Identifying Least-Cost Paths and Corridors for Florida Panther within South-Central Florida

Summary Report

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Copies of the project data layers can be obtained at: Florida Geographic Data Library, https://fgdl.org/, search keyword - panther

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Summary Report

Our aim was to identify potential pathways and corridors that panthers are likely to use under existing land cover/land use conditions from the current species core range (south of the Caloosahatchee River) to potentially suitable large habitat hubs north of Interstate 4 (The Green Swamp and Ocala National Forest). The focus being on predicted panther movements and natural range expansion within the south-central Florida region.

Methods

To perform the Least-Cost Path (LCP) and Corridor (LCC) analyses, we used the Florida Fish and Wildlife Conservation Commission (FWC) cooperative land cover v3.4 polygon data layer. First, we performed manual revisions to update coding inaccuracies and land use changes in the study area that occurred up to the Fall of 2021 (using Google Earth imagery for comparison). Second, we used the US Fish and Wildlife Service's 2012 Panther Habitat Assessment Methodology Classification for calculating Panther Habitat Unit (PHU) valuations to lump land cover classes for use in the LCP/LCC models. We adapted the original FWC land cover classes (192 found within the study area) by consolidating them into 17 classes closely corresponding to the FWS methodology classification categories (Table 1). In addition, special designations were made for wildlife crossing structures (base score=1.0) and wildlife fencing (base score=40).

The LCP/LCC analyses were performed using ArcGIS Desktop 10.8. The **first step** was to create a cost surface from the manually updated FWC existing land cover layer. The original polygons were converted to raster at 10 m resolution. Next, the raster layers were reclassified based on the values in Table 1 and converted to integers by multiplying by 10. The result was the base (original) cost surface layers consisting of values (x) ranging from 1 to 400 (Note that the value zero cannot be processed in the algorithm so it was changed to the value 1).

We also created a second set of cost surface layers consisting of the inverse (1/x) of the base values. The two cost surface algorithms (x; 1/x) generate somewhat different results that are useful in evaluating "alternative" pathways that panthers might select. Two factors interplay in determining the least-cost path: habitat quality and distance between target locations that the pathway is plotted. The base cost surface layers consisting of integer values places somewhat greater emphasis on higher quality habitat, while the inverse function (a floating decimal value) places somewhat greater emphasis on shorter distance. We ran least-cost path on both cost surfaces. Least-cost corridor was only run on the inverse (1/x) cost surface.

The **second step** was to identify target locations to plot least-cost pathways and corridors between. We identified 34 target locations of protected conservation lands within the Florida Ecological Greenways Network [FEGN, 2021] (Table 2; figs. 1 and 2). These included larger conservation reserve areas or hubs that could potentially support breeding populations and smaller "stepping-stone" conservation areas and linkages that would serve as functional habitat

connections for dispersing individuals. Location and size of the target area polygon within each respective conservation area was selected to generate multiple, optional pathways emerging from within each conservation area.

In the **third step** for the LCP process, we created cost backlink (neighboring cell and path direction functions) and cost distance (accumulative costs) raster layers necessary to create the least cost paths. Next, we used the cost path polyline option to plot line features connecting the various target locations.

The cost distance raster layers created for the third step in the LCP process were also required in the LCC process to create predictive, connecting corridors. The corridor tool was used to calculate the accumulated cost of the two cost distance raster layers associated with the source and destination target locations. The resulting raster layer was then sliced into 7 graduated classes using Jenks Natural Breaks. Next, we applied an exclusion threshold that only retained the narrowest range of values while maintaining the 7 graduated classes. We chose the 3 lowest value classes to represent primary, secondary and tertiary corridors. These were converted to polygon features.

Results

The least-cost path analysis resulted in the creation of 76 separate pathways between the 34 target conservation areas (fig. 3). The total length of the pathways was 2,284.4 mi, average length was 30 mi, minimum length was 2.6 mi and maximum length was 93.3 mi. Location of pathways in relation to existing and proposed conservation areas (FNAI 2021) include: 28% in protected conservation areas, 59% in FEGN priority 1-3 (note: conforms to the Florida Wildlife Corridor), 7% in FEGN priority 4-5 and 6% undesignated.

The results of the least-cost corridor analysis are shown in fig. 4. A total of 54 corridors were created between the 34 target conservation areas. The table below provides a breakdown of the extent that the corridors (as split into three levels of value) are within existing conservation lands or the FEGN.

	total acres	%	primary ac	%	secondary ac	%	tertiary ac	%
Protected Lands*	844,717	26%	347,781	32%	298,154	25%	198,782	21%
FEGN# cat 1-3	1,729,554	54%	618,879	57%	661,951	56%	448,723	48%
FEGN# cat 4-5	188,638	6%	57,554	5%	67,861	6%	63,223	7%
out	443,791	14%	61,515	6%	161,752	14%	220,524	24%
	3,206,698		1,085,728		1,189,718		931,252	

*Florida Natural Areas Inventory, 2021
#Florida Ecological Greenways Network, 2021

Overall, 86% of the predicted corridors overlap with existing conservation lands or the FEGN. The primary level corridors consist of 94% existing conservation lands or the FEGN. In many cases the secondary and tertiary areas function as buffers to the primary corridor area. For comparison, fig. 5 overlays the least-cost pathways and least-cost corridors.

