Appendix: Effects of the Action on Florida Panther

Glossary

Action Area – the spatial extent of the physical environment affected by the proposed action that include the Plan Area and existing roads upon which traffic volume (≥ 100 trips/day leaving or entering Transportation Analysis Zones (TAZs) that coincide with the Plan Area) will be added by development proposed in the ECMSHCP.

Plan Area – The sum of the HCP area (159,488 acres) comprised of the Covered Activities Area (43,767 acres), Preserve/Plan-Wide Activities Area (90,576 acres), Very Low-Density Development Area (2,667 acres), Base Zoning Area (2,431 acres), and Lands Eligible for Inclusion (20,047 acres).

- **Covered Activities Area** – the 43,767-acre Open Lands within the Plan Area, including the 5,027 acre boundary of Ave Maria, designated for an additional 39,973 acres of commercial and residential development and Earth mining activities.
- **Preservation/Plan-Wide Activities Area** – the 90,576 acres of lands in the Plan Area where use will be limited to the types of agricultural, ranching, and other rural activities that have occurred historically and are expected to continue. Activities expected to occur in this area include Crop Cultivation; Ranching/Livestock Operations; Forestry and Silviculture; Recreation; Exotic and Nuisance Species Control; and Oil and Gas Exploration and Production.
- **Very Low-Density Use Area** – the 2,667-acre area designated for Very Low Density Use for such purposes as isolated residences, lodges, and hunting/fishing camps. Any construction in this area would be limited to no more than one dwelling unit per 50 acres, with no more than 10 percent of the total existing native vegetation subject to clearing.
- **Base Zoning Are**a – the 2,431 acres of the Plan Area comprising the Half Circle L Ranch, east of Immokalee. These 2,431 acres represents an RLSP "Open" overlay area, where either development or preservation could occur under RLSP regulations, and where base zoning (1 dwelling unit per 5 acres) under the Collier County Land Development Code applies. As of this writing, the Half Circle L Ranch is for sale on the open market. Although the current property owner is a member of the FPPP and an applicant for an ITP, it is not currently known what land designation may ultimately be applied to these 2,431 acres in the event of a sale. State and county conservation acquisition programs (Florida Forever and Conservation Collier) have targeted the property for potential acquisition.
- **Eligible Lands** – 20,047 acres of Open Lands that aren't currently participating in the HCP but which may join the HCP at a later date.

Transportation Analysis Zone (TAZ) - a unit of geography, based on U.S. Census blocks and data, used in transportation planning models.

Transportation Analysis Area- Action Area roadways with a history of panther-vehicle collisions within a 25 mile radius of the Plan Area.

D1RPM Model Area- District One Regional Planning Model (D1RPM, 2010-2040), is a regional traffic model comprised of the Plan Area and a 12 county area beyond it that includes of 5,628 traffic analysis zones (TAZ) covering 12,400 square miles. It represents the travel characteristics of a population of approximately 4.1 million residents.

Rural Lands Stewardship Area – a 185,935 acre area of eastern Collier County where a system of stewardship and restoration credits are used to entitle development at densities higher than those allowed under the Collier County Land Development Code in exchange for the preservation of high-value species' habitat, flowways, water retention areas, and agricultural lands.

- **Stewardship Receiving Area (SRA)** - A designated area within the RLSA District that has been approved for development as a Hamlet, Village, Town or compact rural development (CRD) and that requires the consumption of Stewardship Credits.
- **Stewardship Sending Area (SSA)** - A designated area within the RLSA District that has been approved for the generation of Stewardship Credits in exchange for the elimination of one or more Land Use Layers.
- **Rural Lands Stewardship Overlay Map** – The spatial allocation of habitat stewardship areas, flowway stewardship areas, water retention areas, and open lands in the RLSA.
- **Habitat Stewardship Area (HSA)** – Approximately 40,000 acres of lands delineated on the RLSA Overlay Map, which include both areas with natural characteristics that make them suitable habitat for listed species and areas without these characteristics. These latter areas are included because they are located contiguous to habitat with natural characteristics, thus forming a continuum of landscape that can augment habitat values.
- **Flowway Stewardship Area (FSA)** - Lands delineated on the RLSA Overlay Map, which primarily include privately owned wetlands that are located within the Camp Keais Strand and Okaloacoochee Slough. FSAs form the primary wetland flow way systems in the RLSA District. The FSA comprises approximately 31,000 acres of the RLSA.
- **Water Retention Area (WRA)** - Privately owned lands delineated on the RLSA Overlay Map, that have been permitted by the SFWMD to function as agricultural water retention areas and that provide surface water quality and other natural resource value. WRAs and their buffers comprise approximately 20,000 acres of the RLSA.
- **Agricultural Stewardship Area** – A program proposed by Collier County to incentivize the retention of agriculture lands within the RLSA "Open" designation shown on the Proposed RLSA Overlay Map. The Open designation is generally in agriculture uses and where future development may occur. This Agriculture Credit offers an incentive for property owners to consider an alternative to developing Open lands, and if utilized, will force 45,000 acre cap on development in the RLSA and prevent development at Base Zoning densities elsewhere.
- **Area of Critical State Concern -** The Areas of Critical State Concern Program was created by the "Florida Environmental Land and Water Management Act of 1972." The program is intended to protect resources and public facilities of major statewide significance, within designated geographic areas, from uncontrolled development that would cause substantial deterioration of such resources. Lands identified as "Preserve" and "Covered Activities" in the HCP include portions of the Big Cypress Area of Critical

State Concern; designated by the state to "conserve and protect the natural, environmental and economic resources and the scenic beauty of the Big Cypress Area, including the proposed Federal Big Cypress National Fresh Water Reserve, the Everglades National Park, and ecologically related wetlands, estuarine fisheries, and the fresh water aquifer, and ecologically related areas." (Rule 28-25.002, Florida Administrative Code).

- **Open Lands** – Approximately 95,000 acres of land within the RLSA not designated as HSAs, FSAs, WRAs and their buffers or a 500' restoration zone.

Functional Zone – The only area known to support a viable population of panthers based on the results of recent habitat and PVA modeling. The Functional Zone encompasses 9,094 km^2 of occupied habitat in South Florida and supports a panther population that is demographically viable but will require periodic introduction of new genetic material to be viable in the long-term, perhaps as many as five female puma every 20–40 years. It is made up of Zones A and B as mapped by Service and FWC biologists. These zones comprise areas of suitable habitat identified by the South Florida Random Forest Model (Frakes et al. 2015) and additional areas of habitat known to support panthers based on existing occurrence data. The Service is in the process of updating its current regulatory framework to incorporate information from the South Florida RFP Model, and it is for this reason the Biological Opinion relies on an analysis of impacts to the Functional Zone rather than Panther Habitat Zones defined by Kautz et al. (2006).

- **Zone A –** an area that covers 6,103 km^2 and is largely coincident with the areas of suitable habitat identified by the South Florida RFP model (Frakes et al. 2015) with a probability presence >0.338 and an average probability of presence value of 0.667. Approximately 4357 km^2 (71 percent) of Zone A is within existing conservation lands.
- **Zone B –** an area which covers 2,991 km^2, is comprised of generally lower quality habitat that nevertheless provides connectivity among habitats in Zone A, is used by dispersing panthers, and occasionally supports breeding females. Zone B consists of panther habitat with a probability of presence ranging from 0.1 to 0.29 and an average probability of presence value of 0.158. Approximately 1,339 km^2 (45 percent) of Zone B is within existing conservation lands.

Panther Habitat Zones - An earlier effort to map areas of South Florida important for panther habitat conservation resulted in three distinct regions of panther habitat (Kautz et al. 2006): Primary Zone (9,189km2), Secondary Zone (3,286km2), and Dispersal Zone. Kautz et al. (2006) developed their spatially explicit habitat model based on adult and subadult panther (>2 years old; n = 79) radio telemetry records collected from 1981–2001 and concluded that the habitat zones had the capacity to support approximately 80–94 adult and subadult panthers, a population size determined by the authors to have a high probability of persistence for 100 years. The habitat zones delineated by Kautz et al. (2006) and their assessment that these zones had the capacity to support a viable population of 80–94 panthers formed the basis for the current Service regulatory framework used to assess impacts to panther habitat. However, the best available information now suggests that Kautz et al. (2006) underestimated the capacity of these areas to support panthers, because the density estimate they used (0.91/100 km^2; Maehr et al. 1991) is much lower than the range of densities reported today (1.37 to 4.03/100 km^2; Sollmann et al. 2013, Dorazio and Onorato 2018, Onorato et al. 2020).

- **Primary Zone –** An area defined by Kautz et al. (2006) as lands essential to the long-term viability and survival of the Florida panther. Approximately 78 percent of the Primary Zone is in public ownership, 17 percent is in private ownership, and 5 percent is in tribal ownership.
- **Secondary Zone –** An area considered by Kautz et al. (2006) to be comprised of less suitable habitat only occasionally occupied by panthers, specifically defined as "natural and disturbed lands in south Florida that may be important to transient sub-adult male panthers and have the potential to support an expanding panther population, especially if habitat restoration were possible."

Dispersal Zone – an area that was defined as a small wildlife corridor east of LaBelle, Florida, intended for protection to facilitate long-term movements of panthers out of South Florida and into potentially suitable habitats in Central Florida north of the Caloosahatchee River.

BO section 2.1.1.2 Road Segments in the Action Area

Habitat Loss

We first converted Cooperative Landcover types to more generalized habitat categories more biologically meaningful to Florida panthers (Table 1). We used preference measures for land cover types from a published panther telemetry study (Tables 2 & 3) to weight the relative value of habitats in the Plan Area. We estimate by the "Reasonable Maximum Impact method" of the BO effects analyses that the 39,973 acres of proposed development would remove between 5,567 and 6,033 acres of forest cover from a total development envelope of 66,742 acres (Table 4). In addition to forest cover, though, telemetry studies have found that panthers will use habitat types within 300m of forest cover in proportion to their availability, and that these too should be counted as "panther habitat" (Table 5) . Thus the loss of 5,567 to 6,033 acres of forest cover would reduce the extent of Plan Area panther habitat (forest cover plus non-forest cover within 300 meters) a maximum of 30,616 acres (Table 6). We paired these estimated reductions in habitat value with the low- and high-panther density estimates from within the Plan Area above to compute reductions in panther carrying capacity. We estimate development distributed across a development envelope encompassing habitat in Covered Activities areas, Base Zoning, and Lands Eligible for Inclusion would reduce carrying capacity by the equivalent of 2.5-4.4 adult panthers annually at full buildout (Tables 7 & 8).

Table 1 Habitat Crosswalk

CLC CODE	COOPERATIVE LANDCOVER CLASS	Panther Habitat Class
1120	Mesic Hammock	Upland Forest
1210	Scrub	Other
1311	Mesic Flatwoods	Upland Forest
1312	Scrubby Flatwoods	Upland Forest
1340	Palmetto Prairie	Prairie–Grassland
1400	Mixed Hardwood-Coniferous	Upland Forest
1500	Shrub and Brushland	Other
1800	Cultural - Terrestrial	Other
1821	Low Intensity Urban	Other
1822	High Intensity Urban	Other
1830	Rural (Rural Open Lands)	Prairie–Grassland
1833.1	Cropland/Pasture	Agriculture
1833.13	Improved Pasture	Prairie–Grassland
1833.2	Orchards/Groves	Agriculture

1833.4	Fallow Orchards	Agriculture
1833.5	Other Agriculture	Agriculture
1840	Transportation	Other
1850	Communication	Other
1860	Utilities	Other
1870	Extractive	Other
1880	Bare Soil/Clear Cut	Other
2100	Freshwater non-Forested Wetlands	Marsh–Shrub–Swamp
2110	Prairies and Bogs	Prairie–Grassland
2120	Marshes	Marsh–Shrub–Swamp
2121	Isolated Freshwater Marsh	Marsh–Shrub–Swamp
2200	Freshwater Forested Wetlands	Wetland Forest
2210	Cypress/Tupelo	Wetland Forest
2211	Cypress	Wetland Forest
2213	Isolated Freshwater Swamp	Wetland Forest
2213.1	Dome Swamp	Wetland Forest
2214	Strand Swamp	Wetland Forest
2220	Other Coniferous Wetlands	Wetland Forest
2221	Wet Flatwoods	Wetland Forest
2230	Other Hardwood Wetlands	Wetland Forest
2232	Hydric Hammock	Wetland Forest
3000	Lacustrine	Other
3100	Natural Lakes and Ponds	Other
3200	Cultural - Lacustrine	Other
4200	Cultural - Riverine	Other
7000	Exotic Plants	Other

Table 2 Third-order habitat selection determined via Euclidean distance analysis using GPS location data from 20 independent Florida panthers monitored in South Florida. Ratios < 1.0 indicate habitat preference, whereas ratios > 1.0 indicate avoidance (P > 0.05). Habitats sharing any common letter rank were similarly preferred or avoided (P > 0.05, Bonferroni adjustment) or used in proportion to their availability (Onorato et al. 2010).

Panther Habitat Class	Ratio	*P*-value	Ranks
Upland Forest	0.532	< 0.001	A
Wetland Forest	0.620	< 0.001	AB
Prairie–Grassland	0.785	0.001	B
Marsh–Shrub–Swamp	0.799	0.004	BC
Agricultural	1.039	0.618	C
Other	1.047	0.555	C

Table 3 Weighting factors for acres of habitat in each class using the inverse of EDA ratios to indicate preference, with higher weights indicating greater preference by Florida panthers.

Panther Habitat Class	Ratio	Inverse
Upland Forest	0.532	1.880
Wetland Forest	0.620	1.613
Prairie–Grassland	0.785	1.274
Marsh–Shrub–Swamp	0.799	1.252
Agricultural	1.039	0.962
Other	1.047	0.955

Table 4 Total acres of Panther Habitat Classes by HCP land-use designation

Panther Habitat Category	Development	Preservation	Very Low Density	Base Zoning	Eligible for Inclusion	Plan Area Total	Row Percent	Development Envelope Total
Agriculture	33,370	17,605	0	698	10,289	61,962	38.85%	44,357
Marsh-Shrub-Swamp	1,785	23,630	223	536	2,591	28,766	18.03%	4,913
Other	1,233	2,620	1,119	4	1,891	6,867	4.31%	3,128
Prairie-Grassland	5,446	10,544	507	1,082	1,783	19,361	12.14%	8,311
Upland Forest	1,696	9,704	309	16	1,052	12,777	8.01%	2,764
Wetland Forest	722	25,988	510	94	2,453	29,768	18.66%	3,269
Total	**44,252**	**90,092**	**2,667**	**2,431**	**20,059**	**159,501**	**100.00%**	**66,742**

Table 5 Acres of Panther Habitat Classes within 300m of a Forest Edge by HCP land-use designation

Panther Habitat Category	Development	Preservation	Very Low Density	Base Zoning	Eligible for Inclusion	Plan Area Panther Habitat	Development Envelope
Agriculture	11,342	9,181	0	418	3,174	24,115	14,934
Marsh-Shrub-Swamp	998	15,388	217	350	1,680	18,633	3,028
Other	754	1,987	867	2	915	4,525	1,671
Prairie-Grassland	3,361	7,094	491	727	862	12,534	4,950
Upland Forest	1,696	9,704	309	16	1,052	12,777	2,764
Wetland Forest	722	25,988	510	94	2,453	29,768	3,269
Total	**18,872**	**69,342**	**2,394**	**1,608**	**10,136**	**102,352**	**30,616**
Plan Area Total Acres	**44,252**	**90,092**	**2,667**	**2,431**	**20,059**	**159,501**	**66,742**
% Plan Area that is within 300m of Forest Cover	**42.6%**	**77.0%**	**89.7%**	**66.1%**	**50.5%**	**64.2%**	**45.9%**

Table 6 Panther habitat calculations

A. Panther Habitat Category	B. Total Plan Area Panther Habitat Acres[1]	C. Panther Habitat Acres within Development Envelope[2]	D. Panther Preference Factor[3]	E. Preference-Weighted Plan Area Habitat Acres (B*D)	F. Preference-Weighted Development Envelope Acres (C*D)	G. Post-Development Preference-Weighted Habitat Acres (E-F)	H. Panther Habitat Acres within HCP Development/ Mining Designation	I. Preference-Weighted Development/ Mining Habitat Acres (D*H)	J. Post-Development Preference-Weighted Habitat Acres (E-I)
Agriculture	24,115	14,934	0.962	23,210	14,374	8,836	11,342	10,916	12,294
Marsh-Shrub-Swamp	18,633	3,028	1.252	23,321	3,789	19,532	998	1,249	22,072
Other	4,525	1,671	0.955	4,322	1,596	2,726	754	720	3,602
Prairie-Grassland	12,534	4,950	1.274	15,967	6,305	9,662	3,361	4,281	11,686
Upland Forest	12,777	2,764	1.880	24,016	5,196	18,820	1,696	3,188	20,829
Wetland Forest	29,768	3,269	1.613	48,012	5,273	42,739	722	1,164	46,848
Total	**102,352**	**30,616**		**138,848**	**36,534**	**102,315**	**18,872**	**21,519**	**117,330**

1. Forest cover plus the extent of all other cover categories within 300 meters.
2. Panther habitat within the Development, Base Zoning, and Eligible HCP land-use designations.
3. The inverse of habitat selection ratios reported in Onorato et al. 2010.

