCC habitat, restoration and maintenance. Future sales, real estate agent services and legal services, construction and land improvements including landscaping, as well as in indirect household commodity sales (in case of residential property) and/or commercial, industrial, agricultural or government activities are excluded from the analysis. In the case of business activities, potential agricultural/timberland economic activities are represented by the NAICS code 11: Agriculture, Forestry, Fishing and Hunting sales/revenues in the NETS database.[46] Figure 16 shows the relative distribution of sales of the reporting establishments within the NAICS 11 code.[47]

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[44] With a standard deviation of $5,766. The 90 percent confidence interval is between $2,328 and $16,971.
[45] With a standard deviation of $6,379. The 90 percent confidence interval is between $3,000 and $22,049.
[46] Concerning the defined area for year 2013, NETS reports $4.8 million, which is approximately 0.09 percent of the total sales reported for the year 2013. There are 61 NAICS 11 code establishments reporting employment, of which 48 reported sales in 2013.
[47] Average sales for 2013 is $99,915, median sales is $80,000 and the geometric mean is $85,255.

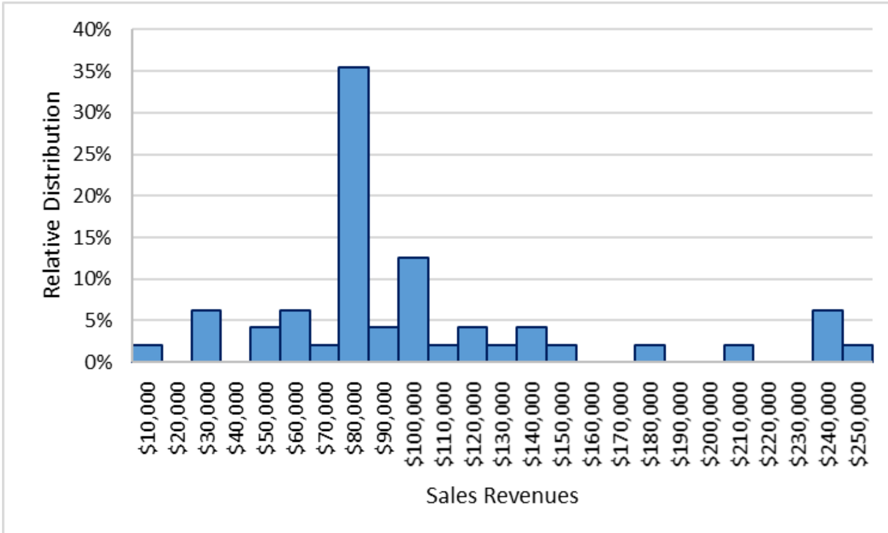

Figure 16. Relative Distribution on Median Sales per NAICS 11

Based on the best data available, the research team estimates the perceived economic loss (or gain) at an annual average level of approximately $100,000, and median level of $80,000, per establishment in the agricultural sector (NAICS 11).[48]

[48] Given that the NETS database reports sales by establishment and not by acreage, the information on partial acreage sales to maintain a business enterprise is not available. An attempt to match latitude-longitude data between the DOR NAL database and the NETS database failed, and linking addresses posed several additional issues. Thus, the research team is able to report sales/revenues results by establishment, but not on a per acre basis.

Further Selection Based on Soil

Table 6 presents the primary and secondary soil types and PCC survey data, sorted by soils with the most observations (presence of PCC).[49]

Table 6. Suitable Soil Types for PCC Ranked by Proportion Presence

Soil Type (by Top 7 and Bottom 5)	Primary/Secondary	Proportion Absence	PCC Present	PCC Proportion Presence	Total PCC Observations	PCC Proportion Present
Plummer Sand	Primary	25.08%	429	36.89%	838	89.94%
Albany Sand, 0-2% Slopes	Secondary	17.78%	182	15.65%	472	
Pelham Sand	Primary	9.20%	127	10.92%	277	
Rutlege Sand, 0-2% Slopes	Primary	15.45%	94	8.08%	346	
Pamlico-Dorovan Complex	Primary	8.28%	90	7.74%	225	
Leefield Sand, 0-2% Slopes	Secondary	3.92%	67	5.76%	131	
Pantego Sandy Loam	Primary	2.64%	57	4.90%	100	
Leon Sand, 0-2% Slopes	Secondary	2.88%	32	2.75%	79	6.96%
Rutlege-Pamlico Complex	Primary	5.89%	29	2.49%	125	
Osier Fine Sand	Secondary	1.23%	12	1.03%	32	
Alapaha Loamy Sand	Secondary	0.06%	5	0.43%	6	
Albany Sands, 2-5% Slopes	Secondary	0.00%	3	0.26%	3	

Based on the FWC survey sample of the PCC population, it appears that the PCC population prefers slightly over three times more "Albany Sand, 0-2° Slopes" acreage or area, to increase to the PCC presence relative to the levels found on "Plummer Sands".
Figure 17 shows the suitable PCC habitat soil types by the base selection of acreage (Tables 3, 4 and 5).

Individual parcels may have several types of soil within that parcel. As such, the soil type which was most abundant in a given parcel was used in order to sort the parcels by their soil types. The most abundant soil type by parcel is shown in the next figure.