We calculated basic figures of road elements associated with the least-cost paths and least-cost corridors. Values were based on roads with more than 200 vehicles/day on average for 2021 (source: FDOT). For the least-cost paths, there were 236 crossings with roads, 41 bridges that intersected cost paths and 227 bridges within ½ mile of cost paths. These figures provide insight as to possible existing conflicts (roadways) with the least-cost paths, and opportunities (bridges) that could either already be suitable or possibly adapted to function as wildlife crossings).

For the least cost corridors, centerline road miles and bridges occurring within the four categories of the corridor analysis are shown below:

Centerline road miles

within:	Miles*	%
Protected conservation target areas	102	7%
Primary corridor	257	18%
Secondary corridor	572	39%
Tertiary corridor	531	36%
Total	1,462	

* applies to roads with AADT of 200 or greater.

Bridges

contained within:	#
Protected conservation target areas	28
Primary corridor	141
Secondary corridor	118
Tertiary corridor	99
Total	386

We also compared recorded telemetry locations from dispersing panthers and bears to the corridor analysis results. Two stipulations related to the calculated values presented below: only telemetry locations north of the Caloosahatchee River and within 0.5 miles of the corridor model results were included. This data comparison is also shown in figs. 6a and 6b.

Number of telemetry locations found within 0.5 mi of the panther corridor model results:

	Recorded Locations	Percent
panther telemetry (GPS; n=2) -	2688	55%
panther telemetry (VHF; n=4) -	592	12%
panther telemetry (All; n=6) -	3280	67%
bear telemetry (GPS; n=2) -	2988	84%

Note: - total # of locations recorded from telemetry subjects- 4,913 (panther), 3,574 (bear).

Note: panther data provided by FWC; bear data provided by Joe Guthrie and Daniel Smith.

An overlap of 67% on the panther telemetry locations and 84% on the bear telemetry locations is reasonable given that these collared animals were generally dispersing in directions and areas at random. Conversely, the least cost paths and corridors are plotted with predetermined sources and destinations. Another notable weakness with this comparison is that only data from 6 individual, collared, male panthers were available from north of the Caloosahatchee River. In addition, bears, while wide-ranging, have somewhat different habitat selection preferences than panthers and often are either indifferent or more willing to encroach into human-oriented, land use types in search of food. The model presented here is based on habitat selection preference of panthers (see Table 1.).

Lastly, we examined relation of known panther-vehicle collisions north of the Caloosahatchee R. and St. Lucie Canal to just north of Interstate 4 (Source: FWC, December 2022; Note: three of the mortalities were of unknown cause, all others were listed as vehicle trauma). We found that 25 of 30 mortalities were within 0.5 mi of the corridor model; nineteen of these were within predicted corridors and targeted conservation areas (fig. 7). Twelve of 30 mortalities were located within 1 mi of the least-cost paths.

Table 1. Valuations of land cover classes for use in LCP/LCC analyses.

Category Rank	Base Score	Description
1	0.0	Pinelands
2	0.3	Forested Wetlands
3	0.5	Upland Hardwood Forests
4	3.2	Dry Prairie
5	3.8	Rural Semi-forested/Unimproved Pasture/Tree Plantation/Mine Reclamation
6	4.0	Shrub/Brush Lands
7	4.3	Rural Open/Improved Pasture
8	4.4	Mining/Utilities Open Space
9	4.6	Orchards/Groves/Trees/Vineyards
10	4.8	Non-forested Wetlands/Natural Streams and Rivers
11	5.0	Xeric Scrub
12	6.5	Barren/Grass/Open Space/Urban Parks/Coastal/Exotic
13	8.5	Row and Field Crops/Seasonal Rotation/Sod Farms
14	9.5	Lo Intensity Built Env/Institutional/Industrial Ag/Artificial Water Features
15	12.5	Med-Hi Intensity Built Env/Mining
16	15.0	Open Water
17	20.0	Roads

Note: Original land cover classes from the Florida Fish and Wildlife Conservation Commission (FWC) cooperative land cover v3.4 adapted to the US Fish and Wildlife Service's 2012 Panther Habitat Assessment Methodology Classification for calculating Panther Habitat Units (PHUs).

Table 2. Target Locations for LCP/LCC Models.

Id	Target Location
1	Florida Panther NWR
2	North Belle Meade
3	Big Cypress NP (west)
4	Corkscrew Swamp Sanctuary
5	Big Cypress NP (east)
6	Okoalacoochee Slough SF
7	CREW
8	Spirit of the Wild (WMA)
1	Fisheating Creek WMA
2	Archbold Biological Station
3	Babcock Ranch Preserve
4	Myakka Conservation Area
5	Avon Park Bombing Range/Kissimmee Prairie SP
6-a	3 Lakes WMA/Whaley Conservation Easement
6-b	Bull Creek WMA/Triple N Ranch
7	Tosohatchee WMA
8	Longleaf Preserve/Port Orange City Forest
9	Hilochee WMA Osprey Unit/Lake Lowery Marsh
10	Disney Wilderness Preserve/Southport Ranch CE
11	Bright Hour Watershed
12	Duette Preserve
13	Alafia River Conservation Area
14	Teneroc Fish Management Area
15	Hillsborough SP/Lower Hillsborough Flood Reserve
16	Green Swamp WMA
17	Lake Louisa SP/Hilochee WMA
20	Tiger Bay SF/Plum Creek CE
21	Wekiwa Springs SP/Rock Springs SP
22	Seminole Ranch Preserve
23	Hal Scott Regional Preserve and Park
30	Babcock-Webb WMA
31	Dupuis/Corbett WMA
32	St. Sebastian River Preserve
33	Ocala National Forest

Notes: blue indicates source areas located south of the Caloosahatchee River; yellow indicates destination areas to the north of the Caloosahatchee River.