Table 7 Interpreting habitat loss as a long-term loss in ecological carrying capacity

Interpreting habitat loss as a long-term reduction in panther carrying capacity.

Variable	Source or Calculation	Value	Units	Measure
a	draft SSA	6,336	acres	Low panther density; 3.9/100km2 = 1 panther per 6336 acres.
b	draft SSA	6,178	acres	High panther density; 4.09/100km2 = 1 panther per 6178 acres.
c	Habitat Calculations B9	102,352	acres	Total Plan Area panther habitat acres (forest cover plus other types within 300m)
d	c/a	16.2	adult panthers	Plan Area low-density carrying capacity.
e	c/b	16.6	adult panthers	Plan Area high-density carrying capacity.
f	Habitat Calculations E9	138,848	weighted acres	Preference-weighted Plan Area habitat acres (total pre-development).
g	Habitat Calculations G9	102,315	weighted acres	Post-development preference-weighted habitat acres; capacity loss from the full development envelope.
h	Habitat Calculations J9	117,330	weighted acres	Post-development preference-weighted habitat acres; capacity loss from the Development/Mining HCP designation only.
i	(g/f)*d	11.9	adult panthers	Post-development Plan Area carrying capacity; low density; loss from the full development envelope.
j	(g/f)*e	12.2	adult panthers	Post-development Plan Area carrying capacity; high density; loss from the full development envelope.
k	(h/f)*d	13.7	adult panthers	Post-development Plan Area carrying capacity; low density; loss from the Development/Mining HCP designation only.
l	(h/f)*e	14.0	adult panthers	Post-development Plan Area carrying capacity; high density; loss from the Development/Mining HCP designation only.
m	d-i	4.3	adult panthers	**Reduction** in post-development Plan Area carrying capacity; low density; loss from the full development envelope.
n	e-j	4.4	adult panthers	**Reduction** in post-development Plan Area carrying capacity; high density; loss from the full development envelope.
o	d-k	2.5	adult panthers	**Reduction** in post-development Plan Area carrying capacity; low density; loss from the Development/Mining HCP designation only.
p	e-l	2.6	adult panthers	**Reduction** in post-development Plan Area carrying capacity; high density; loss from the Development/Mining HCP designation only.

Table 8 Habitat loss equivalent in Florida panther carrying capacity under "worst" and "best" case scenarios

Estimated Reduction in Carrying Capacity (adult panthers, both sexes)	Habitat Loss (acres)	
	If Preferred Panther Habitat is taken First	If Preferred Panther Habitat is taken Last
Plan Area Habitat Quality Supports:	30,616	18,872
Equivalent in *K* at Low-Estimated Panther Density	4.3	2.5
Equivalent in *K* at High-Estimated Panther Density	4.4	2.6

Panther Review Team Analysis: In 2016 the Panther Review Team (PRT), composed of six scientists with expertise in Florida panther ecology and landscape- level natural resource planning, was commissioned by the Florida Panther Protection Program, a partnership of landowners/ITP-Applicants and non-governmental environmental organizations. The PRT Analysis benefits our understanding of the threat of habitat loss in the Plan Area by analyzing several scenarios of development within the Rural Lands Stewardship Area (RLSA) the HCP proposes development in. Specifically, the Florida Panther Protection Program requested the PRT assess the following with respect to landowner proposals for development in the RLSA:

- Landowners' provision of 25% more mitigation for impacts to the panther Primary Zone of the RLSA, increasing the mitigation ratio of Panther Habitat Units (PHUs) to 3.125:1 (i.e., 2.5 x 1.25 = 3.125) from 2.5 for projects located or proposed within those areas (Additional discussion of Service recommended methodology for assessing impacts and mitigation requirements using PHUs are in Appendix A)
- Generation and use of panther credits on lands set aside as Stewardship Sending Areas
- Protection of agricultural lands though establishment of Agricultural Preservation areas
- Establishment of a core transportation network to serve 45,000 acres of development
- Proposal by the landowners for two corridors intended to enhance landscape connectivity Creation of the Paul J. Marinelli Florida Panther Protection Fund

However, the PRT found there were several estimates of the total acreage of possible development at build-out under the existing program. Therefore, the PRT performed 3 analyses:

1. The PRT assessed the relative value of the current and proposed mitigation ratios to panther habitat conservation a GIS analysis of three estimates of allowable development under the existing RLSA program in comparison to benefits associated with capping development at 45,000 acres;

2. The PRT assessed the relative values of five scenarios of development of 45,000 acres based on various percentages of future impact in the panther Primary and Secondary Zones. Finally, the PRT analyzed the benefits of the increased mitigation ratio based on a recommendation that all Secondary Zone Open lands be developed before developing in the Primary Zone' and;

3. The PRT assessed their recommendation that development should occur within the Secondary Zone before development occurs in the Primary Zone. The analyses were based on available data layers for land cover, RLSA land use categories, and panther Primary and Secondary Zones. Increased financial contributions to the Marinelli (Panther) Fund also were estimated.

The three estimates of allowable development analyzed by the PRT under the existing RLSA program, in comparison to a development cap of 45,000 acres, were:

1. Collier County Full Utilization Scenario: Collier County estimated that dedication of all lands designated as HSAs, FSAs, and WRAs to SSAs would generate a quantity of Stewardship Credits sufficient to accommodate development of 41,040 acres of SRAs. An additional 46,738 acres of RLSA Open Lands would remain available for development at baseline conditions of 1 unit/5 acres with no clustering. Development of

the remaining 46,738 acres of Open Land at 1 unit/5 acres would effectively render these areas unsuitable as panther habitat. Therefore, the total development footprint at build-out would include 82,751 acres after subtracting the 5,027 acres within the boundary of Ave Maria (Table 3.2-1 of FPPTRT 2016).

2. WilsonMiller Full Utilization Scenario: This scenario is very similar to the Collier County full utilization scenario. WilsonMiller estimated that dedication of all lands designated as HSAs, FSAs, and WRAs to SSAs would generate a quantity of Stewardship Credits sufficient to accommodate development of 43,300 acres of SRAs. An additional 43,700 acres of RLSA Open Lands would remain available for development at baseline conditions of 1 unit/5 acres with no clustering. Development of the remaining 43,700 acres of Open Land at a density of 1 unit/5 acres would effectively render these areas unsuitable as panther habitat. Therefore, the total development footprint at build-out would include 81,973 acres after accounting for the 5,027 acres within the boundary of Ave Maria (Table 3.2-1 of FPPTRT 2016).

3. WilsonMiller Partial Baseline Scenario: WilsonMiller estimated that dedication of all lands designated as HSAs, FSAs, and WRAs to SSAs would generate a quantity of Stewardship Credits sufficient to accommodate development of 43,300 acres of SRAs. However, WilsonMiller noted that market incentives favor well planned, compact, mixed use communities served by high quality infrastructure and services, and that it is unrealistic to expect development of the remaining 43,700 acres at a density of 1 unit/5 acres. The partial baseline´ scenario assumed 10% conversion of ACSC Open Lands and 25 percent conversion of non-ACSC Open Land. This scenario would result in a build-out estimate of 51,975 acres of development, but only 46,948 acres remain available for future development after accounting for Ave Maria (Table 3.2-1 of FPPTRT 2016), and 35,025 acres of Open Land would remain in agriculture.

4. 45,000-Acre Development Cap Scenario: Proposed revisions to the existing RLSA program would impose a 45,000-acre cap on future development. The existing Stewardship Credit system would be recalibrated to yield the protection of the following areas at build- out: 1) 92,000 acres of NRI-based SSAs, 2) 40,000 acres of agriculture SSAs, 3) 2,300 acres of panther corridors, and 4) 16,546 acres of public and miscellaneous lands. This scenario assumed that approximately 39,973 acres of future development would remain after subtracting the 5,027 acres of Ave Maria from the 45,000-acre cap.

The 5 scenarios of development identified by the PRT that could occur with a 45,000 acre cap (4, above) were:

1. Scenario 1: Assumes that 100% of future impacts occur within the panther Secondary Zone.

2. Scenario 2: Assumes that 75% of future impacts occur within the Secondary Zone and 25% of future impacts occur within the Primary Zone.

3. Scenario 3: Assumes that 50% of future impacts occur within the Secondary Zone and 50% of future impacts occur within the Primary Zone.

4. Scenario 4: Assumes that 25% of future impacts occur within the Secondary Zone and 75% of future impacts occur within the Primary Zone. 36

5. Scenario 5: Assumes that 100% of future impacts occur within the Primary Zone.

To analyze the effects of these proposed modifications to voluntary landowner participation in the RLSA, the PRT utilized Collier County Rural Lands Stewardship Area Overlay. The RLSA program was established in Section 4.08.00 of Collier County's Land Development Code for the purpose of encouraging smart growth patterns within a rural landscape covering 195,846 acres generally in the vicinity of Immokalee, Florida. Collier County's objective was to create an incentive-based land use overlay system referred to as the Collier County RLSA Overlay. The Overlay is intended to protect natural resources and retains viable agriculture by promoting compact rural mixed-use development as an alternative to low-density single use development. The PRT recognized that new development is the driving force for achieving natural resources conservation within the RLSA program. The RLSA program provides a system of compensation to private property owners for the removal of certain land uses in order to protect natural resources and viable agriculture in exchange for transferable credits that can be used to entitle compact development (Policy 1.2). The system is based upon the principles of rural land stewardship as defined in Chapter 163.3177(11), Florida Statutes.

The RLSA program allows for any land within the RLSA to be designated as a Stewardship Sending Area (SSA). Stewardship Credits are generated from SSAs in return for maintaining the areas in permanent agriculture, open space or conservation uses. Stewardship Credits may be used to entitle a Stewardship Receiving Area (SRA) which can be in the form of self-contained planned urban developments within the RLSA. The SSA Program within the RLSA establishes a method for protecting and conserving the most valuable environmental land, including large connected wetland systems and significant areas of habitat for listed species, while directing compact developments to the least environmentally sensitive areas of the RLSA. A Natural Resource Index (NRI) was developed to rank lands within the RLSA according to value for wetlands protection, water resource protection and management, and wildlife habitat conservation. Results from the NRI analysis were used to map all areas of the RLSA according to five major categories of land use (WilsonMiller 2002):

Flowway Stewardship Area (FSA): FSAs are privately owned lands that primarily include wetlands located within the CKS and Okaloacoochee Slough ecosystems.

Habitat Stewardship Area (HSA): HSAs are privately owned lands that include areas with natural characteristics that make them suitable for listed species as well as areas without these 5 characteristics. The latter areas are included because they are contiguous to habitat with natural characteristics, thus forming a landscape continuum that can augment habitat values.

Water Retention Area (WRA): WRAs are privately owned lands that have been permitted by the South Florida Water Management District (SFWMD) to function as agricultural WRAs and that provide surface water quality and other natural resource value. Many of these areas are large natural wetlands that, in some cases, connect to and support FSAs.

Open Land: Open Lands are privately owned lands not otherwise classified as FSAs, HSAs, or WRAs and are generally of lower natural resource quality.

Lake Trafford: The RLSA also includes the open waters of Lake Trafford, which cover approximately 1,460 acres.

Lands designated as FSA, HSA, or WRA are areas of high quality natural resource value based on the NRI analysis. Lands delineated as FSAs, HSAs, or WRAs are the most likely candidates for designation as SSAs because of the greater number of Stewardship Credits available from these lands. Open Lands may be designated as either SSAs or SRAs, but Open Lands are the most likely candidates for SRAs because of the lower Stewardship Credit values applied to these lands. A portion of the RLSA is included within the Big Cypress Area of Critical State Concern (ACSC). Although Big Cypress ACSC lands may be designated as SSAs, additional RLSA standards apply and all Big Cypress ACSC regulations remain in force regardless of SSA designation. In addition, the RLSA contains approximately 15,200 acres of publicly owned lands, which are eligible for designation as FSAs, HSAs, or WRAs, but public lands are not eligible for designation as SSAs or SRAs or for generating or receiving Stewardship Credits.

Results of the PRT analyses were as follows:

Analysis 1 (Baseline Conditions vs. 45,000- Acre Development Cap): The combination of the existing RLSA program and baseline development densities applicable in areas that would not be designated as SRAs had the potential to result in 46,948 ± 82,751 acres of future development (Table 3.2-1 of FPPTRT 2016). The full utilization scenarios would require approximately 913,000 PHUs of mitigation, which would be sufficient to protect approximately 112,000 acres of Primary Zone habitat (Table 3.2-1 of FPPTRT 2016). However, the cost for protecting 112,000 acres of panther habitat would be the development of approximately 87,000 acres of Open Lands, some areas of which are important panther habitats. The partial utilization scenario would require approximately 520,000 PHUs of mitigation, which would be sufficient to protect approximately 63,800 acres of Primary Zone habitat (Table 3.2-1 of FPPTRT 2016). However, the partial utilization scenario would leave approximately 35,000 acres in agricultural uses without protection from future development. These acres could be developed at baseline densities of 1 unit/5 acres if future market conditions increased the demand for this type of development. The proposal for 25 percent more PHUs of mitigation for impacts to the Primary Zone does not apply to the full utilization or partial utilization scenarios.