[49] Data provided by Ms. Melissa Tucker, FWC May 31, 2016

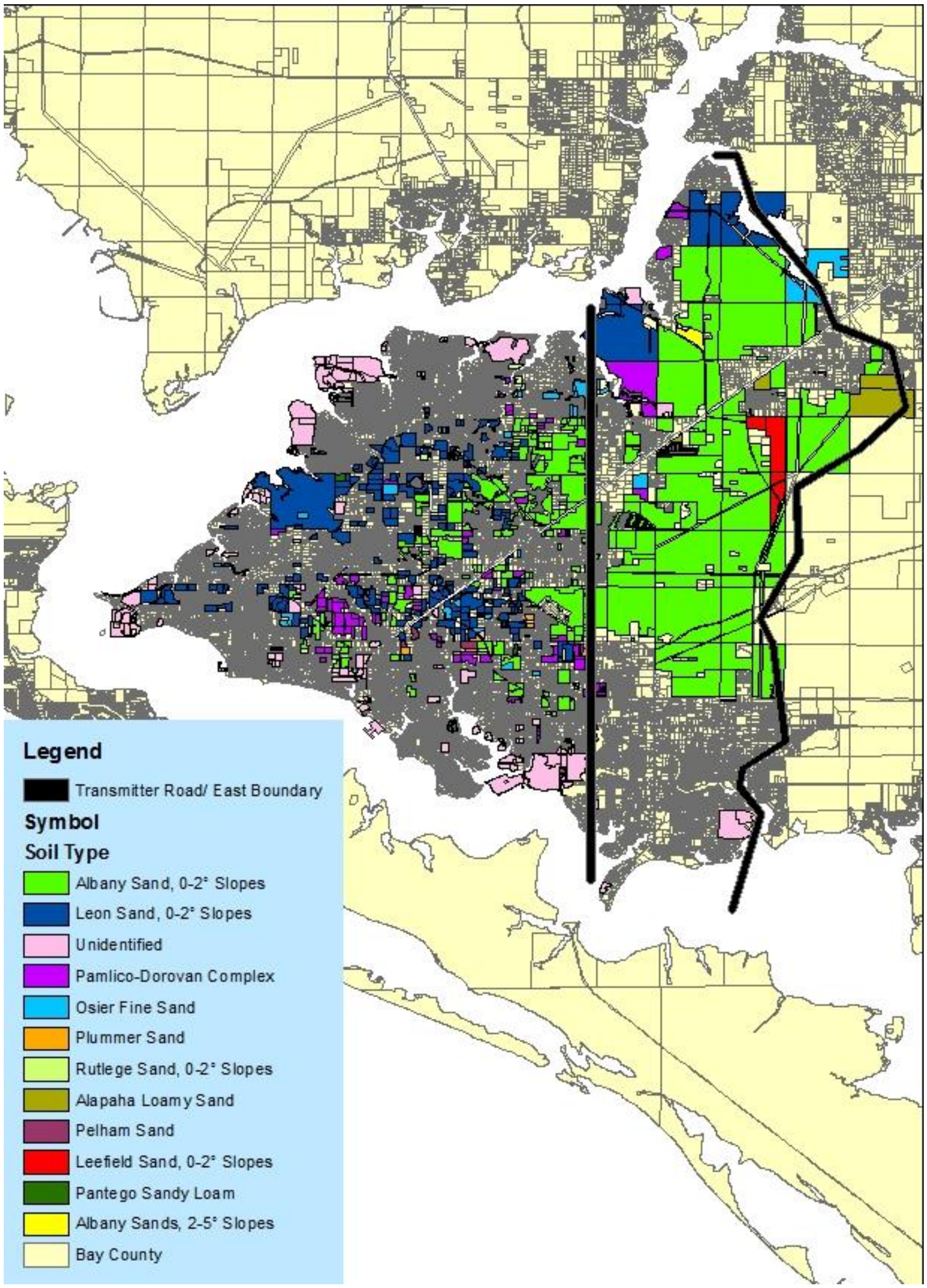

Figure 17. Suitable Soil Types for PCC by Proportion Presence

In order to assess the most common types of soil in Bay County and where the PCC is found with greatest occurrence, the FWC conducted a survey of soil samples to determine the preferred types of soil for the PCC. However, there might have been a slight sample bias due to the proximity of many samples to sites near roads and easily accessible areas. For the purpose of this study, the survey results provide an estimate for PCC populations in different soil types (Table 6).

Out of about 800 parcels[50] the research team identified as suitable for acquisition for PCC conservation, Albany Sand with 0-2% slopes (e.g., 239 parcels) represents the most abundant soil type, or roughly 30% of the total suitable PCC habitat soil types. In the FWC survey, Albany Sand was the second most abundant soil for PCC populations, but in the research team's analysis, Albany Sand was the most abundant soil type for individual parcels. According to the FWC survey of PCC population by soil types, about 15.65% of PCC found were found in areas with Albany Sand.

The second most abundant soil identified in parcels was Leon Sand (e.g., 228 parcels), representing about 28%, of the identified parcels. This is in contrast to the FWC survey, as the Leon Sand was the eighth most commonly found sand in the FWC sample. Only about 2.49% of PCC located in the various types of soil were present in Leon sand samples.

Following Leon Sand, the most abundant soil type by parcel becomes more varied, with Pamlico-Dorovan Complex as the next most abundant soil found in 89 parcels. Pamlico-Dorovan Complex was the fifth most abundant soil type in the FWC survey, where 7.74% of the PCC sample population was present. About 148 of the parcels were unidentified soil types.

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[50] 800 parcels refers to the initial parcels identified based on size constraints; e.g., 670 parcels in the east, and 129 parcels in the western area).

A crosscheck with the lower end just values of agricultural unique parcels reveals that all parcels to the west and the majority of parcels to the east fall in the category of "Albany Sand, 0-2◦ Slopes". On the remainder to the east, three parcels fall in the category "Leefield Sand, 0-2◦ Slopes", one in the category "Leon Sand, 0-2◦ Slopes", and one is dubbed "unidentified" (due to soil mix). Given only one potential exclusion of a parcel where there is still presence of PCC (according to Table 6), the research team opted to include it in the selection. The crosscheck between the Agricultural parcels (selection based on just value) and the soil types is shown in Figure 18.