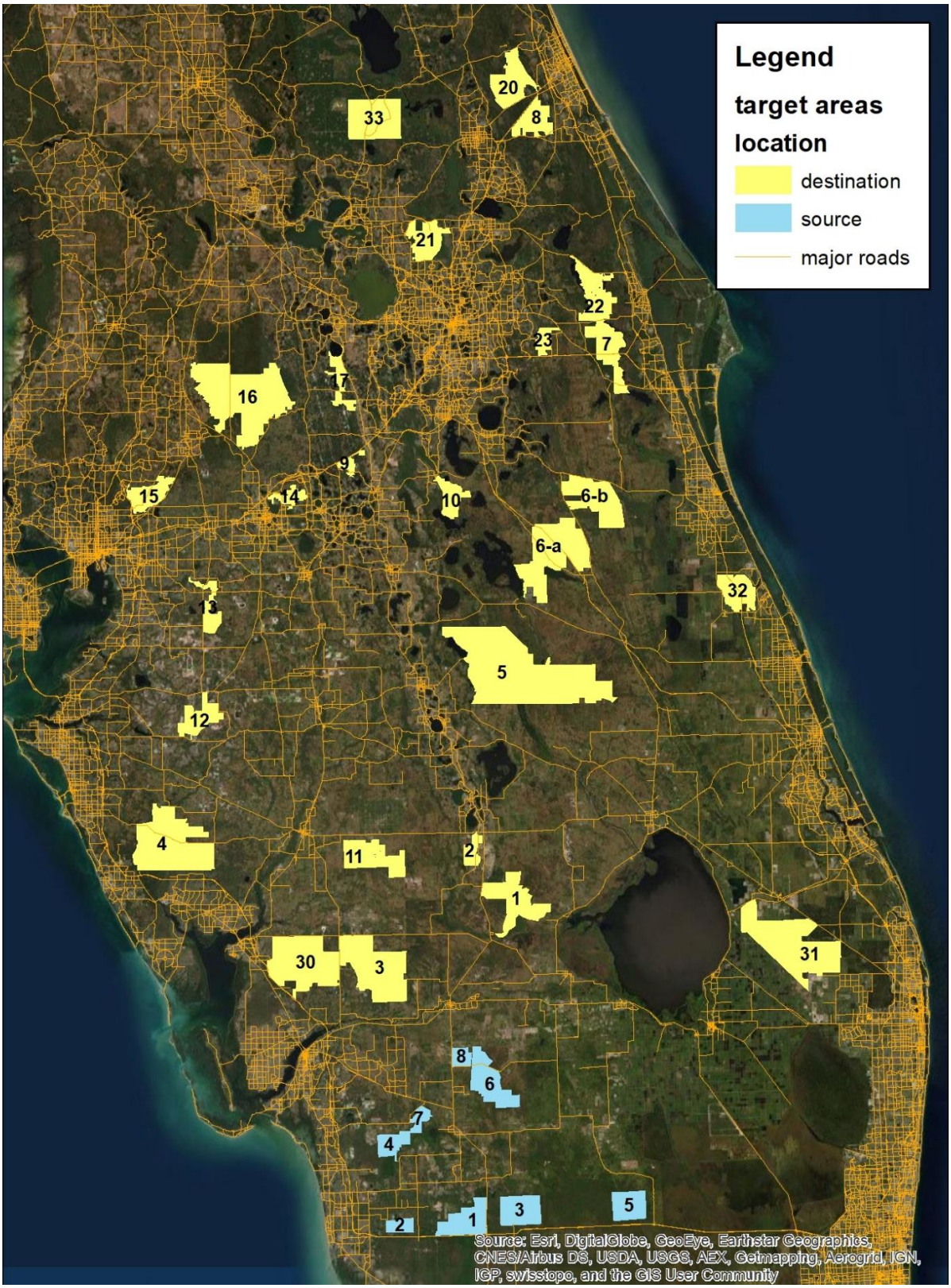

Figure 1. Location of Target Areas for Least-Cost Path/Corridor Analysis (numbers represent different conservation areas, see Table 2 for description).

