MEASUREMENT PROBLEMS AND FLORIDA PANTHER MODELS
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MEASUREMENT PROBLEMS AND FLORIDA PANTHER MODELS
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ABSTRACT
Conservation planning is only as good as the science on which it relies. This paper evaluates the science underlying the least-cost-path model, developed by Meegan and Maehr (2002) , for the Florida panther, Puma concolor coryi. It also assesses the resulting claim that private lands in central Florida are desirable for panther colonization (Maehr et al. 2002a , p. 187; Maehr 2001 , pp. 3–4; Maehr and Deason 2002 , p. 400). The paper argues that panther conservation planning, as proposed by Maehr, is flawed because of its (1) poor analysis of panther-habitat requirements, owing largely to use of only daytime telemetry, a black-box model, and failure to take account of spatial and temporal uncertainties; (2) use of stipulative and misleading definitions of key biological terms, such as “forest obligate” and panther “dispersal”; (3) employment of question-begging value judgments to rank habitat; (4) weak testing of the model; (5) inconsistency in evaluation of forest habitat; (6) inconsistency in evaluation of agricultural lands; and (7) inconsistency in assessing effects of highways on panther habitat.

INTRODUCTION Return to TOC
In a recent paper in Southeastern Naturalist, Meegan and Maehr (2002) develop (what they call) a “dispersal model” for the Florida panther (Puma concolor coryi). Their article relies in part on an extension and amendment of some habitat-use conclusions given in Maehr and Cox (1995) . Using a narrow definition of suitable habitat, as well as a least-cost-path model for which they give no rules, Meegan and Maehr (2002, p. 218) conclude that “development has eliminated most native habitat” of the Florida panther, and conservationists must plan “conduits for expansion of the current [panther] population” and for new colonization into “potential panther habitat” in central Florida. They say lands south of the Caloosahatchee River (where all known panther breeding in the wild currently takes place) are likely “insufficient to support a viable panther population that can survive” (Meegan and Maehr 2002 , pp. 228).
The purpose of this paper is to assess the rigor and objectivity of the science underlying Meegan's and Maehr's (2002) least-cost-path model for the Florida panther; to determine whether this model relies on defensible empirical methods; and to evaluate whether the model can support claims that low-intensity private lands in central Florida are desirable for panther colonization, as they claim (Maehr et al. 2002a , p. 187; Maehr 2001 , pp. 3–4; Maehr and Deason 2002 , p. 400). This paper argues, however, that because their analysis suffers from at least 7 flaws, panther managers should not rely on the Maehr model. Managers need to be wary of continued development in south Florida, the panther's only current habitat, and they ought not assume that a corridor to unvalidated

habitat in central Florida is sufficient to protect the endangered subspecies.

The Florida panther

The Florida panther is a subspecies of cougar or mountain lion. Although once present throughout the U.S., cougars are now extinct east of the Mississippi, except for a small population in the southern tip of Florida. A federally endangered and umbrella subspecies, the Florida panther is an important component of the south Florida ecosystem. It has been monitored with radiotelemetry collars since 1981, and in 1995 several Texas panthers were introduced to help address the problem of inbreeding depression. Nevertheless, only about 80 panthers, perhaps including < 20 breeding females, remain in south Florida, mostly on public land (Comiskey et al. 2002 ; Land et al. 2002 ; McBride 2001 , 2002 ; Seal and Lacy 1989 , pp. 62–63, 69, 106).

The only current home of the Florida panther, south Florida, is a flat and often-wet landscape stretching from Lake Okeechobee south to Florida Bay, and from the Gulf of Mexico to the Atlantic Ocean. Most of the panthers are on public lands that include Big Cypress National Preserve, Everglades National Park, Fakahatchee Strand State Preserve, and Florida Panther National Wildlife Refuge (Maehr and Cox 1995). Both preservation of this current, south-Florida habitat, as well as investigation of possible panther expansion into additional areas, are essential to Florida panther management.

