

Project Title: New Jersey Urban and Community Forestry Program Funded Tree Inventory Analysis with i-Tree Eco

Introduction

Objective of Project – What Issue Will You Address: Tree inventories submitted by New Jersey municipalities to the New Jersey Forest Service’s Urban and Community Forestry Program as part of Resiliency Planning grants are not all conducted in the exact same way. The completed inventories that are received are often different in terms of specific data collected and field names or categories used to organize data. The goal of this project is to work with a sample of existing municipal tree inventories, and edit them so that they can be imported and processed through I-Tree Eco, with the goal of generating reports.

Brief Description of Project: We will take existing municipal tree inventories and edit them to run through I-tree Eco. Our goal is to edit the inventory data fields so that each is compatible with I-Tree Eco, and to run each inventory for Eco Reports. The goal is to generate reports that summarize urban forest characteristics and ecosystem services of each municipality’s urban forest. These reports will help communicate the benefits of urban forests to municipalities participating in the UCF grant program, and reinforce the importance of maintaining an accurate and updated municipal tree inventory. This base of reports will also help the NJUCF Program communicate effectively up-chain in regards to NJ Statewide Carbon emission campaign priorities.

Name of Community, Geographic Area and/or Tree Resource Involved:

For this project we analyzed the completed, funded inventories of 4 different New Jersey municipalities that have each participated in NJUCF’s Resiliency Planning grant program. The following municipality tree inventories were incorporated into our project:

- Byram Township, Sussex County 2019 (designated as not urban in Eco)
- Springfield Township, Union County 2018 (designated as urban in Eco)
- Point Pleasant Beach, Ocean County 2018 (designated as urban in Eco)
- Holland, Hunterdon County 2018 (designated as not urban in Eco)

Methods and Analysis

Methods - General Steps

Each community’s completed and submitted tree inventories were in Excel spreadsheets. After creating a project file in I-Tree Eco for each community inventory, we selected the fields to import from the full spreadsheets into Eco that would be both compatible with Eco, and useful in generating reports.

In Eco, the minimum required fields for importing a complete inventory are DBH (in.) and Species. All four inventories had these two fields in some form. We also wanted to incorporate any recommended (blue) fields that the inventories had, such as crown health (Condition). We omitted some “optional” fields, such as maintenance fields, for the sake of focusing on each inventory’s required and recommended fields. Some of the inventories contained management and maintenance fields specific to the communities, such as street addresses, parcel IDs, utility conflicts, and notes and comments. (See appendix I)

After choosing which fields to import into Eco for each community spreadsheet, we then had to “match” any values that did not already correspond to an existing Eco Value.

To illustrate the importance of proper data collection and Eco Value matching in the import process, for each inventory, we also ran the original unedited fields from the spreadsheet in Eco to show how many records would be rejected without the matching process.(see appendix II)

Once we matched as many of the unmatched values to Eco Values as possible, each inventory was imported into Eco and available to view under “Trees” within the “Inventory Data” tab.

With each completed inventory imported with our selected fields, we were able to run both a full “Written Report” for each inventory and a Condition report, found under the “Composition and Structure” - “Condition” - “By Species” tabs.

Methods – Interesting Steps Specific to Each Inventory

As we learned throughout this project, each community’s inventory is unique, with different data fields collected in accordance with the community’s management goals, budget, and the tree resource itself. This means that the import process often has to be unique to each inventory.

For **Holland, NJ 2018** the following spreadsheet fields were imported and associated to I-Tree Eco fields :