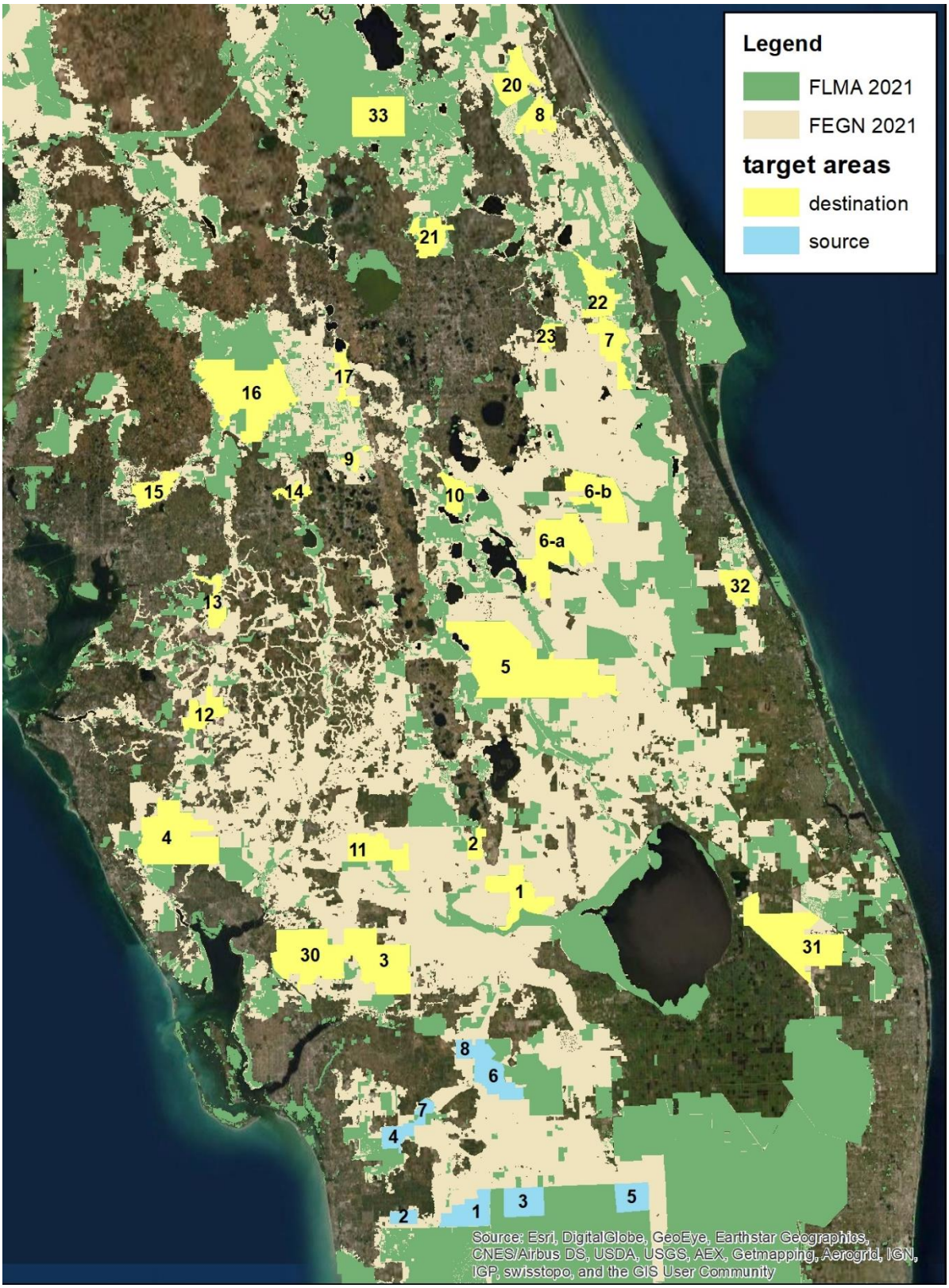

Figure 2. Location of Target Areas with Existing Managed Conservation Areas (FLMA) and the Florida Ecological Greenways Network in background (numbers represent different conservation areas, see Table 2 for description).