The proposed 45,000-acre cap on development would result in a requirement for approximately 443,000 PHUs of mitigation under the 2.5:1 ratio and 517,000 PHUs of mitigation under the 3.125:1 ratio, for a net benefit of approximately 74,000 additional PHUs (Table 3.2-1 of FPPTRT 2016). These PHUs would result in the protection of approximately 54,300 and 63,400 acres, respectively, of panther Primary Zone under the existing and proposed mitigation ratios for a net benefit of approximately 9,000 acres of added protection. The PHUs of mitigation needed under the proposed 3.125:1 mitigation ratio would protect approximately the same number of acres as the partial utilization scenario. However, there is a significant difference between these two scenarios in terms of protection of panther habitats. The partial utilization scenario would leave approximately 35,000 acres of agricultural land at risk of future development at baseline densities of 1 unit/5 acres. Conversely, the 45,000-acre development cap scenario is achieved by a recalibration of the Stewardship Credit system such that all lands that

are not developed at build-out will be protected as NRI-based or agriculture SSAs because all of these areas are needed to generate enough Stewardship Credits to enable development of 45,000 acres. Most of the NRI-based SSAs and many of the agriculture SSAs provide habitats valuable to the conservation of Florida panthers. Protection of these areas would be achieved by the Stewardship Credit system without involving PHUs. Implementation of the proposed 3:125 mitigation ratio would result in a total financial benefit to the Panther Fund of approximately $38.8 million compared to no financial benefit under the three baseline scenarios.

Analysis 2 (Five Scenarios of 45,000- Acre Development Cap): A greater acreage of impact in the Primary Zone results in a greater number of PHUs of additional mitigation credit, a greater number of acres of panther habitat protected, and a higher financial contribution to the Panther Fund (Table 3.3-1 of FPPTRT 2016). The additional 25 percent of PHUs for impacts to the Primary Zone results in 0 ± 139,241 PHUs of additional mitigation with a net result of 0 ± 17,073 acres of additional panther habitat protection assuming the average value of 8.1557 PHU/acre applies to all areas of Primary Zone habitat likely to be protected. Total financial benefits to the Marinelli Fund ranged from $0 to approximately $52.2 million.

Analysis 3 (Development of Secondary Zone Before Primary Zone): The existing 2.5:1 mitigation ratio would require approximately 301,045 PHUs of mitigation compared to 310,000 PHUs resulting from the proposed 3.125:1 ratio, for a net benefit of 8,956 PHUs (Table 3.3-2 of FPPTRT 2016). The proposed mitigation ratio would yield net benefits of approximately 1,098 acres of additional protection and $671,682 of revenue to the Marinelli Fund.

Based on their analysis the PRT concluded a cap development of 45,000 acres and provision of an additional 25 percent of PHUs of mitigation for impacts to the Primary Zone would result in greater benefit to Florida panther habitat conservation than the three baseline scenarios of the existing RLSA program. The PRT also determined a 45,000-acre development cap would provide certainty that the future extent of development would be limited to a specific number of acres (although not tied to known locations), and all remaining areas of the RLSA, including important panther habitats, would be protected as SSAs. Moreover, the PRT found the financial benefits to the Marinelli Fund would range from $23.6 million to $52.2 million depending on the acreage of Primary Zone impacted by future development (Table 3.3-1 of FPPTRT 2016).

However, the PRT were uncomfortable with certain aspects of the 45,000 acre cap proposal with 25 percent greater PHU mitigation in that greater benefit in certainty and mitigation would accrue as a consequence of greater impacts to the Primary Zone, an area that has been described as essential to the survival of the Florida panther (Kautz et al. 2006). This concern was addressed by the PRT recommendation the landowners protect an additional 38,746 acres for panther conservation because the 45,000 acre cap respected by the landowners would still leave approximately 39,330 acres in which future developments could be located with certainty. The PRT also recommended landowners develop all 33,224 acres of Secondary Zone in the RLSA and only 2,084 acres of Primary Zone remaining under the development cap to further minimizes future development impacts on panther habitats. The scenario recommended by the PRT would result in approximately $23.25 million to the Panther Fund using the 3.125:1 mitigation ratio, for a net benefit of approximately $672,000 over the existing 2.5:1 mitigation ratio. The value of the proposed 45,000-acre cap and additional PHUs of mitigation were be compared with the baseline scenarios in terms of total number of acres eventually protected. The PRT found a 45,000-acre cap scenario would result in the protection of virtually all RLSA lands not developed, which

amounts to approximately 150,878 acres, because every acre of undeveloped land would be protected as natural resource or agriculture SSAs to generate the Stewardship Credits needed to develop 45,000 acres. Protected lands and waters would include approximately 15,236 acres currently in public ownership, 84,251 acres of HSAs, FSAs, and WRAs that are outside of public ownership, 1,461 acres of Lake Trafford, and 49,930 acres of agricultural lands designated as agricultural SSAs (Table 2.4-3).

Based on its analysis the PRT further recommended additional areas within the RLSA that receive consideration for some form of additional protection. Specifically, the PRT recommended:

1. Revisions to the south corridor proposed by the landowners (referred to by the PRT as Summerland Swamp Habitat Linkage);
2. Revisions to the north corridor proposed by the landowners (at the time of the PRT study);
3. Buffers along Camp Keais Strand (CKS) in the vicinities of Ave Maria, Town of Big Cypress, and Hogan Island mine;
4. Open Lands of predominantly agricultural uses interspersed with patches of natural habitat within the Big Cypress ACSC;
5. Buffers and natural habitats along the western edge of SSA 16;
6. Agricultural fields south of CR 858 and north of RLSA lands designated as HSAs and WRAs;
7. Natural habitat areas between Immokalee and the Big Cypress ACSC; and
8. Patches of natural habitat and relatively low intensity land use adjacent to Pepper Ranch.

On October 22, 2019 the Collier County Board of Commissioners adopted a recommendation to direct staff to initiate the Growth Management Plan amendment process for proposed changes to the Rural Lands Stewardship Area Overlay (RLSA), develop a regional water partnership, and draft Land Development Code amendments. Among the Amendments to the Land Development Code adopted was a restriction of total number of Stewardship Credits to a cap of 430,000, that would entitle no more than 45,000 acres of Stewardship Receiving Areas. The establishment of a 45,000 acre cap on development under the Rural Lands Stewardship Area Overlay does not prohibit development at baseline zoning standards of 1 dwelling per 5 acres. This means, the remaining balance of 140,935 acres of the 185,935 acres in the RLSA will either be preserved to generate Stewardship Credits for SRAs, used for the construction of institutions such as schools and fire stations, or potentially developed at a ratio of 1 dwelling per 5 acres.

Habitat Fragmentation

Onset of Impacts – Occasional mortality and avoidance of roadways
Continuum of Impacts – Increasing mortality and avoidance of roadways during periods of peak traffic
Major Habitat Avoidance – Few individuals attempt to cross roadways and/or there is high mortality when they do

Near Complete Barrier – Nearly all individuals avoid crossing the road and/or are killed when they try

Table 9 Traffic Volume Impacts on Wildlife at Different Thresholds (Charry and Jones, 2009)

VEHICLES PER DAY	ONSET OF IMPACTS	CONTINUUM OF SUBSTANTIAL IMPACTS	MAJOR HABITAT AVOIDANCE	NEAR COMPLETE BARRIER
100-500	**Amphibians & Carnivores**	**Amphibians* & Reptiles**		
500-1,500	**Ungulates & Birds**	**Amphibians (increases for reptiles)**		
1,500-3,000		**Ungulates (increases for amphibians & reptiles)**		
3,000-6,000		**Carnivores & Birds (increases for amphibians, reptiles, & ungulates**		
6,000-10,000		**Increases for all taxa**		
10,000+			**Birds & Ungulates**	**Amphibians, Reptiles, Carnivores, Ungulates, & Small Mammals**

Panther Review Team Analysis: The PRT described landscape connectivity as a mechanism to mitigate the effects of habitat fragmentation and loss on declining populations (Lindenmayer and Fischer 2006). The PRT noted three types of landscape connectivity have been described in scientific literature:

Habitat connectivity refers to the connectedness among patches of suitable habitat for an individual species.

Landscape connectivity refers to human perceptions of the connectedness of patterns of vegetative cover in a given landscape.

Ecological connectivity refers to the connectedness of ecological processes across multiple scales.

Features described by Lindenmayer and Fischer (2006) that contribute to landscape connectivity and that have application to the RLSA include wildlife corridors and stepping stones. Wildlife corridors are physical linkages between patches of native vegetation that are believed to accomplish some or all of the following goals:

- Facilitate the movement of animals through suboptimal habitat;
- Provide habitat for resident populations;
- Enhance dispersal success, such as reducing mortality during dispersal;
- Prevent and reverse local extinctions by recolonization of empty patches; and
- Promote the exchange of genes between subpopulations (thereby increasing effective population size, reducing genetic drift and inbreeding depression, and maintaining inherent species richness at the patch and landscape scale).

Stepping stones are relatively small patches of native vegetation scattered about the landscape that facilitate movements by species able to reach the smaller isolated patches. Stepping stone connectivity designs may be a suitable alternative to corridors composed of continuous native cover to facilitate movements of animals that are adapted to habitat mosaics and have proven capabilities to disperse through fragmented habitats (Hilty et al. 2006). Corridor dimensions of length and width often are considered when assessing existing and designing new landscape connections (Hilty et al. 2006). Although shorter corridors are generally recommended, corridor lengths must be within the movement capabilities of the target species to be effective (Hilty et al. 2006).

Corridor lengths were reviewed relative to the movement capabilities of Florida panthers. McBride et al. (2008) reported that 99% of daily movements were less than 5.97 miles for females and less than 10.38 miles for males. McBride et al. (2008) cite unpublished records from 24-hour GPS-collar data of one female traveling a daily mean distance of 1.3 miles (0.05 ± 4.60 miles) and one male moving a daily mean distance of 2.17 miles (0.05 ± 5.1 miles). Darrell Land (unpublished data) estimated mean daily movements for three male panthers of 3.59 miles (0.15 ± 14.47 miles), 4.25 miles (0.13 ± 13.66 miles), and 4.89 miles based on 24-hour GPS-collar telemetry data. Maehr et al. (2002) reported effective mean dispersal distances for females of 7.02 miles (3.85 ± 20.03 miles; n=9) and for males of 23.13 miles (15.38 ± 138.94 miles; n=18).

Florida panthers require large areas of interconnected suitable habitats. Therefore, the PRT review focused primarily on identification of habitat connections needed by Florida panthers while acknowledging that corridors identified for panthers provide needs of other species, maintain ecological processes, and to some extent are based on human perceptions of landscape connectedness. The PRT identified some small patches of habitat that may function as stepping 12 stones of connectivity as demonstrated by telemetry records. Corridor widths were reviewed in the context of the recommendations of Beier (1995) and based on PRT measurements of observations of Florida panthers wearing GPS collars and using linear habitat patches.

Buffers to Panther Habitats: Buffers are generally defined as areas of lower intensity land uses that are established adjacent to natural areas and intended to ameliorate the effects of intensive human activity on natural lands (Noss and Cooperrider 1994). Buffer creation around ecologically sensitive areas is an accepted strategy for mitigating adverse impacts of edge effects, which are changes in abiotic and biotic environments occurring at the boundaries of natural and human-modified vegetation types (Lindenmayer and Fischer 2006). Buffer widths are determined as a function of the needs of species inhabiting the natural areas. Although numerous research projects have yielded recommendations for buffer widths needed for amphibians, reptiles, and birds in specific settings (Lindendmayer and Fischer 2006), empirical data useful in determining appropriate widths of buffers for Florida panthers are lacking. Hourly GPS-collar records from several Florida panthers demonstrated that panthers often move along the upland/wetland ecotones of wetlands ecosystems bordered by agricultural fields. This observation suggests that buffers along wetland edges would be beneficial to future panther movements within the RLSA. The PRT opted to draw buffers around selected natural habitats at a distance that either conformed to landscape features (e.g., roads, ditches, fencerows, field edges) based on visual inspection or coincided with the edge of the Primary Zone where obvious landscape features were lacking. Buffers were identified with a vision of the future that included a developed urban landscape in relatively close proximity to preserved and occupied panther

habitats. Buffers were specifically intended to protect the natural habitats of Okaloacoochee Slough and Camp Keias Strand, and the North Corridor proposed by the landowners.

Habitat Peninsulas: Some portions of large wetlands systems exist as narrow peninsulas of habitat that extend into agricultural lands such that they are surrounded on all sides by croplands. These habitat peninsulas are effectively cul-de-sacs with respect to panther movements because there is nowhere for a panther to go to find other suitable patches of habitat beyond the end of the peninsula. Although these areas may be connected to suitable and occupied panther habitats, lands adjacent to peninsulas were not deemed worthy of buffers or other forms of protection for Florida panthers. Conversely, there were some areas where narrow peninsulas of croplands or pasturelands extended into occupied panther habitats, usually wetlands. Such areas were identified as worthy of preservation to avoid intrusions of more intensive human developments into habitat areas that would be occupied on three sides by panthers.

Restoration: The value of some areas as panther habitat could be improved through restoration to more natural conditions.

With these principles in mind, the PRT identified the following existing and corridors important for panther conservation:

Summerland Swamp Habitat Linkage (SSHL): The SSHL in the northwest quadrant of the intersection of SR 29 and CR 858 was expanded to include approximately 5,542 acres of existing agricultural lands interspersed with natural habitats. This area has been and currently is used by Florida panthers based on recent radio telemetry, GPS-collar telemetry, and mortality records. One patch of wetland habitat within this area was used as a den site by FP66 in December 1999, and documented vehicle-related mortalities of dependent aged kittens and reproductive-aged females demonstrates that this area supports a reproductive component of the panther population. This area is a mosaic of natural habitats interspersed within an agricultural landscape that functions as panther habitat, not just as a corridor linking natural areas south of CR 858 to other natural areas northeast of SR 29. The area identified by the PRT includes existing WRAs that serve as effective buffers even though panther telemetry indicates little or no use of these WRAs. The SSHL also was expanded south from CR 858 to the Habitat area associated with SSA 10. The natural habitats interspersed within the agricultural lands of the area south of CR 858 have sustained frequent panther use.

North Corridor: PRT-recommended revisions to the proposed North Corridor create a 10.5-mile-long linear landscape feature comprising approximately 3,178 acres that are predominantly in agricultural uses

Camp Keias Strand Corridor (CKS): Several patches of agricultural land along CKS were identified as buffers to the corridor. Some of the patches of agricultural lands are surrounded by natural cover types, primarily wetlands. Maintaining agricultural uses within these patches, and perhaps eventually restoring some or all of these lands to more natural cover types, would serve to buffer the natural habitats that comprise the CKS corridor, and would enhance the likelihood of continued use of these areas by panthers. GPS collar data indicate that panthers often use the edges of wetland habitats, and preservation of agricultural uses adjacent to the Strand would provide buffers to these wetland edges.

Big Cypress ACSC: The PRT considered all RLSA Open Lands within the Big Cypress ACSC as having value to panther habitat conservation. The RLSA contains approximately 17,913 acres of Open Lands that are within the Big Cypress ACSC. These areas are predominantly in agricultural uses. Approximately 2,529 acres already are protected by approved SSAs, leaving approximately 15,384 acres in the Big Cypress ACSC that are not currently protected as SSAs or in public ownership (Table 2.3-1). The agricultural lands within the Big Cypress ACSC provide important buffers to the natural habitats that comprise the Okaloacoochee Slough ecosystem, an area of sustained panther use and a natural corridor connecting BCNP to OSSF. Section 4.3 of the MOU provides for Open Lands within the Big Cypress ACSC to be eligible to send 2.6 Stewardship Credits to support development within SRAs. All nonagricultural uses would be removed from areas designated as SSAs, and remaining uses would be limited to agriculture and uses that support agriculture, including, without limitation, farmworker housing. There would be no intensification from Ag2 (e.g., unimproved pasture, grazing, forestry, ranching) to Ag1 (e,g., croplands, groves, plant nurseries, improved pasture, dairy, poultry production) after SSA approval. Maintenance of existing agricultural land uses in the Open Lands of the Big Cypress ACSC would function to buffer the natural areas of Okaloacoochee Slough that are used by panthers. The Open Lands of the Big Cypress ACSC also contain areas of natural habitat that have supported and would continue to support occasional use by panthers.