- ID = ID in Eco
- Tree Species = Species, Common name in Eco
- DBH_1 = DBH 1 (in.) in Eco
- DBH_2 = DBH 2 (in.) in Eco
- DBH_3 = DBH 3 (in.) in Eco
- DBH_4 = DBH 4 (in.) in Eco
- DBH_5 = DBH 5 (in.) in Eco
- Crown Health = Crown: Condition (Field Type – Description) in Eco
 - For this field, we needed to Map Source Column Values, since in the inventory, tree Condition was rated on a “1”, “2”, “3”, “Dead” system, with “1” being the best rating. Therefore, before importing the spreadsheet into Eco, we had to edit the raw Excel spreadsheet to replace “Dead” under the condition field with “4”. Without this step, Eco doesn’t recognize “Dead” as a description from the spreadsheet to assign an Eco Value, and all of the “Dead” trees are lost in the import.
 - When matching the “1,2,3,4” condition system to Eco Value Condition percentages, the following matches were made:
 - 1 = Good = 95% to 99%
 - 2 = Fair = 75% to 80%
 - 3 = Poor = 45% to 50%
 - 4 = Dead = 0%
 - These percentages were chosen by us, and may differ from the percentages that the Township may have used, since we only had the “1,2,3, Dead” system to work with.

For **Point Pleasant Beach, NJ 2018** the following steps for import were taken to import selected spreadsheet fields and associate them to I-Tree Eco fields :

- First we had to remove all of the “VAC” (vacant) and “STU” (stump) records from the original spreadsheet, since these entries are not compatible with Eco.
- Along with Survey Date, we imported the following fields:
- Species (Common name)
 - Excel species vs. Eco Value matched when Mapping Source Column Values
 - Apple – apple spp
 - Ash – White ash
 - Crape myrtle – Lagerstroemia spp
 - Fringetree – fringe tree
 - Hawthorn – hawthorn spp
 - Horsechestnut – horse chestnut
 - Japanese Stewartia – Stewartia
 - Little leaf linden – littleleaf linden
 - Magnolia – magnolia spp
 - Persimmon – diospyros spp
 - Scholartree – styphnolobium spp
 - Serviceberry – serviceberry spp
 - Weeping cherry – Higan cherry
 - Willow – willow spp
- DBH (in.)
 - For this field, we needed to Map Source Column Values, since in the inventory, each tree’s DBH was collected as a range between two numbers (i.e. “11 to 17 in.”) Eco does not accept ranges for DBH, only single numbers. Because DBH was collected as a range, we had to average the range values to assign an estimated DBH (in.) to each tree as shown:
 - 0 to 5 in = 3 in.
 - 5 to 11 in = 8 in
 - 11 to 17 in = 14 in
 - 17 to 23 in = 20 in
 - 23 to 29 in = 26 in
 - 29 to 1000 in = 32 in
 - Averaged 29 in and 35 in

For **Byram Township, NJ 2019** the following spreadsheet fields were imported and associated to I-Tree Eco fields :

- ID = ID in Eco
- Tree Species = Species, Scientific name in Eco
 - Removed all “Vacant sites”, “Unknown”, and “Stumps”
 - Removed “spp” and “Species” and corrected multiple misspellings of scientific names.
- DBH = DBH 1 (in.) in Eco
- Crown Health = Crown: Condition (Field Type – Description) in Eco

- For this field, we needed to Map Source Column Values, since in the inventory, tree Condition was rated on a “Good”, “Fair”, “Poor”, “Dead” scale
- When matching the condition scale to Eco Value Condition percentages, the following matches were made:
 - Good = 95% to 99%
 - Fair = 75% to 80%
 - Poor = 45% to 50%
 - Dead = 0%
- These percentages were chosen by us, and may differ from the percentages that the Township may have used, since we only had the “Good- Dead” system to work with.

For **Springfield Township, Union, NJ 2018** the following spreadsheet fields were imported and associated to I-Tree Eco fields :

- Count= ID in Eco
- Tree Species = Species, Scientific name in Eco
- DBH = DBH 1 (in.) in Eco
- Crown Health = Crown: Condition (Field Type – Description) in Eco
 - For this field, we needed to Map Source Column Values, since in the inventory, tree Condition was rated on a “Excellent” , “Good”, “Fair” , “Poor” , and “Dead” scale.
 - When matching the “Excellent-Dead” condition system to Eco Value Condition percentages, the following matches were made:
 - Excellent = 95% to 99%
 - Good = 85-90%
 - Fair = 75% to 80%
 - Poor = 45% to 50%
 - Dead = 0%
 - These percentages were chosen by us, and may differ from the percentages that the Township may have used, but we did our best to remain consistent in our terminology/percentage associations between inventories.