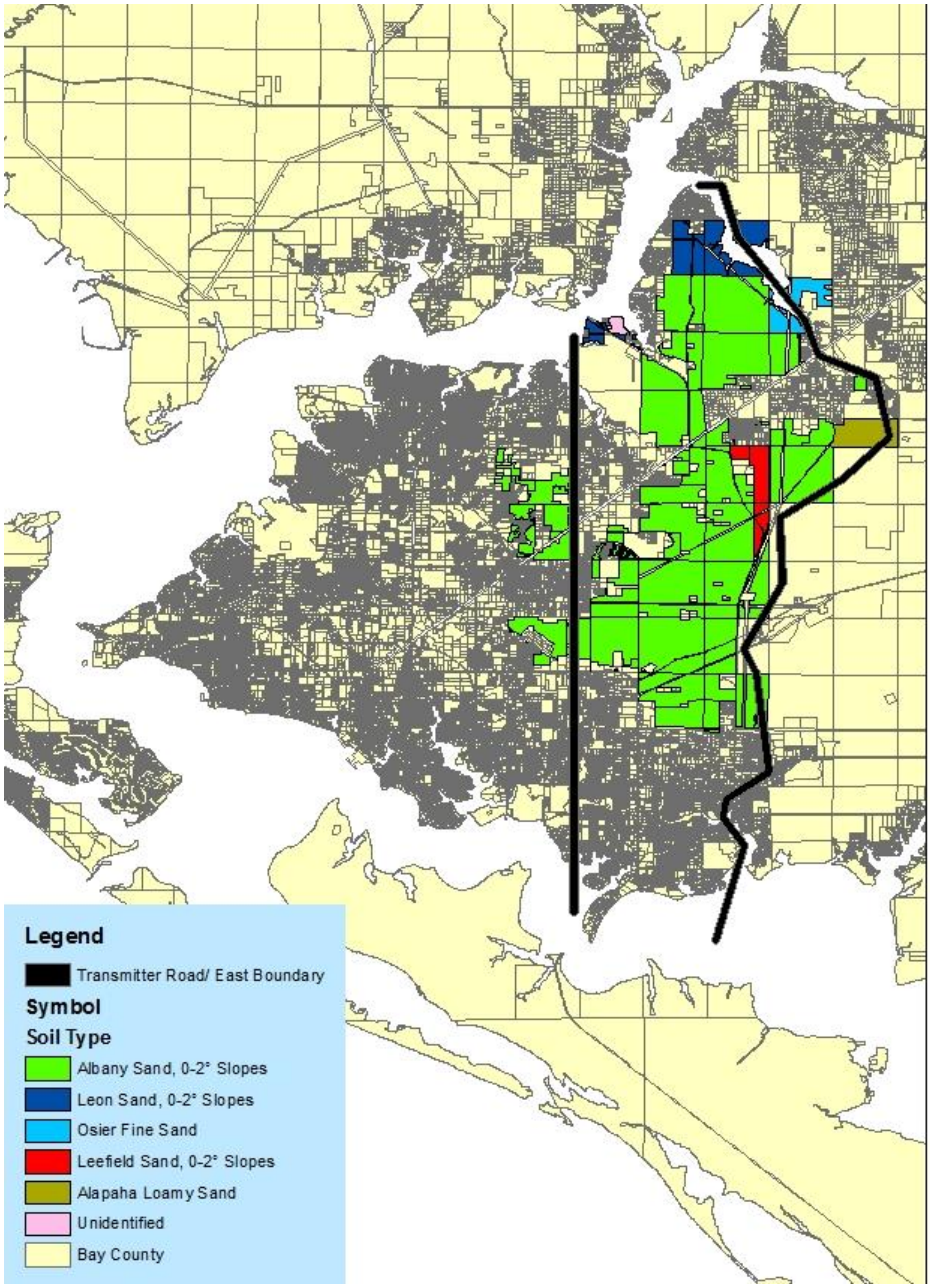

Figure 18. Most abundant Soil Types Identified for PCC on Agricultural Parcels

Beyond this point in the Assessment and Mitigation Tool, the research team did not have the data available in order to make further assessments as to possible PCC habitat based on available parcels selected.[51]

Regarding a suitable land price, the research team suggests using the value $140,000 per urban acre (from the previous section) as an indicator value for mitigation or purchase in general. It is conceivable that a general scalar or point system could be used for further damage assessment, which would be in addition to the baseline of $140,000 per acre. In the case of the lower valued agricultural parcels, or land, a mean value per acre of $8,310[52] on the east section, and $9,978[53] per acre on the west side, could serve as criteria for the valuation of rural (or agricultural) land. Given the FWC objectives as per the PCC Management Plan, about 500 acres are to be added to PCC habitat in the western portion of the range and about 1,500 in the eastern range, resulting in a total purchase, or expense, of $19,122,000, based on just values.[54]

[51] For example, research staff did not have parcel information on contingency, number of trees per acre nor on whether an area was ≥ 75 percent herbaceous covered.

[52] With a 90 percent confidence interval between $2,328 and $16,971

[53] With a 90 percent confidence interval between $3,000 and $22,049

[54] Ceteris paribus (no market dynamics included) and not including real estate services, legal services, restoration and maintenance costs.

Data Limitations and Needs

The data needs, in order for the research team to fully analyze the mitigation tool criteria, would depend on additional environmental data (e.g., number of trees per acre, and percentage herbaceous groundcover, among others). In addition, the aggregate category of Urban versus Non-Urban or Rural assignments is quite rudimentary but provides a solid independent variable (with sufficient data points). The use of Sales (and Employment) data in combination with Urban land acres capture the essence of the analysis, and it provides the necessary slope and curvature for the marginal analyses. An alternative methodology would have shown only small differences.

Concerning the DOR file used in this study, much depends on the "Just Value" assessments, given that the available "Market Value" property sales variables show obvious disparities, discrepancies and inconsistences. In addition, the DOR database lacked a proper delineation between Urban and Non-Urban or Rural, and thus the necessary assumption was made to define Agricultural use as being Rural. In addition, the DOR NAL database use codes could be further developed to provide enhanced parcel detail.