Buffers West of SSA 16: The PRT identified an estimated 1,116 acres west of SSA 16 as a buffer to occupied natural habitats of SSA 16 and adjacent SSAs within the Big Cypress ACSC. This buffer area is predominantly citrus groves (74%) interspersed with small patches of freshwater marsh, pine forest, and hardwood swamp. Although agriculture is the dominant use, this buffer area located between existing WRAs, and the patches of natural habitat within the citrus groves have been used by panthers as indicated by VHF- and GPS-collar telemetry records.

Agricultural Fields South of CR 858: The PRT identified approximately 1,686 acres of cropland and citrus groves south of CR 858 as a buffer area to occupied panther habitats. Although agricultural fields in this area have received little use by panthers based on VHF- and GPS-collar telemetry records, these fields are immediately adjacent to occupied natural habitats that connect to the FPNWR to the south. All of the lands between the agricultural fields and FPNWR have been designated as WRAs, HSAs, or FSAs in the RLSA program, and approximately two-thirds of the fields were designated as Primary Zone habitats (Kautz et al. 2006). Preservation of this area in its current state would provide a significant buffer to occupied panther habitats to the west, south, and east.

Habitats and Buffers East of Immokalee: The PRT identified and mapped approximately 2,254 acres of Open Land east and southeast of Immokalee to consider for additional preservation. These areas consist of natural habitats and unimproved pasturelands interspersed with improved pastures and croplands, and they have a history of documented use by panthers based on VHF telemetry records. Some of the agricultural lands in this area contain no telemetry records, but they nevertheless provide buffers to natural areas with documented use and likely provide support for panther prey (e.g., white-tailed deer and feral hog). The PRT also identified approximately 2,021 acres of land with similar features east of Immokalee but outside of the RLSA boundary. These additional 2,021 acres function together with the 2,254 acres within the RLSA as habitats and buffers valuable to panther conservation.

Four Parcels near Pepper Ranch: The PRT identified four parcels totaling 781 acres in the vicinity of Pepper Ranch as having habitats that would be of conservation value to Florida panthers if preserved. These areas contain a mix of natural cover types, but they also include some low density residential and rural development. Maintaining existing land uses in these areas would protect existing natural areas as panther habitat and would provide buffers to panther habitats on adjacent public lands.

The PRT analysis concluded 17 segments of existing roads and 24 segments of proposed roads within the RLSA that potentially could impact important resource areas used by the Florida panther, including these corridors. Specifically, the PRT identified approximately 105 centerline miles of roads currently existing within the RLSA (excludes local city/town roads); all of which are currently two-lane configurations with traffic levels (on certain segments) as high as 15,000 trips/day (SR 29) and as low as 300 trips/day (CR 858). The PRT reported most roads in the RLSA had traffic levels well below 10,000 vehicles per day. The PRT determined the proposed plan to accommodate anticipated development would include adding lanes to all but four segments of existing roads analyzed. Traffic projections at full build-out (estimated to occur in 2050) ranged from 2,000 to 61,000 trips/day. The PRT estimated seven existing road segments could have more than 40,000 trips/day; another four road segments were projected to have over 20,000 trips/day. Even very low-level traffic roads (CR 858 east of Camp Keias Road and east of SR 29, CR 846 east of the City of Immokalee, and SR 29 south of CR 858) were projected to increase significantly over current levels and likely would increase the probability of panther collisions with vehicles (Seiler 2003).

Based on road mortality and telemetry records (that the PRT identified road segments panthers have crossed, or attempted to cross. They found 10 of the 17 existing road segments within the RLSA, and all but two (SR 29 south of SR 82 and Lake Trafford Rd) were crossed multiple times. Least-cost-path results support these findings. Important existing road segments crossed include CR 846 east of Immokalee, CR 846 west of Camp Keais Road, SR 29 north of CR 858, SR 29 south of CR 858, and all segments of CR 858 in the analysis. The identified road segments also bisected designated HSAs, FSAs, and WRAs, in addition to PRT-proposed revisions to the RLSA map, and Primary and Secondary habitat zones for the Florida panther. They also found two existing, affected roads (SR 82 and SR 29) would divide the proposed northern corridor; also, PRT-proposed modifications to the northern corridor would increase the length of the corridor affected by SR 82. Only CR 850 bordered existing conservation lands. A significant number of wildlife mortality was documented (Main and Allen 2002) on CR 850 adjacent to Corkscrew Marsh, including one Florida panther.

The PRT also found proposed road network included 87.5 centerline miles of additional roads. They estimated road density for existing and proposed roads (excluding all city and town streets) would be 0.59 mi/mi^2 , nearly doubling the size of the current road network. Furthermore, the PRT fond all but two of the 24 new, proposed road segments examined were proposed as four or more lanes wide. Landowner-provided traffic projections on these road segments ranged from 3,500 to 41,700 vehicles/day; with average traffic level for new proposed roads being approximately 17,728 vehicles/day. The PRT also estimated that panthers would have crossed 16 of the 24 proposed roads, that 7 of these would have been crossed multiple times, and nine only once. Proposed road segments identified that intersect important existing habitat linkages and corridors that serves as travel routes for panthers include Immokalee Loop Road (SR 29 bypass), Stockade Road (east of SR 29), Horse Trial, Little League Road (south of Serenoa Circle), and

Randall Boulevard extension. Finally, the PRT found segments of other proposed roads would pose threats to more minor travel routes of panthers or encroach on HSAs, FSAs, WRAs, PRT-proposed revisions to the RLSA map, the Corkscrew Marsh and wetlands associated with

In response to their analysis the PRT made several recommendations to preserve habitat connectivity for Florida panthers. They specifically proposed all planning for all new roads constructed within the RLSA should attempt to avoid bisecting HSAs, FSAs, WRAs, and areas the PRT recommends for protection. They also recommended all new roads should be designed to minimize the loss or fragmentation of panther habitat if no alternative routes that avoid panther habitat exist. The PRT identified five examples where impacts could be avoided. FDOT has proposed three planning corridors as alternatives for the SR 29 bypass: eastern, central and western planning corridors. The PRT also recognized an alignment within the central planning corridor would be preferable from an ecological perspective; as it avoids all significant wetlands and would affect less habitat important to panthers. The PRT also recommended consideration of additional preservation to protect the SSHL as an important habitat segment for Florida panthers; noting construction of Horse Trial Road within this area would greatly diminish value of the SSHL as habitat for Florida panthers. The PRT also observed the proposed alignment of Little League Road (south of Serenoa Circle) and Ave Maria Boulevard (proposed north extension) would effectively separate two large, valuable, supporting wetland-habitat areas from Camp Keais Strand. Lastly, the PRT noted Little League Road (north of SR 82) would cross over the proposed northern corridor if constructed.

Motor Vehicle Mortality

We used the FDOT District 1 Regional Planning Model (D1RPM) to predict traffic levels in the Action Area for the year 2040 and 2070, based on socioeconomic projections (residents/jobs) for southwest Florida. We adjusted the regional socioeconomic projections to account for the addition of residents and jobs at a density comparable to that in the Ave Maria development on 39,973 acres of the Plan Area.

The full geospatial data representation of the D1RPM road segment volume predictions, including a table of the road segment attributes, can be downloaded from the following internet location in the Service's public-facing administrative record repository: . This geospatial data can be viewed in Esri ArcMap–compatible applications. The FDOT 2040 D1RPM road segments are also viewable on computers and smart phones, via Esri's Arc GIS Online web mapping service, at the following internet location: .

Motor Vehicle Mortality Associated with Effects of the Action

We found HCP-proposed developments will likely generate a portion of the total traffic volume in the future. Using the D1RPM and the adjustments describe above (Adjusted D1RPM Model), we estimate the proposed development in the HCP will generate 718,498 new daily trips on regional roadways that either originate in or terminate within areas proposed for development in

the HCP. The range of contribution from the HCP on individual road segments in the model is between a 0 percent and 98.5 percent increase over current AADT.

To analyze the increased risk of this portion of traffic to panthers we do the following:

(1) Current Road Segment Mortality:
Our analysis of panther/vehicle collisions and traffic volume generated from past projects in the Action Area found increasing traffic volume increases impacts to the panther. However, our analysis and literature review also indicate many additional factors aside from traffic volume also influence the probability of panther/vehicle collisions. These include, but are not limited to, the abundance of panthers in proximity to roadways, the availability of suitable panther habitat near roadways, the presence of wildlife crossings, traffic speed, and road width (Schwab and Zandbergen, 2011). We posit the recent history of panther mortalities on a particular road segment is the best available means of integrating the combined influence of all such factors operating along a given roadway. Thus, we predict future annual mortality rates for each road segment in the Action Area will increase as a linear function of traffic volume consistent to that observed by Charry and Jones (2009). We have subsequently confirmed this to be the general pattern of effects with our own analysis of the record of panther vehicle mortality increases in response to increased traffic from past developments in the Action Area, such as those that occurred following the construction of developments like Ave Maria.
Vehicles struck 110 panthers on 91 road segments in the Action Area from 2014 through 2018, with 40 percent of all mortalities being females. The 5-year mortality rate on individual road segments varied between 0 and 5 individuals/5 years; with at least one mortality occurring on the segment between 2014 and 2018. The average annual mortality for a road segment was calculated by counting the number of mortalities on a road segment from 2014 through 2018, then dividing that number by 5 (the number of years from 2014 through 2018). Annual mortality for individual road segments is provided in Appendix A.

(2) Current Road Segment AADT in Action Area:
The current road segment AADTs in the Action Area are an average of AADTs on each road segment from 2014 through 2018, and can be found in Appendix A. The current average AADTs for segments within the FDOT District 1 road network range from 0 to 133,700. Only those segments with a history of panther mortality, and a current road segment AADT data were used for calculating future mortality. These segments are identified in the appendix in the first column of Table 10a as "Road Segment Identifier" (segment), which we generated locally by combining the D1RPM bi-directional "A" and "B" segment identification numbers. The AB Segment number is identified in the first column of Table 5-7 as the "Road Segment Identifier". The current AADT data for each segment was derived from two sources: FDOT's Transportation Data and Analytics Office GIS data (2019), and Collier County's Transportation Data Management System (2019).

(3) Future Road Segment HCP AADT in Action Area:
The Future Road Segment HCP AADTs in the Action Area are found in the Adjusted D1RPM Model and can be found in Appendix A. The segments with a history of panther mortality are identified in the appendix table by the D1RPM "Road Segment Identifier" number for the road segment closest to each documented panther mortality. Only those segments with a history of panther mortality were used for calculating future mortality because the equation for calculating future mortality includes a measure of current mortality. The D1RPM model predicts future segment AADTs, for the year 2040, for all road segments within FDOT District 1 (Figure 5-8.

and Table 10a in Appendix A). The full geospatial data representation of the FDOT 2040 D1RPM road segment volume predictions, including a table of the road segment attributes, can be downloaded from the following internet location in the Service's public-facing administrative record repository: . This geospatial data can be viewed in Esri ArcMap–compatible applications. The FDOT 2040 D1RPM road segments are also viewable on computers and smart phones, via Esri's Arc GIS Online web mapping service, at the following internet location:

. Individual road segments in the geospatial D1RPM model data table are listed under column "AB" (geospatial D1RPM model data is available for download from the USFWS ServCat/ArcGIS Online (AGOL)/DataShare/by telephone or email request). The amount of the future AADT attributable to HCP is defined in the D1RPM model as proportion of traffic volume that either originates in or terminates within areas proposed for development in the HCP. The proportion of HCP-attributable traffic volume is identified in the geospatial D1RPM data table as "HCP_PCT_T".

The method assumes that average annual mortality and average annual AADT over the last 5 years represent a roadway segment's current (baseline) traffic and mortality risk. This estimation method also assumes that changes in mortality are directly related to traffic volume. This method does not consider other important factors that that contribute to mortality risk such as number of panthers accessing roadways, traffic speed, differences in traffic volume throughout the day, wildlife fencing, underpasses, surrounding habitat/land use and panther use of that habitat, etc. We assumed road segments with existing mortality contained all of the features that would contribute to future mortality, such as the presence of habitat and panthers adjacent to areas of current panther-vehicle collision.

(4) Future Road Segment HCP Mortality in Action Area:

We estimate the predicted proportion of future panther mortality due to HCP-generated traffic on each road segment with a history of panther mortality in the Action Area using the following formula:

Future Road Segment HCP Mortality in Action Area = (Current Road Segment Mortality / Current Road Segment AADT in Action Area) x Future Road Segment HCP AADT in Action Area.

Future Road Segment HCP Mortality in the Action Area ranges from ~0.00004 individuals/year to 2.6 individuals/year, and can be found in Appendix A. These segments are identified in the appendix by "Road Segment Identifier" in Appendix tables, or "AB" in the geospatial data set. The road segment identifier is the concatenated key used in the FDOT traffic model that serves as the bi-directional road segment identifier.

(5) Future HCP Mortality in the Action Area:

To estimate the total predicted proportion of future panther mortality due to HCP-generated traffic, all of the predicted proportion of future panther mortality due to HCP-generated traffic on each road segment (step 4) were totaled.

91 segments with a history of panther/vehicle collisions in the Action Area (roadways with an HCP contribution of 100+ vehicle trips/day) were identified by selecting the segment closest a documented panther/vehicle collision with the use of the ArcGIS spatial join selection tool (Table 9). This selection process assumed that the panthers were struck by vehicles on the road segment closest to where they were found. On these road segments 110 panthers were killed or

injured by vehicle collision during a five span of time from 2014 thru 2018. Average annual mortality of panthers on all segments was 22 individuals/year. Annual mortality on individual road segments ranged between 0.2 individuals/year to 1 individual/year. The sum of Annual Average Daily Traffic (AADT) on these road segments from 2014 thru 2018 was 1,714,355 trips per day.

2040 projected AADT for the road segments in the Action Area with a history of panther mortality is 2,420,379 trips/day. Of these 717,987 trips originate in, or will terminate in, transportation analysis zones (TAZs) within the HCP footprint. Our model assumed full build-out, so we consider this to be the full volume of traffic originating or terminating in HCP developments annually after full build out. In 2040 1,679,318 trips/day will originate or terminate in TAZs not associated with the HCP.

To estimate the influence of traffic from non-HCP sources we extrapolated the traffic growth trend for non-HCP traffic volumes to 2070. Specifically, we subtracted the 2014 thru 2018 AADT from the 2040 Non-HCP AADT, divided this by the intervening time interval (22 years), then multiplied the result by 52 to approximate the change in traffic that would occur from non-HCP sources between 2018 and 2070. Our analysis found that non-HCP contributions to traffic in the HCP Action Area would decline over time, and that the decline in non-HCP traffic would ultimately shift the total traffic contribution from its peak of 2,420,379 trips/day in 2040 by 803,923 to a total of 1,521,909 trips/day in 2070. Meanwhile, because of the development cap implemented by the Applicants the contribution of HCP-generated traffic would remain constant at 717,987 trips/day throughout.