Results

Table Summarizing Written I-Tree Eco Reports for 4 NJ Municipality Inventories

Report Summary Categories	<u>Byram 2019</u>	<u>Springfield 2018</u>	<u>Point Pleasant Beach 2018</u>	<u>Holland 2018</u>
Number of Trees	8,329	1,791	1,003	3,264
Tree Cover (acres)	96.88 acres	17.08 acres	11.43 acres	52.13 acres
Most common species of trees Invasive species highlighted	Norway maple, Japanese zelkova, Northern white cedar	Red Maple, Norway maple oak spp	Callery pear, London planetree, Silver maple	White ash, Eastern red cedar, Tulip tree
Percentage of trees less than 6" (15.2 cm) diameter:	28.4%	23.6%	29.9%	14.2%

Carbon Storage	426 thousand tons (\$925 thousand)	1.166 thousand tons (\$199 thousand)	572 tons (\$97.6 thousand)	2.744 thousand tons (\$468 thousand)
Carbon Sequestration	47.19 tons (\$8.05 thousand/year)	10.52 tons (\$1.79 thousand/year)	15.08 tons (\$2.57 thousand/year)	25.79 tons (\$4.4 thousand/year)
Oxygen Production	125.8 tons/year	28.05 tons/year	40.22 tons/year	68.78 tons/year
Avoided Runoff	: 262.1 thousand cubic feet/year (\$17.5 thousand/year)	21.86 thousand cubic feet/year (\$1.46 thousand/year)	32.09 thousand cubic feet/year (\$2.14 thousand/year)	181.4 thousand cubic feet/year (\$12.1 thousand/year)
Structural values	\$21.3 million	\$4.21 million	\$2.14 million	\$9.91 million

All of the inventories were importable after we made our assumptions. The main issue we had across all four inventories was that we were forced to make those assumptions, especially for the crown health data fields.

Since we were not on the ground to assist in collecting the data, we could not glean proper understandings of condition descriptor vs actual dieback percentages from the supplemental reports alone. A standard inventory data field template, or a more detail explanation of how the inventory measurements were taken would help us understand the choices and observations behind the chosen terms. If the goal is the most accurate I-Tree eco report then the appropriate Eco values should ideally be assigned by the people collecting the data. They are most qualified to make any and all assumptions.

The people on the ground are also more qualified in identifying their community’s management and budgetary concerns. Before we start standardizing what it means to collect a “good” inventory we need to remember that the communities we serve in NJ are each unique. Our grant guidelines also allow communities to hire from different vendors. While forestry professionals are specified: (NJ approved forester, NJ Licensed Tree Expert, SAF Certified, ISA Certified, or other professional who abides by the current forestry best management practices and arboricultural industry standards), any two combinations of those professional options could be contracting with different deliverables. So while the lack of consistency across inventories interfered with our ability to run what we infer would’ve been the most accurate Eco reports, the content and data itself is not to be considered “Poor” in anyway as it was collected in accordance with the standards we set for our own communities.

Issues Encountered and Troubleshooting

Issues encountered include:

Species matches – When inventories utilize only common name genera in species identification, it makes matching that genus to a species Eco Value a guessing game and therefore less accurate. For example, the Point Pleasant Beach inventory has “Ash” or “Magnolia” under the species ID field. Contrast this with a situation in Springfield’s inventory, where one of the most prevalent trees was identified as simply Quercus and therefore matched to the general “oak spp” during our import, but upon further review of the inventory documents submitted, all of those “Quercus” were later described in a pie chart as being Northern Red Oaks.

DBH ranges - (Point Pleasant Beach) Eco does not accept ranges for DBH, only single numbers. When DBH is collected as a range, we had to average the range values to assign an estimated DBH to each tree. We assume this will contribute to a less accurate eco value report.