Concerning the economic value analyses, there is a need for further resolution or detail, as well as more observations in terms of data criteria set for selection. The research team believes that additional progress can be made in terms of defining natural functions. This doesn't end with listing criteria as contiguous, acreage, trees and/or groundcover, but should involve alternative use functions of land. While property or parcel value can be increasing in added value, value pertains also to different uses of a scarce resource.

Conclusions

The FSU research team perceived the core of the assistance request by the FWC team to be one of value and/or cost allocation of scarce resources (i.e. available land), land value, proportional land allocation shares (e.g. zoning) and economic impact. Not included in this study are the costs of implementing permitting strategies, since that is either an administrative issue or a black box depending on the type of strategy implemented.[55] Re-allocation or re-zoning has a value impact as well as economic consequences, thus, an economic valuation methodology was applied. The essence of the methodology examines the reallocation of urban land acres for PCC habitat use.

Since value or pricing information regarding wildlife is scarce, the task is a difficult one. The present analysis uses the valuation of urban land acres, to implicitly calculate the value of non-urban, or rural, land acres (with the caveat that land and building improvements and structures are included).

The economic valuation methodology can be extended, however, depending on data availability. A further breakout of alternative uses within the realm of Non-Urban, or Rural land uses, was not included in this study as it was perceived to be beyond the present scope of work. In addition, available data wasn't sufficient to conduct such analyses. Re-allocation or re-zoning results in an economic value determination, thus, the study team applied an economic valuation approach to the potential re-allocation of land to PCC habitat. The essence of the methodology examines the reallocation of urban land acres for PCC habitat use. Re-allocation or re-zoning is in essence viewed either as an elimination, or cost/loss of urban land (or conversely, a benefit in valuation of habitat restoration). The re-allocation reduces further use of the same land for urban economic purposes. A further

[55] See: Panama City Crayfish Management Plan- February 2016. Page 26 for plan implementation costs.

breakout of alternative uses within the realm of non-urban, or rural land uses, was not included in this study. Regarding the analysis results, the minimum total integral cost, or re-allocation at the optimal point of one urban acre to one of non-urban or rural use is estimated at approximately $140,000 in indirect economic benefit/loss, and/or $140,000 in direct total parcel purchase costs (or the out of pocket costs) when an urban acre is bought for re-allocation purposes.

In the western portion of the PCC habitat range, about 129 parcels were found that fit the FWC criteria or conditions on acreage[56], while there were 670 parcels found in the eastern range. The additional applied selection criteria on value (over $1,000), and including unique agricultural parcels, resulted in only 21 parcels to the east and 7 parcels to the western range.

A further selection based on just values of parcels shows that agricultural lands are the least expensive parcels, of the total land use codes/types. A large number of soils on the agricultural parcels are listed as “Albany Sand, 0-2° Slopes”, which has a 15.65% PCC presence (or less than a third of the PCC found on Plummer Sand).

The research team found the mean value per agricultural acre in the eastern area to be $8,310 per acre, and $9,978 per acre, on the western section of the PCC habitat range. Based on the acreage size decision criteria of a future FWC purchase of 500 acres in the western section, and 1,500 acres in the eastern section, the expected price of the potential agricultural acres is estimated to be $19,122,000 (based on just values). The potential purchase or reallocation of acres for PCC habitat use will have economic benefits/loss consequences. The purchase of parcels will preclude any future planned or perceived other uses and activities in perpetuity, but for PCC habitat, restoration and maintenance.

[56] Criteria on acreage: greater than 25 acre parcels in the east, and greater than 5 acre parcels in the western sections

To the perception of the research team, it would depend highly on additional available data concerning the real estate market conditions to further refine the economic valuation analysis. In conclusion, the research team found that the further selection and purchase of agricultural parcels on the eastern side for PCC preservation would result in an average price of $8,310 an acre, compared to about $140,000 for an urban acre. There is an added benefit of a reduction in restoration costs of the agricultural parcels in order to be designated, or transformed, to suitable PCC habitat.

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Appendix 1: Assessment and Mitigation Tool