Further review of the model and our assumptions found that most traffic volume (74.7 percent) generated from non-HCP sources between now, 2040, and 2070 would likely constitute future federal actions the Service would consult on through Section 7 of the Endangered Species Act. Thus, we recognized we can not assume the full body of estimated non-HCP traffic will be realized without additional avoidance, minimization, and mitigation measures being implemented to offset non-HCP traffic impacts to panthers. Because of this we adjusted our estimate of panther/vehicle mortality to reflect only the 25.3 percent of 2070 estimated panthers that would be impacted by vehicles originating or entering future non-HCP developments that will likely occur without consultation with the Service.

Only those segments with a history of panther mortality were used for calculating future mortality because the equation for calculating future mortality includes a measure of current mortality (Figure 1). We assumed road segments with existing mortality contained all the features that would contribute to future mortality, such as the presence of habitat and panthers adjacent to areas of current panther-vehicle collision. We estimated future mortality by treating it as a linear function of traffic volume:

Future Mortality = Current Mortality × (Future AADT / Current AADT)

Our summary of the estimate of future panther/vehicle collisions attributable to source by segment and total is represented in Table 9 of this appendix.

Figure 1. Road Segments with panther/vehicle mortalities (PVM) in the past 5 years. Only those segments likely to be impacted by 100 or more trips/day originating in, or terminating in, the HCP footprint were analyzed further.

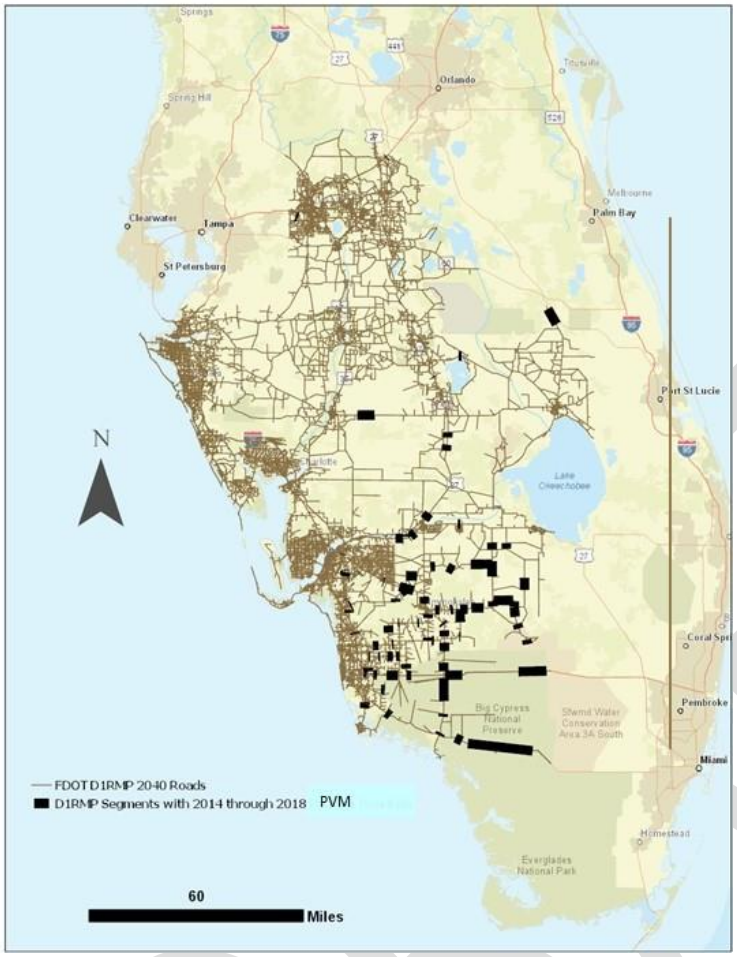

Table 9a Annual Average Daily Traffic (AADT) and Panther/Vehicle Mortality (PVM) by year and road segment. Road segments shaded in grey indicate a crossing is already under construction at that site. Segments in peach indicate road segments which will exceed 10,000+ vehicle trips/day because of traffic generated by development proposed in the HCP. The first 9 segments where a wildlife crossing is not already under construction were used to simulate the establishment of wildlife crossings for the purpose of analyzing the effect of 8 additional wildlife crossings being facilitated by the Applicants.

Road Segment Identifier	2014-2018 AADT	2014-2018 Total PVM	2014-2018 Annual PVM	Portion of total traffic attributable to HCP	2070 HCP AADT	2070 Non-HCP AADT[1]	2070 Total AADT	2070 HCP PVM	2070 Non-HCP PVM	Total 2070 PVM
11416_11415	490	1	0.2	0.1559	1,604	5,042	6,646	0.65	2.058	2.713
27167_27202	11,860	5	1	0.6694	25,253	6,097	31,350	2.13	0.514	2.643
27369_24041	1,475	1	0.2	0.9762	19,210	268	19,477	2.60	0.036	2.641
27457_27458	3,814	2	0.4	0.9653	20,962	405	21,367	2.20	0.042	2.241
26919_26934	7,493	3	0.6	0.9719	17,772	234	18,006	1.42	0.019	1.442
27414_24845	1,762	1	0.2	0.9603	9,868	220	10,088	1.12	0.025	1.145
24039_27446	4,220	1	0.2	0.9652	20,953	401	21,354	0.99	0.019	1.012
27360_27362	10,842	1	0.2	0.9852	48,593	381	48,974	0.90	0.007	0.903
25001_25027	2,197	1	0.2	0.0242	422	9,415	9,837	0.04	0.857	0.895
24206_24208	2,490	1	0.2	0.8934	10,305	642	10,947	0.83	0.052	0.879
27362_27363	10,842	1	0.2	0.9847	47,010	379	47,389	0.87	0.007	0.874
27213_27221	15,130	2	0.4	0.7753	28,729	3,801	32,530	0.76	0.100	0.860
26539_26638	33,672	3	0.6	0.4318	30,481	17,356	47,837	0.54	0.309	0.852
24627_24810	4,600	1	0.2	0.0606	1,683	14,080	15,763	0.07	0.612	0.685
27156_27180	18,640	3	0.6	0.2846	10,087	10,547	20,634	0.32	0.339	0.664
11506_11826	1,270	1	0.2	0.0835	610	3,596	4,206	0.10	0.566	0.662
24054_27453	6,220	1	0.2	0.9769	19,768	230	19,998	0.64	0.007	0.643
27453_24047	6,220	1	0.2	0.9768	19,759	230	19,989	0.64	0.007	0.643
24068_27441	6,220	1	0.2	0.9765	19,458	229	19,687	0.63	0.007	0.633
26493_26539	33,672	2	0.4	0.4181	29,781	18,000	47,781	0.35	0.214	0.568
24030_24035	5,400	1	0.2	0.9833	14,455	115	14,570	0.54	0.004	0.540
26952_27018	18,640	2	0.4	0.2097	8,646	14,384	23,030	0.19	0.309	0.494
26934_26919	7,493	1	0.2	0.9719	17,772	234	18,006	0.47	0.006	0.481
27168_27163	6,785	1	0.2	0.9841	16,153	119	16,272	0.48	0.004	0.480
24833_24830	1,762	2	0.4	0.8167	1,828	134	1,962	0.42	0.030	0.449
27231_27233	7,209	1	0.2	0.9836	15,696	115	15,811	0.44	0.003	0.439
26750_26770	10,840	1	0.2	0.4160	13,878	9,453	23,331	0.26	0.174	0.430
27213_27202	15,130	1	0.2	0.7661	27,279	3,754	31,033	0.36	0.050	0.410
24811_27270	16,450	1	0.2	0.7736	28,332	3,667	31,998	0.34	0.045	0.389
27270_27271	16,450	1	0.2	0.7724	28,151	3,662	31,813	0.34	0.045	0.387
26265_26252	27,000	2	0.4	0.0549	2,971	21,737	24,708	0.04	0.322	0.366
26662_26668	10,840	1	0.2	0.3871	9,724	6,902	16,627	0.18	0.127	0.307
26493_24000	33,672	1	0.2	0.4181	29,781	18,000	47,781	0.18	0.107	0.284
27452_27655	1,420	1	0.2	0.8538	1,869	120	1,989	0.26	0.017	0.280
27087_27018	18,640	1	0.2	0.2190	9,943	16,163	26,106	0.11	0.173	0.280

27439_27440	1,420	1	0.2	0.8418	1,846	130	1,975	0.26	0.018	0.278
11420_11421	570	1	0.2	0.1372	193	556	749	0.07	0.195	0.263
11512_11418	570	1	0.2	0.1405	193	537	730	0.07	0.188	0.256
27485_27492	430	1	0.2	0.8454	503	32	535	0.23	0.015	0.249
11828_11827	10,480	1	0.2	0.0610	1,557	10,911	12,467	0.03	0.208	0.238
11467_27489	980	1	0.2	0.6570	962	184	1,146	0.20	0.038	0.234
24833_27477	1,762	1	0.2	0.8176	1,826	133	1,959	0.21	0.015	0.222
27429_27422	1,760	1	0.2	0.8443	1,846	109	1,954	0.21	0.012	0.222
27180_27156	18,640	1	0.2	0.2846	10,087	10,547	20,634	0.11	0.113	0.221
25888_25800	33,400	1	0.2	0.0248	1,956	34,760	36,716	0.01	0.208	0.220
25920_25922	33,400	1	0.2	0.0248	1,956	34,760	36,716	0.01	0.208	0.220
25924_25922	33,400	1	0.2	0.0248	1,956	34,760	36,716	0.01	0.208	0.220
25927_25931	33,400	1	0.2	0.0248	1,956	34,760	36,716	0.01	0.208	0.220
27185_27200	3,440	1	0.2	0.5468	2,875	886	3,761	0.17	0.051	0.219
27202_27200	3,440	1	0.2	0.5468	2,875	886	3,761	0.17	0.051	0.219
27549_27263	2,340	1	0.2	0.1692	801	1,680	2,482	0.07	0.144	0.212
27153_24825	3,380	1	0.2	0.5322	2,666	854	3,521	0.16	0.051	0.208
11468_11800	980	1	0.2	0.6093	782	167	949	0.16	0.034	0.194
10435_10336	4,780	1	0.2	0.0143	147	4,455	4,603	0.01	0.186	0.193
23802_27057	13,073	1	0.2	0.3605	7,350	4,905	12,255	0.11	0.075	0.187
27536_27549	2,871	1	0.2	0.1529	803	1,820	2,623	0.06	0.127	0.183
25883_25885	33,400	1	0.2	0.0221	1,492	28,105	29,597	0.01	0.168	0.177
11440_11508	1,270	1	0.2	0.3402	652	467	1,119	0.10	0.073	0.176
11534_11553	980	1	0.2	0.5411	672	185	857	0.14	0.038	0.175
11648_11469	980	1	0.2	0.5411	672	185	857	0.14	0.038	0.175
26666_26771	26,500	1	0.2	0.1578	7,246	15,399	22,645	0.05	0.116	0.171
24433_24481	39,142	1	0.2	0.0108	839	32,571	33,410	0.00	0.166	0.171
27482_27499	3,240	1	0.2	0.1531	803	1,708	2,512	0.05	0.105	0.155
26294_24018	26,500	1	0.2	0.0827	3,679	15,980	19,659	0.03	0.121	0.148
23952_26666	26,500	1	0.2	0.1430	5,955	13,491	19,446	0.04	0.102	0.147
26605_26464	23,796	2	0.4	0.2400	4,230	3,383	7,614	0.07	0.057	0.128
11440_11473	1,270	1	0.2	0.4996	570	144	715	0.09	0.023	0.113
11473_11440	1,270	1	0.2	0.4996	570	144	715	0.09	0.023	0.113
11531_11473	1,270	1	0.2	0.4996	570	144	715	0.09	0.023	0.113
26155_26078	40,300	2	0.4	0.0417	1,335	7,748	9,083	0.01	0.077	0.090
24216_24219	3,731	1	0.2	0.6600	1,420	185	1,604	0.08	0.010	0.086
27461_27500	21,760	1	0.2	0.2892	5,471	3,396	8,867	0.05	0.031	0.082
27564_27566	21,760	1	0.2	0.2892	5,471	3,396	8,867	0.05	0.031	0.082
27107_26867	23,796	1	0.2	0.2400	4,230	3,383	7,614	0.04	0.028	0.064
27162_27107	23,796	1	0.2	0.2400	4,230	3,383	7,614	0.04	0.028	0.064
27218_27204	23,796	1	0.2	0.2400	4,230	3,383	7,614	0.04	0.028	0.064
26859_27111	23,796	1	0.2	0.2255	3,899	3,383	7,282	0.03	0.028	0.061
11928_12538	21,125	1	0.2	0.0072	154	5,449	5,603	0.00	0.052	0.053

11892_11955	7,965	1	0.2	0.0216	154	1,756	1,910	0.00	0.044	0.048
11953_11954	7,965	1	0.2	0.0243	154	1,560	1,714	0.00	0.039	0.043
24320_24337	28,600	1	0.2	0.0154	348	5,616	5,964	0.00	0.039	0.042
11658_11514	1,270	1	0.2	0.6737	234	29	262	0.04	0.005	0.041
25955_26075	40,300	1	0.2	0.0385	1,105	6,969	8,074	0.01	0.035	0.040
25069_25051	97,300	1	0.2	0.0180	1,107	15,305	16,412	0.00	0.031	0.034
24534_24541	97,300	1	0.2	0.0098	584	14,904	15,488	0.00	0.031	0.032
24541_24547	97,300	1	0.2	0.0098	584	14,904	15,488	0.00	0.031	0.032
24559_24553	97,300	1	0.2	0.0103	600	14,594	15,194	0.00	0.030	0.031
23492_23581	86,100	1	0.2	0.0047	235	12,655	12,890	0.00	0.029	0.030
23893_24095	88,800	1	0.2	0.0033	164	12,681	12,845	0.00	0.029	0.029
24060_23982	88,800	1	0.2	0.0033	164	12,681	12,845	0.00	0.029	0.029
24847_27489		2	0.4	0.7218	241	55	297			
Totals	**1,714,355**	**110**	**22**		**717,987**	**627,266**	**1,345,254**	**26**	**11**	**37**

Table 10b. Future proposed crossings and status of planning

Underpass Name	Segement AB	Stage of Planning	Funding	SFESO: Reasonably Certain to Occur? (Yes or No)	Reasoning
ECPO proposed in HCP (X # of underpasses)		pre-planning	Committed to first $12.5 from Marinelli fund		
SR 82 over Panther Creek FPID 430848-1	27213_27202	under construction	part of FPID 430848-1 which is currently funded for construction in FY 2023 (scheduled for a 7/21/2022 letting)	Yes	part of FPID 430848-1 which is currently funded for construction in FY 2023 (scheduled for a 7/21/2022 letting)
SR 82 under canal FPID 430848-1	27167_27202	under construction	part of FPID 430848-1 which is currently funded for construction in FY 2023 (scheduled for a 7/21/2022 letting)	Yes	part of FPID 430848-1 which is currently funded for construction in FY 2023 (scheduled for a 7/21/2022 letting)
SR 29 at Owl Hammack (417540-3)	24059_27450	At this time, this project isn't funded for ROW or Construction	None	No	At this time, this project isn't funded for ROW or Construction
SR 29 at Twelve Mile Slough (417878-5)	11384_11439	Under design. ROW in FY 2025, construction not in 5 year Work Program	None	No	Construction not in 5 year Work Program
SR 29 at Sears and Roberts Canal (417878-7)	11387_11511	Under design, ROW in FY 2023, construction not in 5 year Work Program	None	No	Construction not in 5 year Work Program
SR 80 east of Labelle	11376_11692	under construction	funded	Yes	Under Construction
BRIDGE 030141 ON IMMOKALEE ROAD	24828_27489	pre-planning	?	?	pre-planning
BRIDGE 030158 ON COUNTY LINE ROAD	24847_27489	pre-planning	?	?	pre-planning
Corkscrew at Corkscrew Crossings	24965_25224	Designed and funded	Funded	?	Planned but won't be built until County has a fix on future road capacities