Condition ratings- (Point Pleasant Beach) Lack of consistent condition ratings meant we had to remove the field from the set of fields imported into Eco. Only some trees had leaf condition ratings of either "Good", "Fair", "Poor", or "Dead or Dying". Without condition ratings, Eco in condition report will default all trees to "Fair" Condition. 100% of trees in the Point Pleasant Beach inventory are considered "Fair". (Reference Condition Report)

Condition ratings- (Holland, Springfield, and Byram) These inventories did have completed condition ratings in the original inventory spreadsheet, and even though it's an optional field, we attempted to include as much detail of the original data as possible. However, the descriptions/scales of condition were different for all three. To combat this inconsistency we decided to make standard assumptions across all three based on the default crown health categories and the 22 percentage options. We chose the following as our standard choices since each inventory had a scale of either four or five categoric options:

- The highest "score" will be equal to 95-99%
 - Holland (1), Springfield (Excellent), Byram (Good)
- 85-90%
 - Holland (unassigned), Springfield (Good), Byram (unassigned)
- 75-80%
 - Holland (2), Springfield (Fair), Byram (Fair)
- 45-50%
 - Holland (3), Springfield (Poor), Byram (Poor)
- The lowest "score" will be equal to 0%
 - Holland (4), Springfield (Dead), Byram (Dead)

Lessons Learned

Any collected entries that cannot be imported into Eco for analysis or matched with an existing Eco Value is missed and cannot be valued within Eco. This emphasizes the importance of complete and accurate data collection to the best of the data collector's ability, time, and resources. Prior planning to take into account which fields need to be imported into Eco for analysis can make inventory data collection more efficient and effective when it comes to importing the data and generating reports.

For instance, in Point Pleasant Beach's inventory, all 1,635 records were rejected from the original unedited inventory during our test import to see how many records would be rejected without matching. In particular, because the inventory incorporates the DBH field as a range between two DBH measurements in inches, instead of a single measurement, every record was rejected.

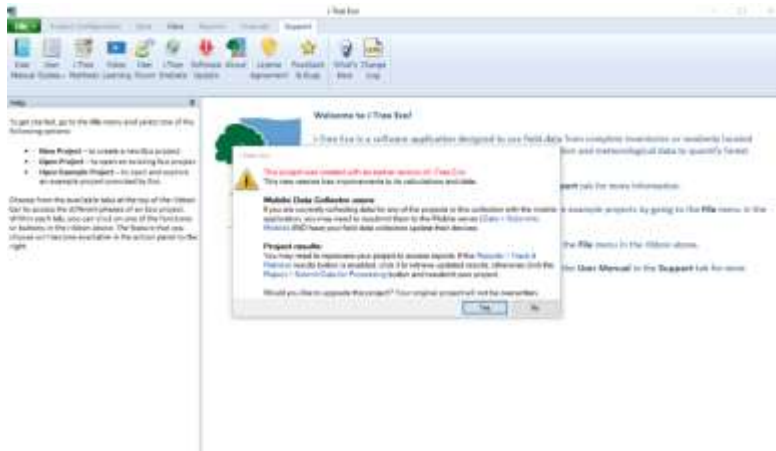
Unmatched species records and vacant areas were also reasons for rejection, especially in Byram's inventory. These data entries were present in all four inventories, and included dead, unknown trees, stumps, vacate sites, and 7uyh.

In Holland's inventory, out of 3,412 records analyzed for import, 145 could not be imported. These were all records with empty cells for species. However, although all of the records with species and DBH were imported from the original inventory, none of the condition ratings were imported