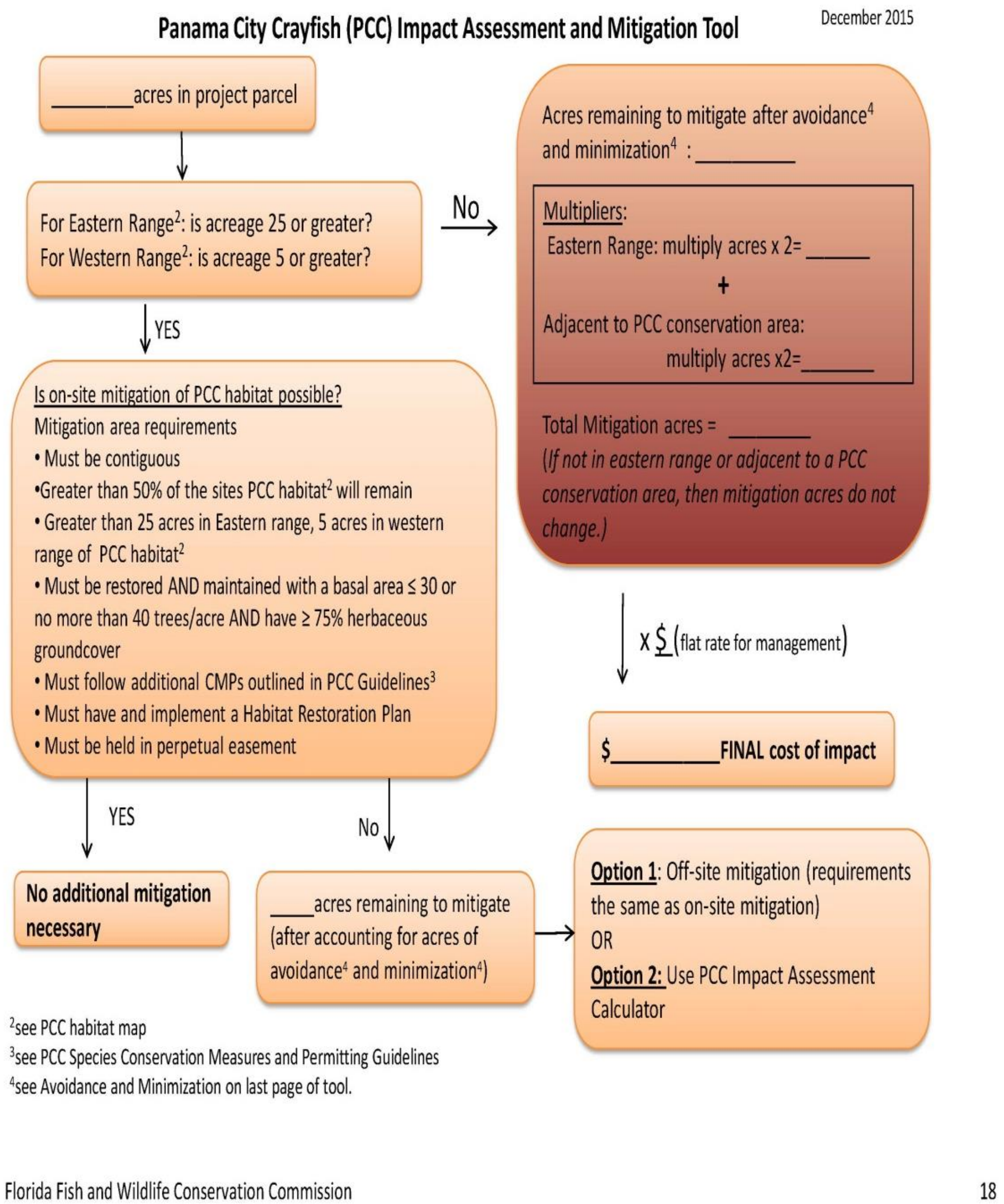

Figure 19. An Example of the Panama City Crayfish (PCC) Impact Assessment and Mitigation Tool

Appendix 2: Assessment Calculator

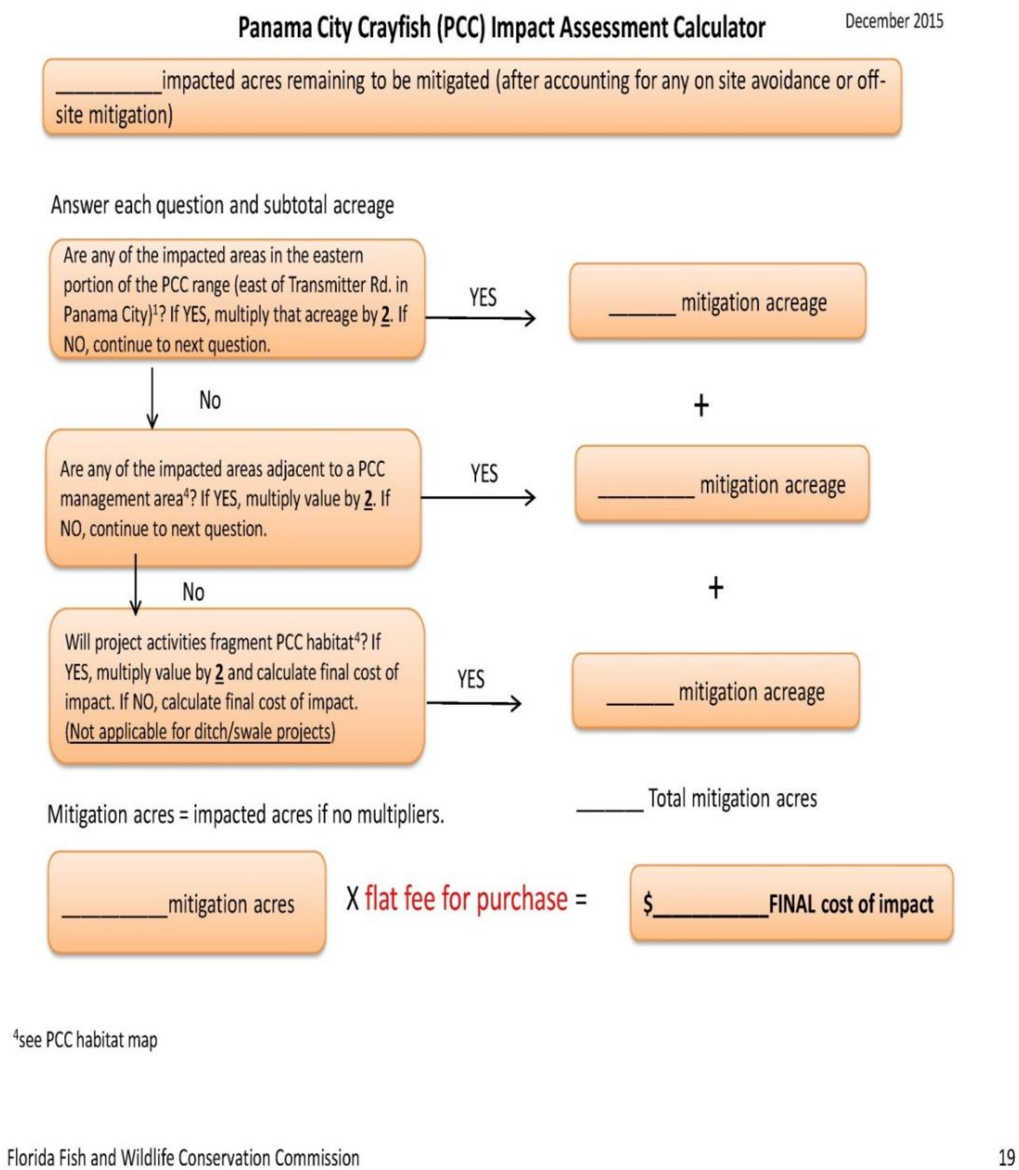

Figure 20. The Panama City Crayfish (PCC) Impact Assessment Calculator

Appendix 3: Empirical Framework/Analyses

In an alternative approach, a simplified production function is used which will include proxy-variables that closely resembles production factor variables, and an additional independent variable.[57] The use of the production function is in estimating the economic benefit/loss in not developing (i.e. eliminating) a parcel of land for Urban use purposes.