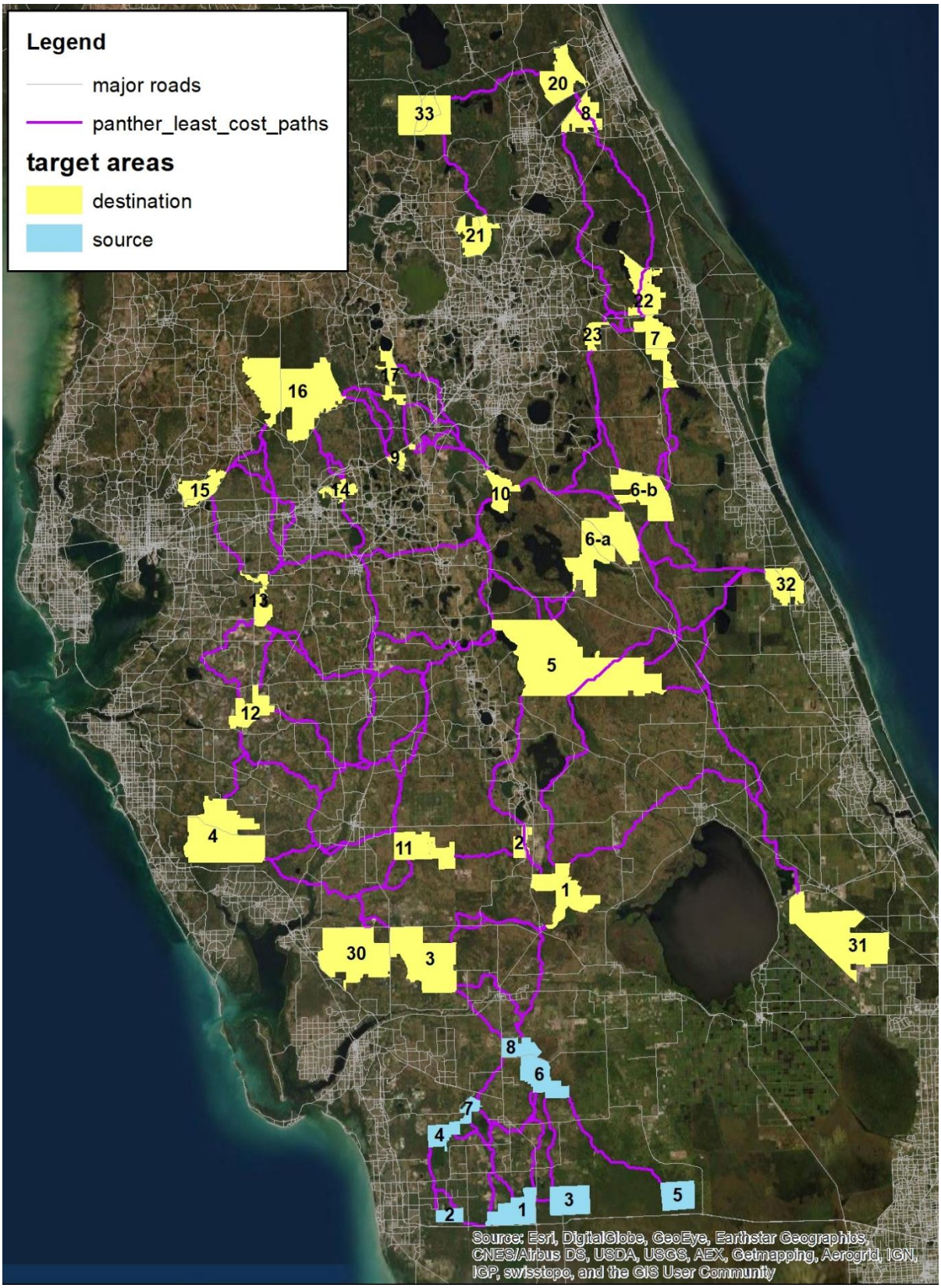

Figure 3. Least-Cost Path Analysis Results (numbers represent different conservation areas, see Table 2 for description).

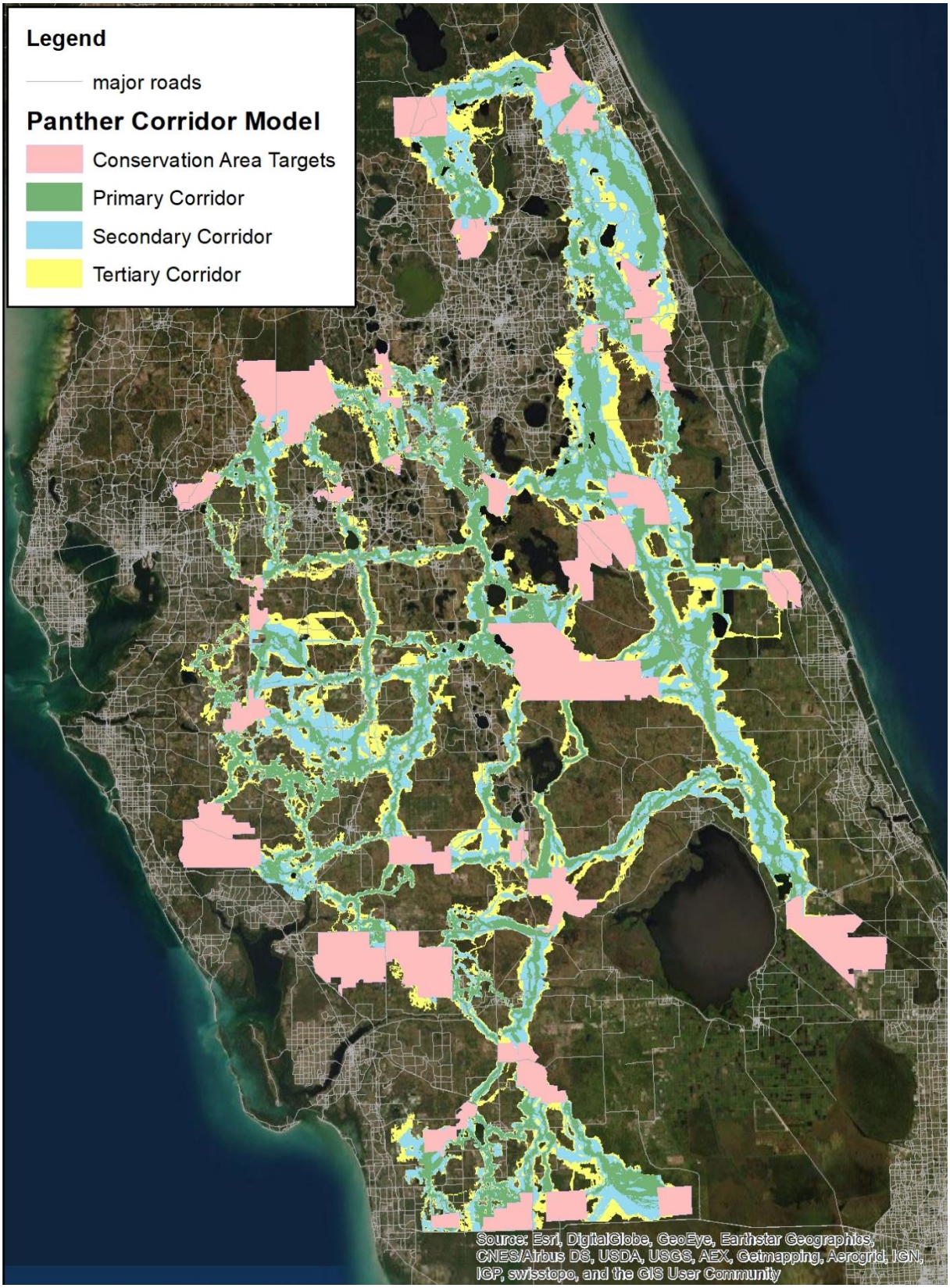

Figure 4. Least-Cost Corridor Analysis Results.