Crossing Effectiveness

We estimate that the Applicants' commitment of $12.5 million from the Marinelli Fund would facilitate the construction of at least 8 wildlife crossings. Before applying these to the 8 deadliest road segments in the Action Area, we first estimated the average effectiveness of wildlife crossings in reducing panther/vehicle collisions within ¼ of a mile of the crossing location. We did this by counting the number of panther/vehicle collisions that occurred within ¼ mile of existing wildlife crossings prior to construction and the number of panther/vehicle collisions that occurred within ¼ mile of the crossing after it was installed. We then averaged the numbers for each category (before construction and after) and applied the equation:

Crossing Effectiveness = 1- (Average Panther-Vehicle Collisions Before Construction/Average Panther-Vehicle Collisions After Construction)

An alternative calculation was to convert the number of mortalities at each location into annual rates of the record at that location and treat effectiveness as a function of reducing the annual rate of panther vehicle collisions. For this calculation the number of years in the record prior to construction and after were each summed and the total number of mortalities for each respective period (before or after) divided by the number of years in the record to find the annual rate of panther/vehicle mortalities within ¼ mile of a crossing before and after it was built. We then applied a modification of the previous equation to calculate the average reduction in annual rate of mortality:

Crossing Effectiveness = 1- (Annual Panther-Vehicle Collision Rate Before Construction/Average Panther-Vehicle Collision Rate After Construction)

Because the effectiveness of crossings where panther/vehicle collisions occurred within ¼ mile of the crossing location prior to construction was 100 percent, and because new crossings would be imbedded into the network of crossings and already on the landscape, we opted for the higher outcome of the two methods of estimating crossing effectiveness (Table 10). It is our assessment this is a reasonable representation of the average effectiveness of crossings integrated into a landscape network comprised of wildlife crossings located in sequence along common corridors of panther movement across the landscape. The results, located in Tables 11 & 12, indicate the aggregate of new wildlife crossings will reduce panther/vehicle collisions within ¼ mile by an average of 80 percent.

Table 10 Analysis of Average Wildlife Crossing Effectiveness

Crossing name	Year installed	# of Years in Record Prior to Construction	# of Years in Record After Construction	# of Panther/Vehicle Collisions Prior to Construction	# of Panther/Vehicle Collisions After Construction	Annual Panther/Vehicle Collision Rate Prior to Construction	Annual Panther/Vehicle Collision Rate After Construction
CR 846 - City Gate	2012	40	6	2	0	0.05	0
CR 846 - W of Immokalee	2013	41	5	1	0	0.02439	0
Oil Well Road (W)	2012	40	6	0	0	0	0
Oil Well Road (E)	2012	40	6	0	0	0	0
CR846- Western Wildlife Crossing	2001	29	17	0	0	0	0
SR 29 - Crossing A (northern most)	2007	35	11	1	0	0.028571	0
SR 29 - Crossing B (3rd N. of I-75)	2007	35	11	1	0	0.028571	0
SR 29 - Crossing C (2nd N. of I-75)	1995	23	23	0	1	0	0.043478
SR 29 - Crossing D (1st N. of I-75)	1995	23	23	1	0	0.043478	0
SR 29 - Crossing E (1st S. of I-75)	1997	25	21	0	0	0	0
SR 29 - Southernmost	1998	26	20	0	1	0	0.05
I-75 on Miller Canal (western most)	2016	44	2	2	0	0.045455	0
I-75 on Faka Union Canal	2016	44	2	1	0	0.022727	0
I-75 SE of air strip	1993	21	25	0	0	0	0
I-75 over Stumpy Strand #2	1990	18	28	0	0	0	0
I-75 bwn Stumpy and Pennington	1993	21	25	0	0	0	0
I-75 over Pennington Camp #4	1989	17	29	0	0	0	0
I-75 btwn Pennington and Salt Prairie (W)	1993	21	25	2	0	0.095238	0
I-75 btwn Pennington and Salt Prairie (mid)	1993	21	25	2	0	0.095238	0

I-75 btwm Pennington and Salt Prairie (E)	1993	21	25	0	0	0	0
I-75 Salt Prairie #8	1989	17	29	1	0	0.058824	0
I-75 btwn Salt Prairie and Shanna's (W)	1993	21	25	1	0	0.047619	0
I-75 btwn Salt Prairie and Shanna's (Mid)	1993	21	25	0	0	0	0
I-75 btwn Salt Prairie and Shanna's (E)	1993	21	25	0	0	0	0
I-75 over Shannas #12	1989	17	29	0	0	0	0
I-75 Wildlife Crossing #13	1990	18	28	0	0	0	0
I-75 Wildlife Crossing #14	1991	19	27	0	0	0	0
I-75 Wildlife Crossing #15	1990	18	28	0	0	0	0
I-75 btwn #15 and16	1993	21	25	0	0	0	0
I-75 Wildlife Crossing #16	1991	19	27	0	0	0	0
I-75 btwn #16 and 19 (W)	1993	21	25	0	0	0	0
I-75 btwn #16 and 19 (East)	1993	21	25	0	0	0	0
I-75 Wildlife Crossing #19	1990	18	28	0	0	0	0
I-75 btwn #19 and 23 (W)	1993	21	25	0	0	0	0
I-75 btwn #19 and 23 (E)	1993	21	25	0	0	0	0
I-75 Wildlife Crossing #23	1992	20	26	0	0	0	0
I-75 Wildlife Crossing #24	1992	20	26	0	0	0	0
I-75 Wildlife Crossing #25	1992	20	26	0	0	0	0
I-75 Wildlife Crossing #26	1992	20	26	0	0	0	0
I-75 btwn #26 and 28	1993	21	25	0	0	0	0
I-75 Wildlife Crossing #28	1992	20	26	0	0	0	0
I-75 Wildlife Crossing #29	1991	19	27	0	0	0	0
I-75 btwn #29 and 31	1993	21	25	0	0	0	0
I-75 Wildlife Crossing #31	1991	19	27	0	0	0	0
I-75 btwn #31 and 33	1993	21	25	0	0	0	0
I-75 Wildlife Crossing #33	1992	20	26	0	0	0	0
I-75 btwn #33 and 35	1993	21	25	0	0	0	0
I-75 Wildlife Crossing #35	1991	19	27	0	0	0	0
I-75 E of 35 (W)	1993	21	25	0	0	0	0
I-75 E of 35 (mid-W)	1993	21	25	0	0	0	0
I-75 E of 35 (mid-E)	1993	21	25	0	0	0	0
I-75 E of 35 (E)	1993	21	25	0	0	0	0
Corkscrew Road	1994	22	24	0	1	0	0.041667
SR 80	2014	42	4	0	0	0	0
TOTAL				**15**	**3**	**0.540**	**0.135**
AVERAGE				**0.278**	**0.056**	**0.010**	**0.003**
% Decrease					**80.00%**		**74.98%**

Effect of Conservation Measures

We multiplied 20% (the inverse of crossing effectiveness) by the total estimated panther/vehicle collisions in the 8 road segments with the highest annual rate of panther/vehicle collisions (Table

12), without a crossing already being constructed, to simulate effect of 8 crossings facilitated by the Applicants on future panther/vehicle collisions. The results of this simulation are reported in Table 13 of this appendix.

The following steps were used to determine the reduced number of mortalities expected in the Action Area due to HCP-generated traffic once the crossings are considered:

(A) Current Panther Mortality on High Mortality Road Segments

We looked at the current road segments and included any road segments that had panther road mortality from 2014 through 2018. We selected the 8 segments with the highest panther mortality in the present to estimate the reduction in mortality from HCP-generated traffic increases if the 8 wildlife crossing the Applicants' funding is expected to facilitate are constructed at either these locations or similarly high mortality road segments in the future. In other words, in the future we will look across the landscape and are likely to select the locations with the highest past and present mortalities. The high mortality road segments with associated panther mortality is found in Table 5-8. Combined, a total of 22 panther mortalities (~4.4/year) have occurred on these road segments and mortalities range from 2 (0.4/year) to 5 (1/year) on individual road segments.

(B) Current AADT on High Mortality Road Segment

These AADTs are found in Appendix A Table 10a in rows 1 and 3 through 9.

(C) Future AADT on High Mortality Road Segments from HCP-generated Traffic

The Future AADTs on High Mortality Road Segment from HCP-generated traffic was calculated using the Adjusted D1RPM Model and can be found in Appendix A. These segments are identified in the appendix by a Road Segment Identifier, constructed through the combination of two-way road segment traffic volumes listed under "A" and "B" in the FDOT D1RPM Model outputs. Only those segments with a history of panther mortality were used for calculating future mortality because the equation for calculating future mortality includes a measure of current mortality. We assumed road segments with existing mortality contained all of the features that would contribute to future mortality, such as the presence of habitat and panthers adjacent to areas of current panther-vehicle collision.

(D) Future HCP mortality on High Mortality Road Segments

We estimate the predicted proportion of future panther mortality due to HCP-generated traffic on each road segment with a history of high panther mortality using the following formula:

Future HCP mortality on High Mortality Road Segments = (Current Panther Mortality on High Mortality Road Segments / Current AADT on High Mortality Road Segment) x Future AADT on High Mortality Road Segment from HCP-generated Traffic.

Future mortality on high mortality Road Segments ranges from 0.4 to 2.6, and can be found in Appendix A. These segments are identified in the appendix by a Road Segment Identifier, constructed through the combination of two-way road segment traffic volumes listed under "A" and "B" in the FDOT D1RPM Model outputs.

(E) Future HCP Mortality Reduction on High Mortality Road Segments

To estimate the amount of mortality that is predicted to be reduced along each high mortality road segment when the conservation measure is implemented we assumed 1 crossing with fencing in each location would reduce mortality by 80 percent (See section 5.2.2.4 for method used to determine 80 percent reduction per crossing) at that location. The following equation was used to determine the reduction at each high mortality road segment:

HCP Mortality Reduction on High Mortality Road Segment = Future HCP Mortality on High Mortality Road Segments x 0.80

The reduction per high mortality road segment is listed in Table 12 in Appendix A.

(F) Future HCP Mortality Reduction due to HCP Conservation Measure

To estimate the total reduction in mortality after the conservation measure is considered we totaled the reduction in mortality at each high mortality road segment. The total reduction in panther mortality expected due to implementation of the 8 wildlife crossings is 3 fewer mortalities per year (above present) in the Action Area (Table 5-9).

Finally, to account for the possibility that crossing effectiveness could be increased in the future, we simulated conditions where mortality at the 8 highest mortality 'hot spots' were reduced by 100 percent within ¼ mile for the purpose of comparison. This simulation found that 8 wildlife crossings with 100 percent effectiveness reduced projected mortality by 4 panthers/year at full build out. The reduction in mortality from increasing effectiveness from 80 percent to 100 percent would result in 1 fewer mortality (above present) in the Action Area.

(G) Future Reduced HCP Mortality in the Action Area

To estimate total predicted proportion of future panther mortality due to HCP-generated traffic after implementation of the minimization measure, we used the following formula:

Future Reduced HCP Mortality in the Action Area = Future HCP Mortality in the Action Area – Future HCP Mortality Reduction due to HCP Conservation Measure

Table 11 PVM Adjusted for the Installation of 8 New Wildlife Crossings Proposed by the Applicants

Road Segment Identifier	2070 Non-HCP PVM	2070 HCP PVM	2070 Total PVM	2070 Non-HCP PVM w/ 8 Crossings	2070 HCP PVM w/8 Crossings	2070 Total PVM w/ 8 Crossings
11416_11415	2.058	0.006	**2.713**	0.412	0.001	**0.413**
27167_27202	0.514	0.186	**2.643**	0.103	0.037	**0.140**
27369_24041	0.036	0.626	**2.641**	0.007	0.125	**0.132**
27457_27458	0.042	0.002	**2.241**	0.008	0.000	**0.009**
26919_26934	0.019	0.474	**1.442**	0.004	0.095	**0.099**

27414_24845	0.025	0.655	**1.145**	0.005	0.131	**0.136**
24039_27446	0.019	2.198	**1.012**	0.004	0.440	**0.443**
27360_27362	0.007	0.001	**0.903**	0.001	0.000	**0.002**
25001_25027	0.857	0.071	**0.895**	0.171	0.014	**0.186**
24206_24208	0.052	0.535	**0.879**	0.052	0.535	**0.587**
27362_27363	0.007	0.896	**0.874**	0.007	0.896	**0.903**
27213_27221	0.100	2.129	**0.860**	0.100	2.129	**2.230**
26539_26638	0.309	0.177	**0.852**	0.309	0.177	**0.486**
24627_24810	0.612	0.005	**0.685**	0.612	0.005	**0.618**
27156_27180	0.339	0.108	**0.664**	0.339	0.108	**0.448**
11506_11826	0.566	1.120	**0.662**	0.566	1.120	**1.687**
24054_27453	0.007	0.112	**0.643**	0.007	0.112	**0.120**
27453_24047	0.007	0.636	**0.643**	0.007	0.636	**0.643**
24068_27441	0.007	0.635	**0.633**	0.007	0.635	**0.643**
26493_26539	0.214	0.004	**0.568**	0.214	0.004	**0.218**
24030_24035	0.004	0.435	**0.540**	0.004	0.435	**0.440**
26952_27018	0.309	0.045	**0.494**	0.309	0.045	**0.354**
26934_26919	0.006	0.050	**0.481**	0.006	0.050	**0.057**
27168_27163	0.004	0.033	**0.480**	0.004	0.033	**0.036**
24833_24830	0.030	0.068	**0.445**	0.030	0.068	**0.099**
27231_27233	0.003	0.476	**0.439**	0.003	0.476	**0.479**
26750_26770	0.174	0.325	**0.430**	0.174	0.325	**0.499**
27213_27202	0.050	0.342	**0.410**	0.050	0.068	**0.118**
24811_27270	0.045	0.760	**0.389**	0.045	0.760	**0.804**
27270_27271	0.045	0.344	**0.387**	0.045	0.344	**0.389**
26265_26252	0.322	0.001	**0.366**	0.322	0.001	**0.323**
26662_26668	0.127	0.030	**0.307**	0.127	0.030	**0.157**
26493_24000	0.107	0.354	**0.284**	0.107	0.354	**0.461**
27452_27655	0.017	0.260	**0.280**	0.017	0.260	**0.277**
27087_27018	0.173	0.055	**0.280**	0.173	0.055	**0.228**
27439_27440	0.018	0.207	**0.278**	0.018	0.207	**0.226**
11420_11421	0.195	0.196	**0.263**	0.195	0.196	**0.392**
11512_11418	0.188	0.068	**0.256**	0.188	0.068	**0.256**
27485_27492	0.015	0.090	**0.249**	0.015	0.090	**0.105**
11828_11827	0.208	0.073	**0.238**	0.208	0.048	**0.256**
11467_27489	0.038	0.103	**0.234**	0.038	0.103	**0.140**
24833_27477	0.015	0.415	**0.222**	0.015	0.415	**0.430**
27429_27422	0.012	0.263	**0.222**	0.012	0.263	**0.276**
27180_27156	0.113	0.361	**0.221**	0.113	0.361	**0.474**
25888_25800	0.208	0.012	**0.220**	0.208	0.012	**0.220**
25920_25922	0.208	0.012	**0.220**	0.208	0.012	**0.220**
25924_25922	0.208	0.012	**0.220**	0.208	0.012	**0.220**
25927_25931	0.208		**0.220**	0.208	0.000	**0.208**
27185_27200	0.051	0.167	**0.219**	0.051	0.167	**0.219**
27202_27200	0.051	0.004	**0.219**	0.051	0.004	**0.055**