A standard production function is used with the format:

$$Y = f(A, B, C)$$

Showing the functional relation between inputs A, B, and C, and output Y. The variables denoted or used are: Sales as output, and Employment, Urban Land Acres and Max Treated Drinking Water as inputs.

Figure 21 depicts total Sales on the left hand side, and Employment on the right hand side, both taken from the NETS database for the years 1999 through 2013 on the selection of local establishments in the PCC habitat range.

[57] For example, the Research team uses time series data from the NETS database on Sales instead of local Gross Domestic Product (GDP). Sales is a direct and market driven variable while GDP is determined based on value added. Given that there is a direct relation between the two variables, the used multiple regression output or outcomes wouldn't be significantly different. Similarly, the research team will use employment (also from the NETS database) instead of population. Again, the relation between the two is rational or linear without significant impact on the multiple regression analyses. In addition, neither direct nor causal relation between the variables used is assumed.

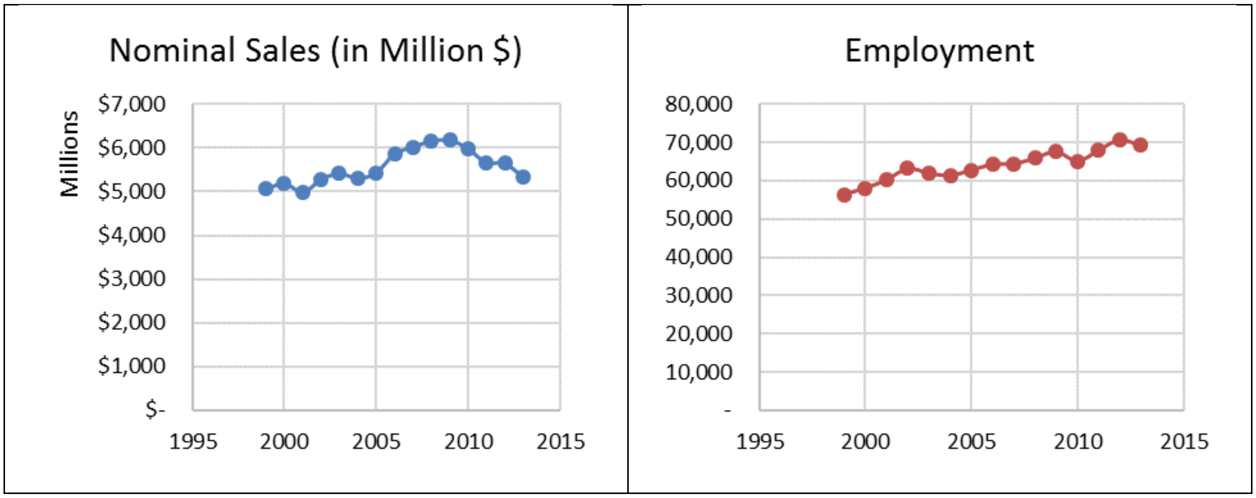

Figure 21. Sales and Employment from Reporting Establishments in the NETS Database Relating to the PCC Habitat Range, 1999 through 2013

The purpose of both the Sales and Employment variable is to have a consistent set, with the Sales variable to represent a local value of economic activity, and Employment a close indicator of population.[58] In addition to Sales and Employment, land use is a necessary component of the analyses. The necessity of a land use variable lies in the policy tool or objective to re-allocate land. Table 5 provides some additional descriptors, such as the natural endowments; land area, water area, core demographics as population, and population density, and a breakout in urban and rural areas as tabulated.[59] The square

[58] Sales is a different measure than local Gross Domestic Product (GDP). Sales represent revenue, while Product is an Added Value measure. Employment may be used as an indicator of population given that it is a consistent subset of the population at large. Application in multiple regression would not differ significantly, since transformation from employment to population would constitute a near linear transformation of input data. Neither Population nor Employment will be further analyzed. In addition, no breakout to the PCC habitat area is applied since most activity will be in the populated area, while a linear breakout again doesn't impact the multiple regression outputs.

[59] Data in part retrieved from www.city-data.com/zips. Sq. mi. Urban Land area and sq. mi. Rural Land area are reverse calculated based on Urban and Rural population and the overall Population density. Population data pertains to the year 2013, and is used only as dummy variable to calculate the Urban and Rural

miles of land area combined with the breakout of Urban and Rural Population and the Population Density were used to break out the square mileage into Urban and Non-Urban or Rural land allocations. Given a slight disparity between the square land mileages here and the Department of Revenue NAL13F20 database reported landmass in the defined PCC-habitat range of Figure 1, a cross calculation was applied to present the breakout of Urban and Rural land areas in acres in the last two columns of Table 7.