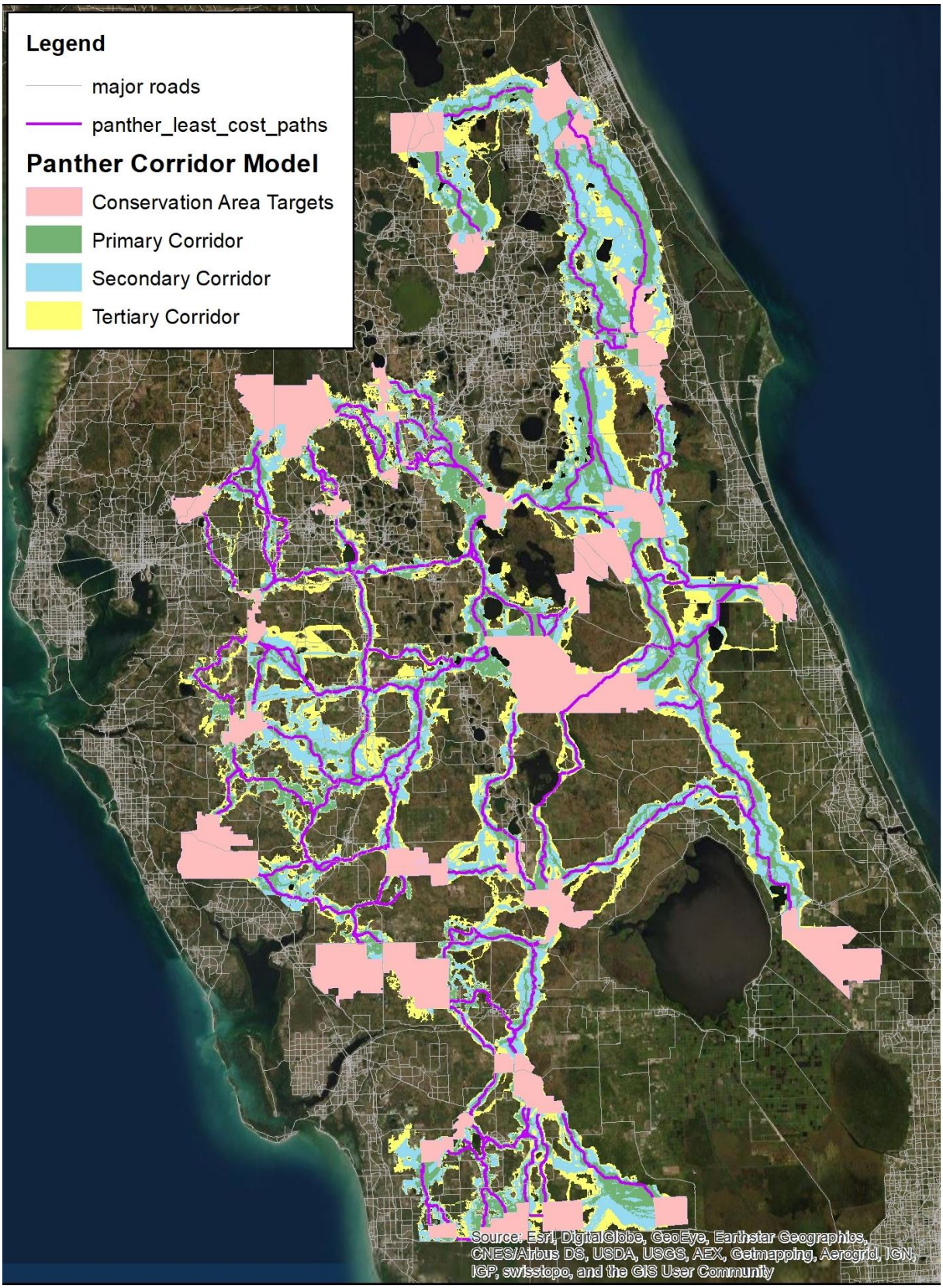

Figure 5. Least-Cost Path and Corridor Analysis Results.