Predicting Florida panther dispersal, however, requires an accurate understanding of its habitat. The earliest habitat studies appeared more than a decade ago (e.g., Maehr 1990 , Maehr and Cox 1995) and emphasized the importance of forest as preferred panther habitat (Maehr 1997 , 2001 ; Maehr and Deason 2002 ; Maehr and Lacy 2002 ; Maehr et al. 2002a ,b). These studies were based on analyses of radio-collared panther locations, with respect to digital maps of vegetation and roads, as determined from fixed-wing aircraft. The authors concluded (a) that 96 percent of their panther radio locations occurred either within, or within 90 meters of, a preferred “forest” cover type, and that panthers were reluctant to cross non-forested areas (Maehr and Cox 1995 , p. 1014), (b) that “preferred” panther habitat was hardwood hammock and, to a lesser degree, cypress swamp (Maehr and Cox 1995 , pp. 1012–1013), and (c) that grasslands, shrub, brush, mangrove swamp, freshwater marshes, and water were “avoided” Florida panther habitat (Maehr and Cox 1995 , pp. 1012–13). This emphasis on forests and the rejection of wet or marshy areas (as panther habitat) led the authors to claim that the Everglades is too wet for panthers (Maehr 1997), and forest is their “only vital habitat” (Maehr 1997 , 2001 ; Maehr and Lacy 2002). Such habitat claims are scientifically questionable in at least 7 respects.

Habitat claims underlying the Maehr model

All of Maehr's panther analyses rely only on daytime telemetry for this nocturnal animal and fail to take account of spatial uncertainty in radiotelemetry and vegetation maps (Comiskey et al. 2002 ; see Meegan and Maehr 2002 , pp. 217, 221, 223, 226, 227; see also Maehr and Deason 2002). The failure of Meegan and Maehr (2002) to take account of spatial uncertainty in their least-cost-path model is particularly disturbing, given that Belden et al. (1988) , Dees et al. (2001) , and Janis and Clark (2002) , all provided estimates of telemetry error for the radio locations of Florida panthers, and they used the same radio-telemetry methods that Maehr used. Years before Maehr's 1991 and 1995 papers, Belden et al. (1988) provided a telemetry-error estimate of 230 m. However, Maehr and his coauthors appear to have repeatedly ignored this work. They have provided no uncertainty bounds on their telemetry points, and they have ignored the complete set of land-cover types within a circle (of 230 m radius) around any telemetry point. Instead they have focused on the fact that panther-telemetry locations were within 90 m of forests, a distance that is smaller than the spatial error associated with telemetry locations. As a result, Maehr may have overemphasized the importance of forest as panther habitat and

biased his landscape rankings, in part because he ignored other land-cover types within the relevant circles. The difficulty is that Maehr ignores not only (what appears to be more reliable) work of other scientists but also spatial uncertainties, which may have led to inadequately supported conclusions about panther preferences for forests. Moreover, Maehr and Cox (1995) and Kerkhoff et al. (2000) fail even to mention the fact that all their telemetry data were taken from morning-only locations.

Maehr and Cox (1995) , on which Meegan and Maehr (2002) is based, likewise failed even to mention the fact that they excluded 40% of panthers from their analysis (see Comiskey et al. 2002). Yet their map and description of the study area suggest to the reader that they used all animals. The only hints that Maehr and Cox (1995) excluded available data were two. First, on p. 1010, they claim to have used an “average of 382 locations for each of 23 panthers.” But this gives 8,786 locations, not the 14,548 locations they refer to in both the abstract and methods section. Second, they compared panther locations to 8500 random locations, a number close to 8,786, not 14,548. Maehr and Cox (1995) used many points south of I-75 only as available points and assumed they were not already used by the panther, but some of these points actually were used by panthers during the period of study. They further compared panther locations to those in “available” habitat by selecting the 8500 random points from an area extending 40 km beyond all panther locations used in the analysis, a method that resulted in the inclusion of some areas beyond the geographic range of the panther. Maehr and Cox (1995) thus compare the locations used by a subset of panthers to a set of “available” points that includes not only areas beyond the known range of the panther, but also areas used by panthers that were excluded from the analysis. Finally, for Maehr and Cox to treat 8,500 panther locations as statistically independent was inappropriate for their chi-square and regression analyses.

Maehr and Cox (1995) also originated the claim that forest patches larger than 500 ha are important. Yet this claim is based on a flawed analysis. The claim appears in the discussion section but is never mentioned in the methods section. Instead Maehr and Cox (1995) said, in the discussion, both that a linear regression of patch size showed panther occupancy was more likely in patch sizes > 500 ha, and that only 25% of panther locations were in patches < 500 ha. They then concluded that patches of 500 ha were likely needed for frequent panther occupation. Like other questionable analyses in Maehr and Cox (1995) , this regression appears to have treated each location as an independent observation, suggesting the authors provided a replication. Yet no genuine replication occurred, given the dependence among the data. The regression result probably reflects only the fact that, all things being equal, large patches, like large quadrats, contain more of what is observed. The fact that 25% of the Maehr and Cox (1995) panther locations occurred in patches < 500 ha could reflect factors like aversion, indifference, or preference for patches of some size. And all of these factors depend on the available pool of such patches to each radio-tagged panther. Yet Maehr and Cox (1995) do not compare use and availability of patch sizes. Despite such problems, Maehr and Deason (2002) use the 500-ha threshold as the basis for much of their panther-habitat evaluation model (PHEM) (based on Maehr and Cox 1995).