Table 7. Zip Codes and Some Descriptors of the PCC Habitat Range

Zip Code	sq. mi. Land Area	sq. mi. Water Area	NAL13F20 Selected Acres	Urban Popu-lation	Rural Popu-lation	Popu-lation Density	Acres Urban Land Area	Acres Rural Land Area
32401	10.7	5.8	***6,919***	23,577		2,204	***6,919***	
32402								
32404[60]	128.8	18.6	***34,208***	32,774	4,165	287	***30,351***	***3,857***
32405	19	4.5	***12,708***	30,976	18	1,632	***12,700***	***7***
32444	9.4	4.8	***6,188***	19,205		2,044	***6,188***	
Total			***60,022***				***60,022***	

It should be noted that Rural land acreages is different than the Department of Revenue NAL13F20 database information. For purposes of the production function, additional data on land allocation is needed, especially time series, matching the NETS data on Sales and Employment. The research team opted to use the development of Urban versus Rural area information, however, only two data points could be traced or reconstructed namely for the years 2000 and 2013, respectively (using Urban v/s Rural population and overall

landmasses. The results are transposed to the obtained landmass of 60,022 acres from the DOR working database.

[60] Zip code area 32404 is tallied in the total for 18.12 percent only based on the estimated acres within the PCC area and the total acreage. No particular quality breakdown could be applied, in other words an equal spread of Urban v/s Rural is assumed in the PCC area and the total zip code area.

population density). Results are (as before) adjusted to the estimated operational PCC habitat range acreage (as per the last two columns of Table 7). For the prior and intermediate years, a polynomial was calculated.[61]

Table 8. Urban and Rural Land Acres Allocation and Development in the PCC Habitat Range.

Zip Code	Acres Urban Land Area 2000	Acres Rural Land Area 2000	Acres Urban Land Area 2013	Acres Rural Land Area 2013
32401	*6,918.78*		*6,918.78*	
32402				
32404[1]	*30,350.45*	*3,857.30*	*30,350.71*	*3,857.04*
32405	*12,699.75*	*7.75*	*12,700.12*	*7.38*
32444	*6,187.86*		*6,187.86*	
Sub-Total	*56,156.85*	*3,865.05*	*56,157.47*	*3,864.42*
Total	*60,022*		*60,022*	

Finally, and in addition to Sales, Employment and land, an additional water variable is defined based on data from the Drinking Water Data Base of the Florida Department of Environmental Protection. In particular, data on "Maximum Treated" drinking water is collected, this of course selective to the zip codes at hand.[62] Figure 22 shows the maxima of treated drinking water in million gallons daily (MGD) in the defined Panama City area.

[61] Acres Urban = 55,426.57 year $^{1.7220E-03}$ and
Acres Rural = 4,674.73 year $^{-2.5023E-02}$

[62] Various annual drinking water data bases were downloaded from the link, and appropriate water plants were selected. The operational variable selected is "Maximum Treated" drinking water. Data retrieved from: http://publicfiles.dep.state.fl.us/DWRM/Drinking%20Water%20Data/MOR/

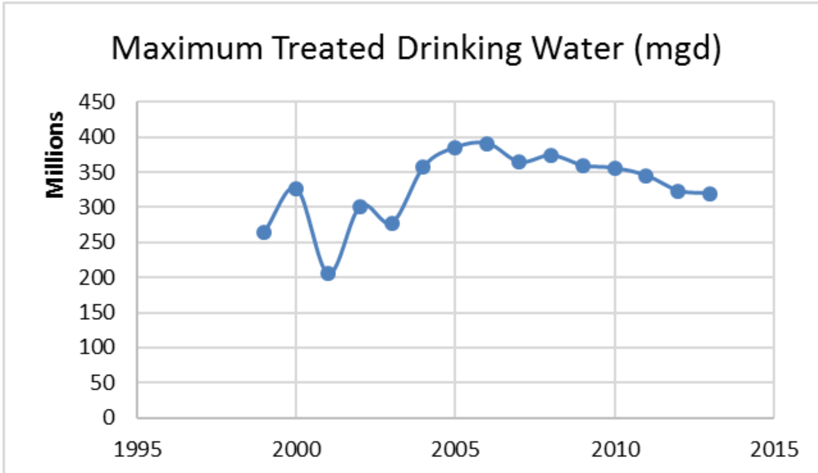

Figure 22. Maxima of Treated Drinking Water in MGD, in Panama City, 1999 through 2013

In combining the four variables, Sales, Employment, Urban Land area in acres and Maximum Treated Drinking Water, the following function between inputs and sales or output is:

$$\boldsymbol{Sales} = \boldsymbol{f}\ (\boldsymbol{Employment}, \boldsymbol{Urban\ Acres}, \boldsymbol{Max\ Treated\ Drinking\ Water})$$

From the data collected it can be derived that:

$$\boldsymbol{Sales_t} = \mathbf{0.9327} \times \boldsymbol{Employment}_t^{\mathbf{0.4380}} \times \boldsymbol{Urban\ Acres}_t^{\mathbf{1.4913}} \times \boldsymbol{Max\ Treated\ Drinking\ Water}_t^{\mathbf{0.2218}}$$

This equation enables to do some further analyses, this under the ceteris paribus assumption. For the year 2013, while keeping the two variables Urban acres and Maximum

Treated Drinking Water[63] the same, with Urban land acres as independent variable, the following can be obtained:

$$\boldsymbol{Max\ Treated\ Water} = \left[\frac{\mathbf{41,924,839}}{\boldsymbol{Urban\ Acres}^{\mathbf{1.4913}}}\right]^{\frac{1}{0.2218}}$$

Or given that both variables are positive:

$\boldsymbol{Urban\ Acres}^{\mathbf{1.4913}} \times \boldsymbol{Max\ Treated\ Water}^{\mathbf{0.2218}} = \mathbf{41,924,839}$ or
$\boldsymbol{Max\ Treated\ Water} = \mathbf{2.7308}\boldsymbol{E} + \mathbf{34}\ \boldsymbol{Urban\ Acres}^{\mathbf{-6.7234}}$

Or, the graphical depiction in Figure 23, with in blue the production indifference curve at the level of $5.9 billion in Sales this under varying different input combinations; here Urban land acres (as the independent variable) and Maximum Water Treatment (as the dependent variable).