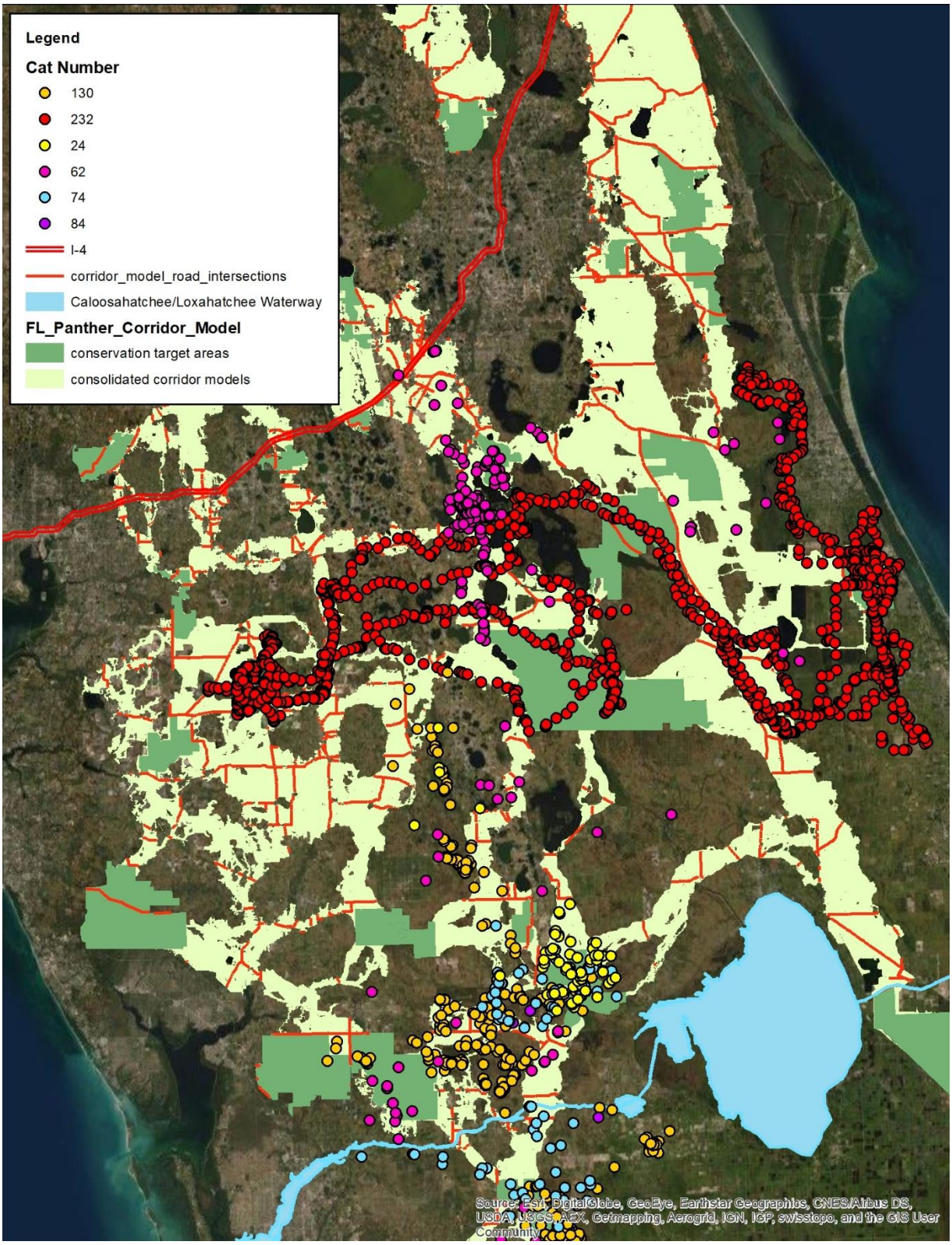

Figure 6a. Least-Cost Corridor Analysis Results and Panther Telemetry Locations.