27549_27263	0.144	0.158	**0.212**	0.144	0.158	**0.301**
27153_24825	0.051	0.050	**0.208**	0.051	0.050	**0.100**
11468_11800	0.034	0.068	**0.194**	0.034	0.068	**0.102**
10435_10336	0.186	0.828	**0.193**	0.186	0.828	**1.014**
23802_27057	0.075	0.001	**0.187**	0.075	0.001	**0.077**
27536_27549	0.127	0.167	**0.183**	0.127	0.167	**0.294**
25883_25885	0.168	0.543	**0.177**	0.168	0.543	**0.711**
11440_11508	0.073	0.076	**0.176**	0.073	0.076	**0.150**
11534_11553	0.038	0.137	**0.175**	0.038	0.137	**0.175**
11648_11469	0.038	0.160	**0.175**	0.038	0.160	**0.197**
26666_26771	0.116	0.867	**0.171**	0.116	0.867	**0.983**
24433_24481	0.166	0.012	**0.171**	0.166	0.012	**0.178**
27482_27499	0.105	0.056	**0.155**	0.105	0.056	**0.161**
26294_24018	0.121	0.107	**0.148**	0.121	0.107	**0.227**
23952_26666	0.102	0.028	**0.147**	0.102	0.028	**0.130**
26605_26464	0.057	0.036	**0.128**	0.057	0.036	**0.092**
11440_11473	0.023	0.090	**0.113**	0.023	0.090	**0.113**
11473_11440	0.023	0.090	**0.113**	0.023	0.090	**0.113**
11531_11473	0.023	0.137	**0.113**	0.023	0.137	**0.160**
26155_26078	0.077	0.256	**0.090**	0.077	0.256	**0.333**
24216_24219	0.010	0.210	**0.086**	0.010	0.210	**0.220**
27461_27500	0.031	0.050	**0.082**	0.031	0.050	**0.082**
27564_27566	0.031	2.605	**0.082**	0.031	2.605	**2.636**
27107_26867	0.028	0.036	**0.064**	0.028	0.036	**0.064**
27162_27107	0.028	0.036	**0.064**	0.028	0.036	**0.064**
27218_27204	0.028	1.423	**0.064**	0.028	1.423	**1.451**
26859_27111	0.028	0.038	**0.061**	0.028	0.038	**0.067**
11928_12538	0.052	0.993	**0.053**	0.052	0.993	**1.045**
11892_11955	0.044	0.096	**0.048**	0.044	0.096	**0.140**
11953_11954	0.039	0.004	**0.043**	0.039	0.004	**0.043**
24320_24337	0.039	0.179	**0.042**	0.039	0.179	**0.219**
11658_11514	0.005	0.234	**0.041**	0.005	0.234	**0.239**
25955_26075	0.035	0.013	**0.040**	0.035	0.013	**0.048**
25069_25051	0.031	0.009	**0.034**	0.031	0.009	**0.040**
24534_24541	0.031	0.001	**0.032**	0.031	0.001	**0.032**
24541_24547	0.031	0.002	**0.032**	0.031	0.002	**0.033**
24559_24553	0.030	0.001	**0.031**	0.030	0.001	**0.031**
23492_23581	0.029	0.000	**0.030**	0.029	0.000	**0.030**
23893_24095	0.029	0.000	**0.029**	0.029	0.000	**0.029**
24060_23982	0.029	0.044	**0.029**	0.029	0.044	**0.073**
24847_27489		0.037		0.000	0.037	**0.037**
TOTAL	11	26	**37**	8	22	**31**
Above Present	5	11	**16**	2	8	**10**

Table 12a and 13b. The effects of additional wildlife crossings and internal trip capture on panther mortality above present. All values indicate annual mortality at full build-out of HCP proposed developments. Negative values indicate a reduction in mortality from a non-HCP source or from current mortality. Bold and orange cell shading indicates the range expected with currently proposed HCP conservation measures applied. For the purpose of the PVA all values were rounded up to the nearest whole number

		Internal Trip Capture								
		HCP (a)								
		80%	**70%**	**60%**	**50%**	**40%**	**30%**	**20%**	**10%**	**0%**
	0	4.28	6.41	8.55	10.69	12.83	14.97	17.10	23.09	21.38
	5	3.86	5.79	7.72	9.65	11.58	13.51	15.44	20.85	19.30
	8	2.95	4.42	5.89	**7.37**	8.84	10.32	11.79	15.91	14.74
	10	2.75	4.13	5.51	**6.88**	8.26	9.64	11.01	14.87	13.77
	12	1.78	2.68	3.57	**4.46**	5.35	6.25	7.14	9.64	8.92
	15	1.69	2.54	3.38	4.23	5.08	5.92	6.77	9.14	8.46
Additional Wildlife Crossings	**20**	0.89	1.33	1.78	2.22	2.67	3.11	3.56	4.80	4.45
	25	0.69	1.03	1.37	1.72	2.06	2.41	2.75	3.71	3.44
	30	-0.03	-0.05	-0.06	-0.08	-0.10	-0.11	-0.13	-0.17	-0.16
		HCP + Cumulative Effects (b)								
	0	8.92	11.05	13.19	15.33	21.74	22.81	23.88	24.95	26.02
	5	6.36	8.29	10.22	12.15	17.94	18.91	19.88	20.84	21.81
	8	5.41	6.88	8.36	**9.83**	14.25	14.99	15.73	16.46	17.20
	10	4.49	5.87	7.24	**8.62**	12.75	13.44	14.13	14.81	15.50
	12	3.43	4.33	5.22	**6.11**	8.79	9.24	9.68	10.13	10.57
	15	2.33	3.18	4.03	4.87	7.41	7.83	8.25	8.68	9.10
	20	0.93	1.37	1.82	2.26	3.60	3.82	4.04	4.26	4.48
	25	0.40	0.75	1.09	1.44	2.47	2.64	2.81	2.98	3.15
	30	-0.57	-0.58	-0.60	-0.62	-0.66	-0.67	-0.68	-0.69	-0.70

Table 13c. Relationship between acres developed, human population size, daily trips, and panther/vehicle mortality on 91 road segments with existing records of panther/vehicle mortality. This table assumes 50 percent internal capture. For the purpose of the PVA all numbers were rounded to the nearest whole number.

Percent Developed	Acres Developed	Residents Above Present	Dwellings Above Present	Daily Trips From/To HCP Footprint	Daily Trips From/To Non-HCP Areas	2070 Total Daily Trips	HCP Annual PVM Rate Above Present	Non-HCP Annual PVM Rate Above Present	Total Annual PVM Rate Above Present	*Total Annual PVM Rate Above Present	Mortality from other sources	Total Morality
0%	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00
10%	3,997	17,400	9,148	71,799	62,727	134,525	1.07	0.46	1.53	0.98	0.40	1.38
20%	7,995	34,800	18,296	143,597	125,453	269,051	2.14	0.93	3.06	1.97	0.80	2.77
30%	11,992	52,200	27,444	215,396	188,180	403,576	3.20	1.39	4.60	2.95	1.20	4.15
40%	15,989	69,600	36,592	287,195	250,907	538,101	4.27	1.86	6.13	3.93	1.60	5.53
50%	19,987	87,000	45,740	358,994	313,633	672,627	5.34	2.32	7.66	4.92	2.00	6.92
60%	23,984	104,400	54,888	430,792	376,360	807,152	6.41	2.78	9.19	5.90	2.40	8.30
70%	27,981	121,800	64,036	502,591	439,087	941,677	7.48	3.25	10.72	6.88	2.80	9.68
80%	31,978	139,200	73,184	574,390	501,813	1,076,203	8.54	3.71	12.26	7.86	3.20	11.06
90%	35,976	156,600	82,332	646,188	564,540	1,210,728	9.61	4.18	13.79	8.85	3.60	12.45
100%	39,973	174,000	91,480	717,987	627,266	1,345,254	10.68	4.64	15.32	9.83	4.00	13.83

**with 8 additional wildlife crossings*

Habitat Degradation & Other Causes

Process of Estimating Mortality from All Other Causes

In addition to lost carrying capacity, panthers displaced from the developed portions of the Plan Area will be exposed to greater risk of mortality from intra-specific aggression and other lethal/injurious stressors (e.g., traffic on roads), and even where these don't occur competition for limited feeding, breeding, and sheltering resources will likely shorten life expectancy and reproductive output of panthers.

1. 10 percent increase in Housing Density = 6.5 percent increased risk of individual mortality (Moss et al. 2016)
2. 25 percent increase in Housing Density in the Plan Area (39,973 developable acres in the 159,489 acres Plan Area)
3. (0.25/0.10 x 0.065) x 100 = 16.3 percent increase in risk of mortality
4. 16.3 percent increase in risk of mortality x 33.41 Florida panthers = 5.2 panthers/year
5. Correction Factor = only estimating mortality on the likely proportion of new roadways on which Panther Vehicle Mortality hasn't already been estimated (0.413) (Table 14) and causes of mortality without an analog in South Florida (-0.09998) (Table 15).
6. (Correction Factor) x Unadjusted Mortality of Panthers to all other Causes = Adjusted Annual Mortality from all other Causes
7. (0.413-0.09998) x 5.2 = 1.6 additional panthers take/year from all other causes, rounded to 2 panthers taken/year at full buildout

Table 13 Correcting our estimate of panther mortality from all other causes to exclude mortality occurring on roadways on which panther mortality has already been estimated in Section 5.3.1.4

		Proportion of Whole	***Original All-source Mortality Est.***	***Corrected Mortality***
Existing Roads in RLSA	**118 mi.**	**0.587**	**N/A**	**N/A**
Future Estimated Additional Roads in RLSA	**83 mi.**	**0.413**	**2.89**	**2**

Table 14 Correcting our estimate of panther mortality from all other causes by eliminating sources of mortality identified by (1) Moss et al. (2016) but for which there is no analog in South Florida.

Source of Mortality	**Florida Panther N ~ 118 2007-2013**	**Consolidated Source of Mortality**	Florida Panther **Proportion of Population a.**	***Puma concolor*** [1] **N ~119 2007-2013**	Cougar **Proportion of Population b.**	**Correction a-b**
Shot (legally or illegally)	0.710	0.850	0.092	6.533	0.769	**-0.677**
Removal & Euthanasia	0.140					
Disease	1.000	1.000	0.108	0.000	0.000	**0.108**
Wildfire	0.571	0.571	0.062	0.000	0.000	**0.062**

Interspecific Aggression	4.400	4.400	0.475	1.960	0.231	**0.244**
Unknown	2.290	2.290	0.247	0.714	0.084	**0.163**
ANNUAL RATE	9.111	9.111		9.207		**-0.09998**

Cumulative Effects

Motor Vehicle Mortality Associated with Cumulative Effects

Within the Action Area our cumulative effects analysis analyzes the impact of increases in traffic volume from future, non-Federal, non-HCP sources we believe are reasonably certain to occur on the same roadways. Based on our review of past developments in the region we estimate approximately 25.3 percent of future, possible developments are pursued without review by the Service. Thus, we assume that 25.3 percent of traffic volume identified in the D1RPM would likewise originate from developments the Service would not have opportunity to review.

Because the requested duration of the ITPs is 50 years during which we anticipate full build-out, we used estimates of future traffic volumes in the year 2070. Specifically, we analyzed cumulative effects by:

1. Current Road Segment Mortality**:**

Our analysis of panther/vehicle collisions and traffic volume generated from past projects in the Action Area found increasing traffic volume increases impacts to the panther. However, our analysis and literature review also indicate many additional factors aside from traffic volume also influence the probability of panther/vehicle collisions. These include, but are not limited to, the abundance of panthers in proximity to roadways, the availability of suitable panther habitat near roadways, the presence of wildlife crossings, traffic speed, and road width (Schwab and Zandbergen, 2011). We believe the recent history of panther mortalities on a particular road segment is the best available means of integrating the combined influence of all such factors operating along a given roadway. Thus, we predict future annual mortality rates for each road segment in the Action Area will increase as a linear function of traffic volume consistent to that observed by Charry and Jones (2009) and subsequently confirmed by our own analysis of the record of panther vehicle mortality increases in response to increased traffic from a development in the Action Area that is similar to those described in the HCP (Ave Maria).

Vehicle collisions killed 110 panthers on 91 road segments in the Action Area between 2014 and 2018, with 40 percent of all mortalities being females. The 5-year mortality rate on individual road segments varied between 0 and 5 individuals/5 years, with at least one mortality occurring on the segment during the baseline period. Annual mortality for individual road segments is provided in Appendix A.

2. Current Road Segment AADT in Action Area**:**

The current road segment AADTs in the Action Area are an average of AADTs on each road segment from 2014 through 2018, and can be found in Appendix A. The current AADTs for segments within FDOT's District 1 road network vary from 0 to 133,700. Only those segments

in the Action Area with a history of panther mortality were used for calculating future mortality. These segments are identified in the appendix by their Road Segment Identifier. The reason for only including these segments is that the equation for calculating future mortality includes a measure of current mortality.

3. 2040 Road Segment Non-HCP AADT in Action Area:

The 2040 Road Segment non-HCP AADTs in the Action Area as calculated using the Adjusted D1RPM Model can be found in Appendix A. These segments are identified in the appendix by the road segment identifier, which is the concatenated key used in the FDOT traffic model that serves as the bi-directional road segment identifier. The AADT for these segments is the increase in AADT above the current AADT. Only those segments with a history of panther mortality were used for calculating future mortality because the equation for calculating future mortality includes a measure of current mortality. We assumed road segments with existing mortality contained all of the features that would contribute to future mortality, such as the presence of habitat and panthers adjacent to areas of current panther-vehicle collision.

4. 2070 Road Segment Non-HCP AADT in Action Area

The 2070 Road Segment AADTs were estimated because the duration of the ITP, if issued, is 50 years. We estimated the non-HCP generated 2070 AADT per segment (non-HCP sourced traffic volume increase at the time of ITP expiration) by first determining the expected annual rate of traffic increase between current and 2040 per road segment using the following equation:

Expected annual rate of traffic increase per road segment = (2040 Non-HCP AADT per segment – Current AADT per segment) / 22 years.

We then used this rate to estimate the 2070 traffic volumes per road segment due to non-HCP generated traffic by multiplying the rate calculated above by 52 years (the number of years between 2018 and 2070).

5. 2070 Road Segment non-HCP Mortality in the Action Area

We estimate the predicted proportion of future panther mortality due to non-HCP generated traffic on each road segment with a history of panther mortality in the Action Area using the following formula:

2070 Road Segment non-HCP Mortality in Action Area = (Current Road Segment Mortality / Current Road Segment AADT in Action Area) x 2070 Road Segment Non-HCP AADT in Action Area.

2070 Road Segment non-HCP Mortality in the Action Area ranges from .04 to 8, and can be found in Appendix A. These segments are identified in the appendix by "AB Segment"; or simply "AB" in the adjusted D1RPM geospatial data set.