[63] Opted is for Water Treatment as auxiliary variable over Employment given the relative better P-value and T-Stat in the multiple regression analyses. The multiple regression was done with the constant at zero, while the Total Factor Productivity is set at 0.9327 to match the Sales value in 2013. This only constitutes a linear shift which doesn't impact the analyses, which will focus on the slope of the curves being derived.

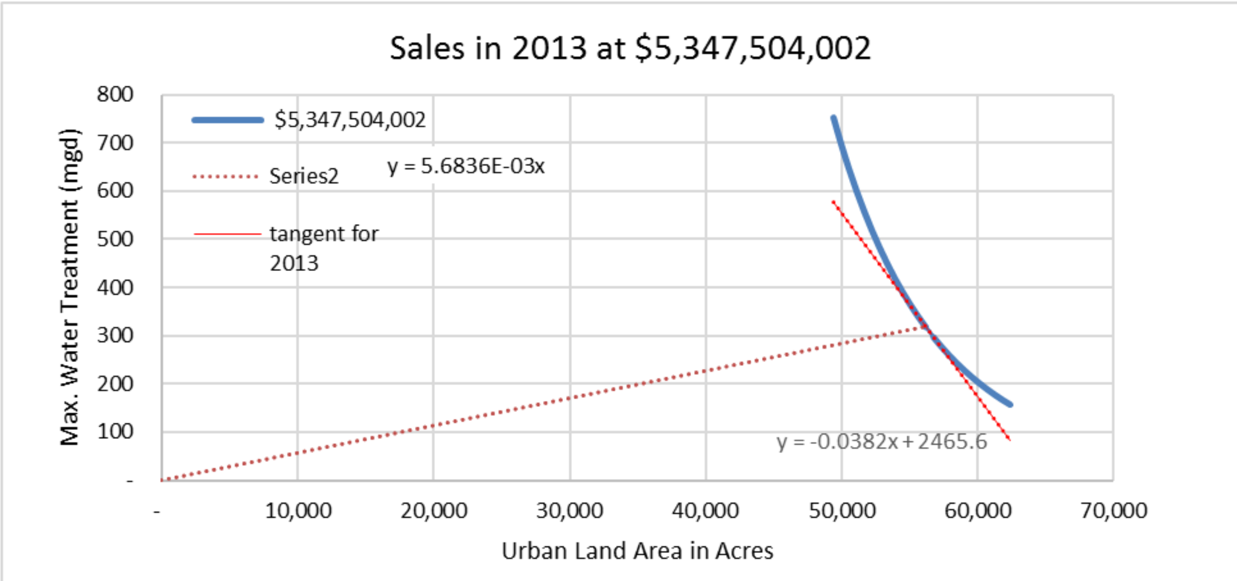

Figure 23. Indifference Curve at 2013 Sales Level with Urban Land in Acreage as Independent and Water as Dependent Variable

Using the production function, small changes (under ceteris paribus) may be applied to the variable Urban land acres, i.e. in case taking out or re-zoning land to Non-Urban or Rural for the purpose of PCC habitat. Given income as well as substitution effects, changes in Urban land use ultimately changes Sales (new Sales levels under changed conditions or input). Figure 24 shows two different indifference curves on total Sales, at differing price ratios, and two optimal points or maxima of combinations between Urban land inputs and Maximum Treated Drinking Water (in mgd.), this given plus or minus 2,000 Urban land acres.

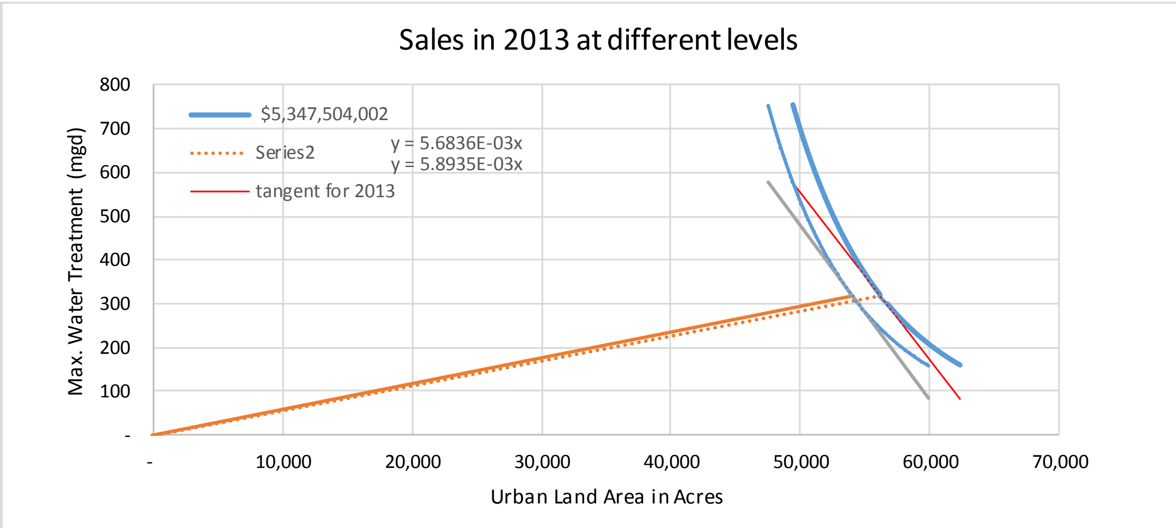

Figure 24. Two Indifference Curves at different Sales Levels with Urban Land in Acreage as Independent Variables

In addition to the two optimal points depicted in Figure 24, several other points were calculated. Combining the various optimal points: Urban land acres (inputs) and calculated new Sales levels (via the differing indifference curves), a functional relation is derived between the two variables, namely:

$$\text{Sales} = 441.7907 \text{ Urban Land Acres}^{1,4913}$$

which is depicted in Figure 6 (p. 27) of the main text.