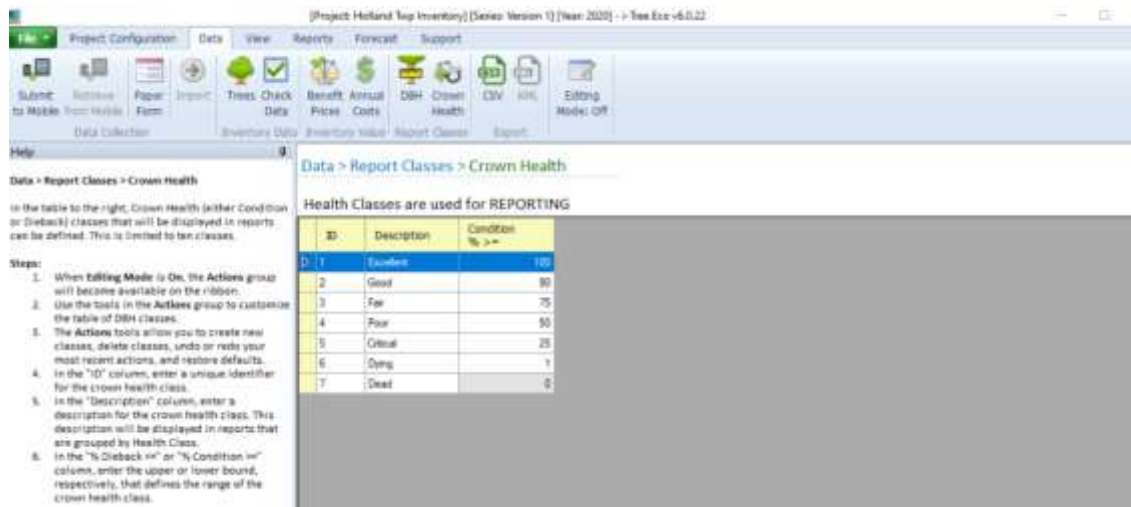
Supplemental: Same Inventory, Different Eco Results: Example from Holland, NJ 2018

In order to see how different organizations may run the same I-Tree inventory, we requested the original “.ieco” file from Holland Township to see how their personnel imported their inventory into Eco.

- The inventory was originally run through an earlier version of Eco, so when we opened their .ieco file in the newest version of Eco, Eco required that the file be upgraded before opening the project (shown in the image below).



- They imported the following fields
 - ID, Species, DBH 1, DBH 2, DBH 3, DBH 4, DBH 5, Crown Condition
- The condition parameters that the Township used in their reporting look to match the default Condition percent parameters in Eco (shown in the below picture).
 - They matched Crown condition to percentages as followed:
 - 1 = 95% - 99% “Good”
 - 2 = 65% - 70% “Poor”
 - 3 = 20% - 25% “Dying”
 - Dead = 0% “Dead”



- To compare, for our import of the same inventory into Eco, we used the following parameters after changing all of the “Dead” entries to “4” in the raw Excel spreadsheet.
 - 1 = Good = 95% to 99%
 - 2 = Fair = 75% to 80%
 - 3 = Poor = 45% to 50%
 - 4 = Dead = 0%
 - We were then able to run the same full “Written Report” and “Condition Report” for each version of import of the Holland inventory.

The biggest takeaway from comparing the two Condition Reports was that how you categorize your reporting percentages can affect your inventory breakdown in the reporting results. In our run of the report, because of our categories, the same trees showing up as “Fair” condition, fell under the “Poor” category in Holland Township’s run of their report. Trees categorized as “Critical” condition in our run of the report were categorized as “Dying” in the Holland Township run of the report. So our trees in the “Fair” and “Critical” categories are one category of condition higher than the same trees in the Holland Township internal report. The “Good” and “Dead” categories are the same between the two reports.

Overall, it may be better to stick to the default Eco settings so that there is consistency across reports, even if different organizations are running reports on the same project. Some of the trees in our inventory run are being categorized higher than they would under the default condition settings.

- In the full written reports, the following charts are different between our Holland inventory run and the Township’s internal run of the inventory.
 - Carbon Storage and Sequestration – Our run estimates less carbon storage and sequestration than the township’s internal run, but white ash still stores and sequesters the most carbon.
 - Township Run: The gross sequestration of Holland Twp Inventory trees is about 37.21 tons of carbon per year with an associated value of \$6.35 thousand.