6. 2070 Non-HCP Mortality in the Action Area

To get the total Non-HCP predicted mortality in 2070 we totaled the 2070 mortality per road segment from step 5.

Effects of Conservation Measures on Motor Vehicle Mortality

The following steps were used to determine the reduced number of mortalities expected in the Action Area due to non-HCP generated traffic once the crossings are considered.

(A) Current Panther Mortality on High Mortality Road Segments

We looked at the current road segments and included any road segments that had panther road mortality from 2014 through 2018. We selected the 8 segments with the highest panther mortality to estimate the reduction in mortality from HCP-generated traffic increases if the 8 wildlife crossing the Applicants' funding is expected to facilitate are constructed at either these locations or similarly high mortality road segments in the future. The high mortality road segments with associated panther mortality are found in Table 5-9. Combined, a total of 22 panther mortalities have occurred on these road segments over a 5-year period and mortalities range from .4 to 1 per year on individual road segments.

(B) Current AADT on High Mortality Road Segments

These AADTs are found in Appendix A Table 10a in rows 1 and 3 through 9.

(C) 2070 AADT on High Mortality Road Segment from non-HCP generated Traffic

The 2070 AADTs on High Mortality Road Segment from non-HCP generated traffic was calculated using the Adjusted D1RPM Model and can be found in Appendix A. We calculated the 2070 AADT for all road segments in step 4 above, and the high mortality segments are identified in the appendix by the road segment identifier. The road segment identifier is the concatenated key used in the FDOT traffic model that serves as the bi-directional road segment identifier. Only those segments with a history of panther mortality were used for calculating future mortality because the equation for calculating future mortality includes a measure of current mortality. We assumed road segments with existing mortality contained all of the features that would contribute to future mortality, such as the presence of habitat and panthers adjacent to areas of current panther-vehicle collision.

(D) Future non-HCP Mortality on High Mortality Road Segments

We estimate the predicted proportion of future panther mortality due to non-HCP generated traffic on each road segment with a history of high panther mortality using the following formula:

Future non-HCP Mortality on High Mortality Road Segments = (Current Panther Mortality on High Mortality Road Segments / Current AADT on High Mortality Road Segment) x 2070 AADT on High Mortality Road Segment from non-HCP generated Traffic.

Future non-HCP mortality on high mortality Road Segments ranges from 0.4 to 8, and can be found in Appendix A. These segments are identified in the appendix by the road segment identifier.

(E) Future non-HCP Mortality Reduction on High Mortality Road Segments

To estimate the amount of mortality that is predicted to be reduced along each high mortality road segment when the conservation measure is implemented we assumed 1 crossing with

fencing in each location would reduce mortality by 80 percent (See section 5.2.2.4 for method used to determine 80 percent reduction per crossing) at that location. The following equation was used to determine the reduction at each high mortality road segment:

HCP Mortality Reduction on High Mortality Road Segment = Future HCP Mortality on High Mortality Road Segments x 0.80

The reduction per high mortality road segment is listed in Table 5-9, and in the Appendix.

(F) Future non-HCP Mortality Reduction due to HCP Conservation Measure

To estimate the total reduction in non-HCP mortality after the conservation measure is considered we totaled the reduction in non-HCP mortality at each high mortality road segment. The total reduction in panther mortality expected due to implementation of the 8 wildlife crossings is 4 fewer mortalities per year in the Action Area.

(G) Future Reduced non-HCP Mortality in the Action Area

To estimate total predicted proportion of future panther mortality due to non-HCP generated traffic after implementation of the minimization measure we used the following formula:

Future Reduced non-HCP Mortality in the Action Area = Future non-HCP Mortality in the Action Area – Future non-HCP Mortality Reduction due to HCP Conservation Measure

Population Viability Analysis (PVA)

1. PVA is a widely utilized, species-specific method of structured risk assessment that allows managers to compare the potential effects of different proposed courses of action, and manners of carrying out proposed actions, on the viability of populations over time.

2. Federal agencies, including the Service, regularly use PVAs as a conservation tool.

3. The Service formally trains dozens of biologists annually to perform PVAs using platforms such as Excel, VORTEX, and RAMAS in numerous courses offered through the National Conservation Training Center.

4. PVAs performed on these platforms are regularly published in peer-refereed scientific publications.

5. Recovery criteria for Florida panther are defined by the results of PVAs run in RAMAS GIS (Root, 2004) and VORTEX (Seal and Lacy 1989). PVA also defines the Recovery Criteria for the 68 species covered by the South Florida Multi-Species Recovery Plan. For this reason we analyzed the impact of the ECMSHCP using the same tool and metrics used to analyze threats and needs of listed species across South Florida.

6. A recent PVA is used extensively to defines the status of the species in the current draft Florida Panther Species Status Assessment. Thus, we analyzed the impact of the ECMSHCP on the status of Florida panther using the same PVA, but loaded into a platform that can be more easily replicated by Service-trained biologists (See 3 Above).

7. The parameters used for our PVA are well known, peer-reviewed, and published. Likewise, the model has been tested, published and supported. When we input the demographic parameters estimated by Hostetler et al. (2013), and re-estimated and used by van de Kerk et al. (2019), into the Metapop feature in RAMAS Landscape 6 we were able to reproduce the same results as the authors of the most recent study, accurately predict the population trend represented by the Minimum Annual Count of panthers from 1996 to 2015, and arrive at the same Baseline future probability of extinction previous authors did when genetic information was excluded from the model.

   Additional Assumptions (See Table 16):

   a. The Florida panther population south of the Caloosahatchee River is a closed population (no appreciable immigration or emigration of individuals).
   b. The majority of the Florida panther population will remain south of the Caloosahatchee River.
   c. The Service will maintain the genetic health of the population through translocation when necessary, and in a manner consistent with the recommendations of van der Kerk et al. (2019).
   d. The present Florida panther population is between 120 and 230 adults of both sexes.
   e. The present Florida panther population is at or near average annual carrying capacity (*K*) of habitat south of the Caloosahatchee River. However, it is possible future habitat management may increase carrying capacity to range-wide effect. It is also possible present assumptions about maximum attainable panther densities are wrong. Thus we assume the true *K* could actually be up to 40 percent higher than the present population size.
   f. The current Florida panther population is at a stable age distribution.
   g. Florida panthers are polygynous and the survivorship and reproduction of females are the man influence on population size and growth.
   h. Scramble competition best describes the density dependent effect of individual panthers competing with one another for resources.
   i. All sources of past mortality were captured in the vital rate statistics estimated by van der Kerk et al. (2019).
   j. Sea Level Rise of 1m will occur by 2070 but will not take additional Florida panther habitat beyond that time.
   k. Full build-out of development proposed in the HCP will occur gradually and require the entire 50 year period of the proposed Incidental Take Permit to complete.
   l. New communities will have an average of 50 percent internal trip capture due to the presence of services that limit the need of residents to travel.

m. Impacts of HCP proposed development to panthers will be proportional to the amount of proposed development completed at any given time.
n. Collisions with motor vehicles and other instances of anthropogenic impact will strike individual Florida panthers at a rate relative to the representation of their sex, age, and reproductive status in the population.
o. All development in the HCP footprint will be compact and concentrated away from Florida panther habitat to the maximum extent practicable.
p. There will be no loss of Florida panther preferred habitats in the Preserve Areas.

8. We applied the Effects of the Action by adding them as gradually increasing "Harvests" in RAMAS Landscape. To achieve this, we gradually increased the severity of effects from 0 to the maximum estimated effect across a 50 year time span to simulate gradual buildout of HCP proposed development and accretion of effects to panthers in the Metapop Harvest Function. Specifically, the maximum reduction in Carrying Capacity (K) attributable to habitat loss was 0 at time step (year) 0, and 2 at time step (year) 50 and beyond, with the maximum reduction in individuals accumulating gradually across all time steps until the maximum of 2 was reached in year 50.

9. We constrained the Effects of the Action on Florida panthers by the abundance of Florida panthers. For example, when there are fewer panthers there are fewer panther/vehicle collisions, and when there are more panthers there are more panther/vehicle collisions. The regression of panther/vehicle collisions and Population Size (N) established a density-dependent limit on how many panthers could be taken from the Effects of the Action at any given N (Figures 2 & 3). Constraints were both time limited (see above) and N limited, with constraints on maximum possible mortality at any given time interval being input in the Change In Harvest from N_{Min}/to N_{Max} feature of the Harvest Function in RAMAS Metapop.

10. Values for Minimum and Maximum Panther/vehicle mortality when N=X, where X=PVM, were constant. For example, whether the population between 1995 and 2015 was 26 to 149 panthers (counted by McBride) or actually represented a growth of 40 to 230 adults over the same period, the Minimum and Maximum panther/vehicle mortalities allowable in the PVA were the same.

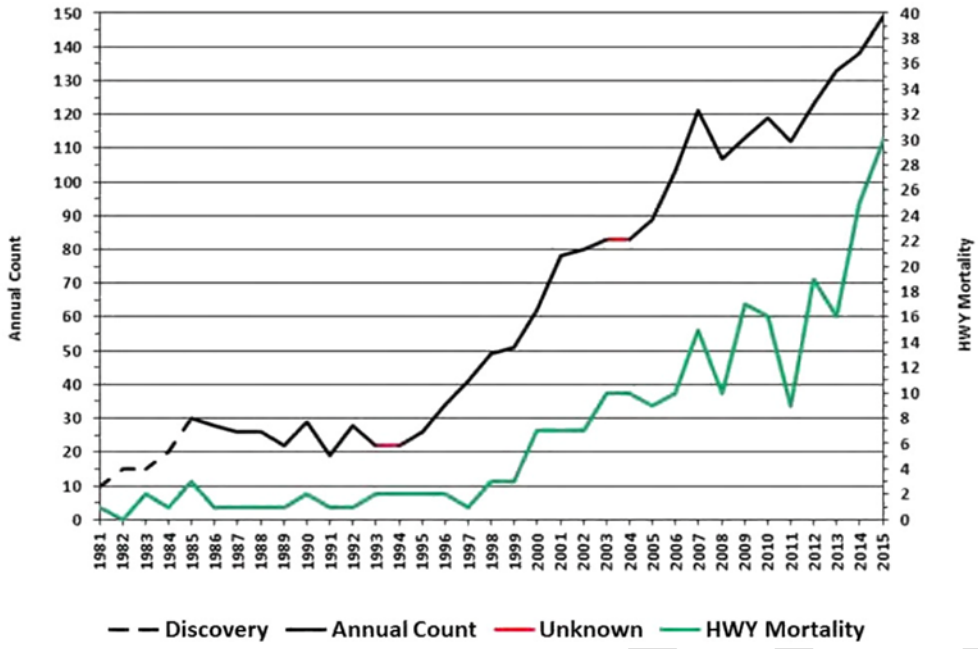

Figure 2 McBride Count and Panther/Vehicle Mortality over time

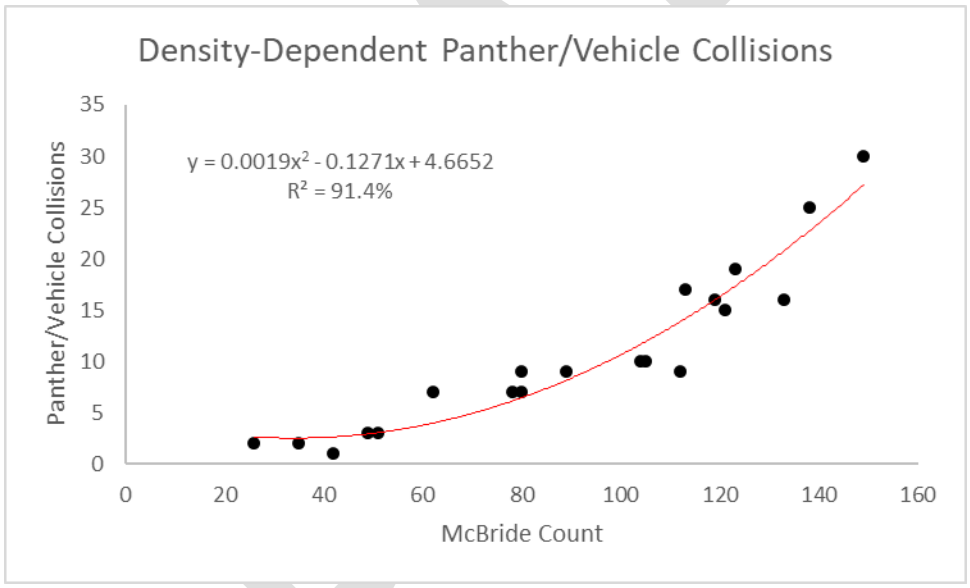

Figure 3 Regression used to scale maximum-possible panther/vehicle collisions at N = X.

11. Each scenario incorporated demographic and environmental stochasticity (random change from year to year) by allowing for the random selection of demographic values and carrying capacity (K) values within 1 standard deviation of the parameter estimate, and within 1 standard deviation of the maximum carrying capacity of the system as defined in the model.

12. Different scenarios were run to account for a range of possible actual initial population sizes (N_0 ranging between 120 – 230 adults) and carrying capacities (N_0=K_0, N_0=80 percent of K_0, and N_0 = 60 percent of K_0), and every possible combination of these.

13. Each scenario (N_0, K_0, and Effects) (Baseline + SLR, Baseline + SLR + HCP, & Baseline + SLR + HCP + CE) was run for at least 100 iterations for a duration of 150 years (time span of the proposed Incidental Take Permit + 100 years). Each combination was also repeated at least 3 times with different possible values for R_{max} (the maximum rate at which the population can grow when it is small).

14. Each scenario was saved in the Service's Administrative Record, and relevant outputs transcribed to a spreadsheet also retained in the Administrative Record. Results of each PVA permutation were analyzed statistically as described in Section 5.5.

Table 15 PVA information.

PVA Inputs
Software: Ramas Landscape 6
Replications: 100
Duration: 150 time steps
One time step = 1 year
Population (120-230), Only Females (60-115)
Three Stages: Juvenile, Adult, and Old Adult @ Stable Age Distribution
Demographic Stochasticity is in effect, 1 SD of input values
Environmental stochasticity distribution is Lognormal
Extinction threshold for metapopulation: 10
Density Dependence Type: Scramble
2018 Abundance[1] (N_0) = 60, 88, 115 Females
2018 Carrying Capacity Remaining[2] ((K-N)/K) = 0.0 0.2, and 0.4 of N_0
Standard Deviation of K: 1.0
Relative fecundity = 1
R_{max} = 1.02,1.04,1.06
Habitat Loss from 1m Sea Level Rise (SLR) by 2070: 18%
***Demographic Inputs* (der Kerk et al (2019))**
Survival
Female Subadult 0.97 ± 0.02
Prime adult 0.86 + 0.03
Old adult 0.78 ± 0.09
Probability of Reproduction
Female Subadult 0.35 ± 0.08
Prime adult 0.50 ± 0.05
Old adult 0.25 ± 0.06
Kittens Produced Annually
Female Subadult 2.80 ± 0.05
Prime adult 2.67 ± 0.01
Old adult 2.28 ± 0.13

1. *Our past scenarios only included the minimum likely N_0 of 120 adult panthers (60 females). We've since expanded our analysis to include the full range of possible current population sizes estimated by FWC (120-230 individuals).*
2. *Our past PVA only utilized $N_0 = K_0$ and $N_0 = 80$ percent of K_0. Our current PVA incorporates scenarios where N_0 may equal 60, 80, and 100 percent of K_0.*