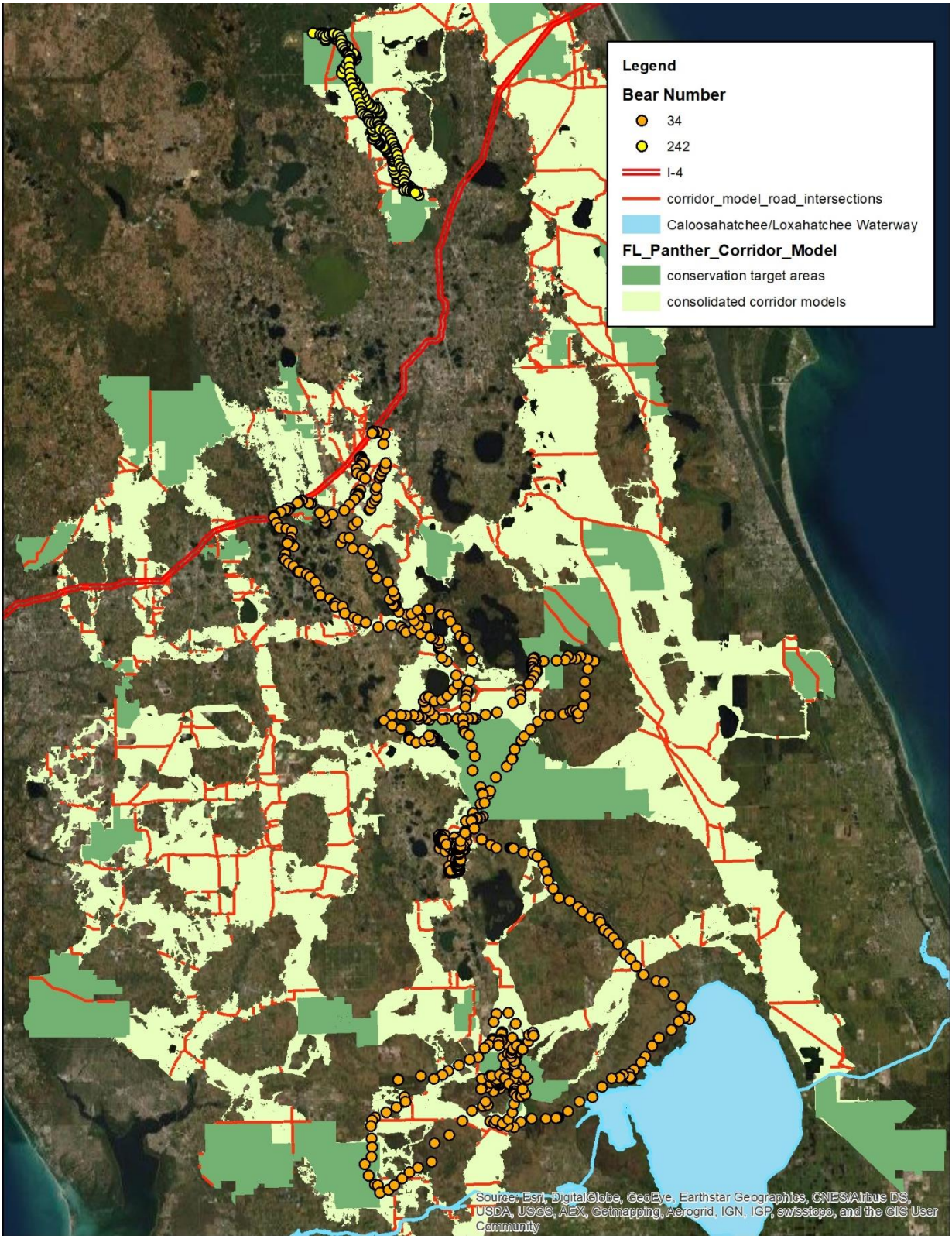

Figure 6b. Least-Cost Corridor Analysis Results and Bear Telemetry Locations.

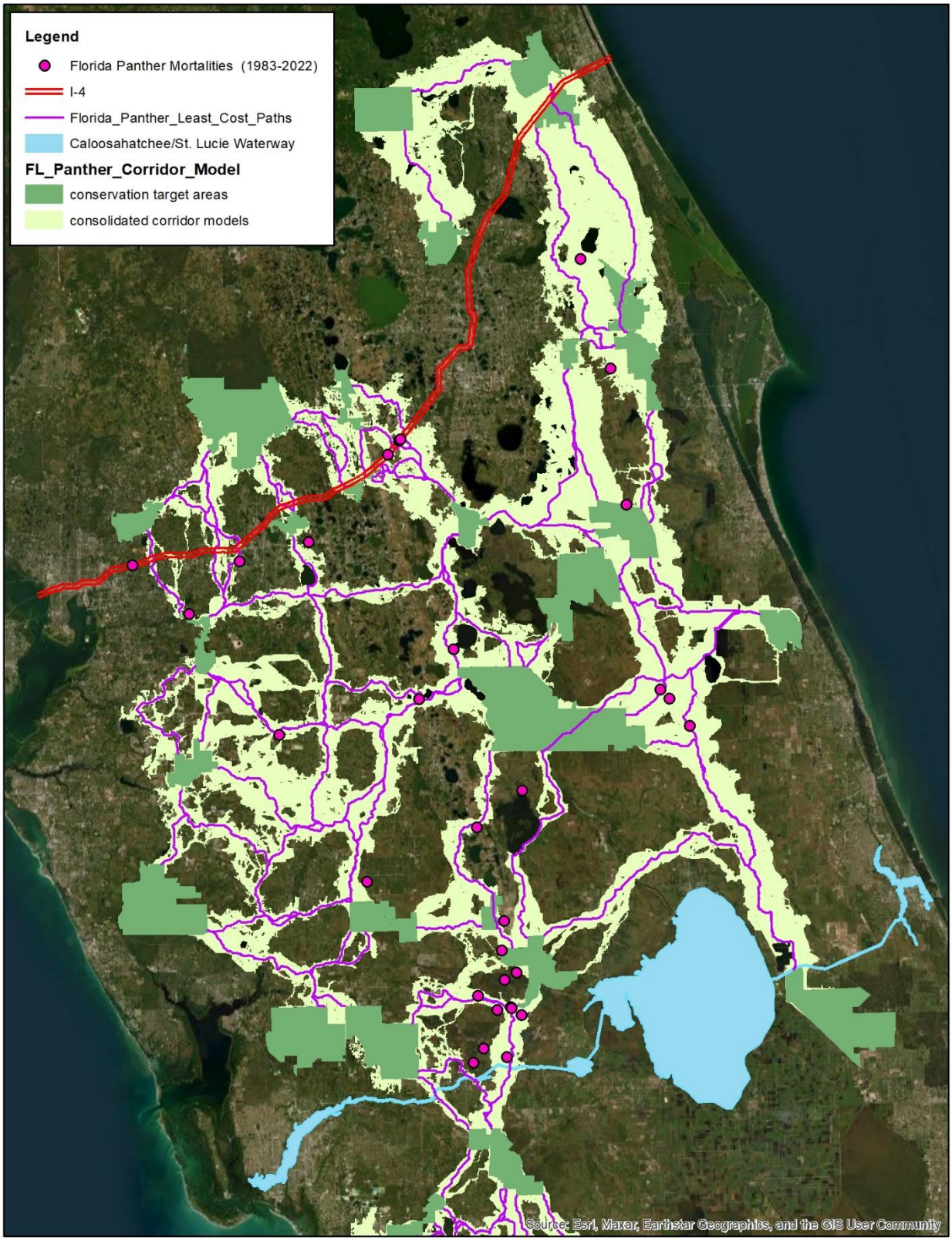

Figure 7. Florida Panther Mortalities (source: FWC) North of the Caloosahatchee River to just North of I-4 in Relation to Least-Cost Paths and Corridors (Note: 3 of the mortalities were of unknown cause, all others were listed as vehicle trauma).