- Township Run: Trees in Holland Twp Inventory are estimated to store 2910 tons of carbon (\$497 thousand). Of the species sampled, White ash stores and sequesters the most carbon (approximately 23.5% of the total carbon stored and 16.6% of all sequestered carbon.)
 - Our Run: The gross sequestration of Holland, NJ 2018 Inventory trees is about 25.79 tons of carbon per year with an associated value of \$4.4 thousand.
 - Our Run: Trees in Holland, NJ 2018 Inventory are estimated to store 2740 tons of carbon (\$468 thousand). Of the species sampled, White ash stores and sequesters the most carbon (approximately 24.9% of the total carbon stored and 26.8% of all sequestered carbon.)
- Avoided Runoff – Our inventory run estimates more avoided runoff for the trees than the internal township run.
 - Township Run: The trees and shrubs of Holland Twp Inventory help to reduce runoff by an estimated 75.2 thousand cubic feet a year with an associated value of \$5 thousand (see Appendix I for more details). Avoided runoff is estimated based on local weather from the user-designated weather station. In Holland Twp Inventory, the total annual precipitation in 2016 was 38.3 inches
 - Our Run: The trees and shrubs of Holland, NJ 2018 Inventory help to reduce runoff by an estimated 181 thousand cubic feet a year with an associated value of \$12 thousand (see Appendix I for more details). Avoided runoff is estimated based on local weather from the user designated weather station. In Holland, NJ 2018 Inventory, the total annual precipitation in 2018 was 69.1 inches.
 - Likely cause of difference – 2018 had (our inventory) had much more rainfall than 2016 (township run)

Overall, this is an example of how the same tree inventory can generate different reporting results in Eco, not only because of different users, but because from year to year weather conditions will change and affect Eco's outputs.

Appendix I

- Project configuration
 - Varies due to parent project's data fields. Goal, be as supportive of Eco's modeling while maintaining consistency when we must make assumptions.

Data collection options	Byram 2019	Springfield 2018	Point Pleasant Beach 2018	Holland 2018
Species	yes	yes	yes	yes
DBH	yes	yes	yes	yes
Condition	yes	yes	no	yes
Land Use	no	no	no	no
Map (GPS)	yes	yes	no	no
Total tree height	yes	no	no	no
Crown size	no	no	no	no
Crown Health	no	no	no	no
Crown Light Exposure	no	no	no	no
Survey Date	yes	yes	yes	no

Appendix II

- Rejection of records.
- After importing and cleaning our data, we realize that much of the information if not reformatted or retyped to match Eco's acceptable terms would've been rejected. To explore this, and see how much our standardization effort was actually "helping", we went back to the original spreadsheets and neglected to clean the data or properly match the fields to eco-values. This gave us a "baseline" for each inventory as follows:
 - Holland
 - Original data: 3,412
 - Rejected: 145
 - Point Pleasant
 - Original data: 1,635
 - Rejected: 1,635
 - DBH was collected by "range" not single measurement. Resolved after replacing ranges with appropriate averages.
 - Byram
 - Original data: 13,181 entries
 - Rejected: 4853 entries
 - 4,220 entries "Stump/unknown/vacant site" were removed
 - 633 entries were resolvable after correcting species wording/spelling
 - Springfield
 - Original data: 2,480 entries
 - Rejected: 714 entries
 - _ entries removed
 - _ entries were resolvable after correcting species wording/spelling

In the case of Point Pleasant Beach, assigning each DBH range to its proper average was essential. The other consideration in reviewing the inventories from the point of view of a grant administrator is that the Eco report cannot communicate the value of the funds that communities are investing in inventorying potential tree placements. This was particularly apparent in Byram's inventory. Of the 4853 data entries rejected during import 4220 of them were stump, unknown (which were mostly listed as condition dead), or vacant site entries. This reminds us that on the ground our municipal tree inventories are as much about information on our current trees as they are about planning for our future trees. Vacant sites entries are imperative to a municipality's understanding of their stocking level, and though Eco has a "dead/ 0" option for crown health condition rating, we couldn't actually include those entries because the inventory-er was unable to ID the dead tree.

We should never assume that un-importable data is of no value in terms of grant investment.