A team of panther modelers and field biologists, using the full set of available telemetry data to investigate panther habitat use and dispersal patterns (Comiskey et al. 2002), have challenged Maehr's forest-centered paradigm of panther habitat use. They documented deficiencies in previous habitat-selection studies (Kerkhoff et al. 2000 , Maehr and Cox 1995), including unacknowledged data omissions, spatial and temporal errors, sampling biases, unsupported assumptions, misinterpretations of demographic patterns, failure to take account of uncertainties, and the suite of errors associated with assuming representativeness of daytime telemetry to describe 24-hour panther-habitat use

(Comiskey et al. 2002). They also argued that ranking habitats as “preferred” and “avoided” by Florida panthers, based on telemetry recording only the animals' day-use (or resting) activities, was unfounded and failed to take account of non-resting panther activities (Comiskey et al. 2002). Instead, the critics of Maehr's habitat studies supported their observations by analyses of home ranges delineated by telemetry and by a series of field reports that stressed the importance to panthers of the mosaic of habitats that make up panther home ranges in south Florida (Land et al. 2002 ; McBride 2000 , 2001 , 2002). Using a more ecologically-based approach to habitat protection, one focused on broad habitat requirements to support the entire life-cycle needs of inter-connected panther breeding groups, Comiskey et al. (2002) , Slack (2001 , 2002) , and other critics of Maehr recognize that Florida panther habitat entails much more than just resting spots or certain kinds and amounts of undeveloped land. It entails, among other things, the circumstances to maximize effective population size, to facilitate natural social behaviors, and to minimize the adverse effects of extrinsic forces (Shrader-Frechette and McCoy 1993 , pp. 213–214). Yet Meegan and Maehr (2002) ignored these criticisms of their approaches.

Although these problems with panther-habitat studies have been carefully documented and analyzed, notably by Comiskey et al. (2002 ; Slack 2001 , 2002) , Maehr and his coauthors have ignored these criticisms. They trimmed their daytime telemetry data by looking only at panthers wearing collars and living north of I-75 (Maehr and Cox 1995 , p. 1010), that is, only 1/3 to 1/4 of the total Florida panther population. Yet they did not reveal how limited their data were (Comiskey 2002 ; see also Land et al. 2002 , pp. 48–53). Ignoring these critiques, Meegan and Maehr (2002) continued to rely on the habitat definitions presented in their earlier papers. They compared central Florida (north of the Caloosahatchee River) and south Florida (south of the river) as panther habitats, then noted that south Florida has many public lands and hydrology that “precludes human development” (Meegan and Maehr 2002 , p. 218), while central Florida has “predominately private ownership where citrus and cattle production are significant land uses” (Meegan and Maehr 2002 , p. 218). Yet they claimed that the patchy private lands of central Florida have “higher-quality panther habitat” than the largely uninhabited public lands of south Florida (Meegan and Maehr 2002 , p. 218), where the panther now lives. Their only apparent reason for this comparative judgment of habitat quality was that there are more forests in central Florida. Yet this claim is doubtful, given their failure (1) to answer criticisms of their black-box panther-habitat model; (2) to substantiate their forest-centered view (Meegan and Maehr 2002 , p. 226); (3) to take account of the fact that panthers arguably utilize mainly forests with the requisite understory (Comiskey et al. 2002); (4) to explain why panthers have survived in south, not central, Florida, and (5) to explain why central Florida is a better habitat, given its greater human disturbance. If Maehr and his coauthors have not addressed problems (1) – (5), it is hard to see how they can convincingly substantiate their least-cost-path model that relies on their forest-habitat claims.

Subjective redefinitions of standard scientific terms

The Meegan and Maehr (2002) model also relies on misleading redefinitions of standard scientific terms. Hence, the scientific theory used to support their arguments (about least-cost-path analysis) does not make logical contact with the changed scientific terminology they employ. Consider three examples of this problem in Meegan and Maehr (2002) : the use of “obligate,” panther “dispersal,” and habitat “support.”

Meegan and Maehr (2002, p. 221) characterize the Florida panther as having a “tendency as a terrestrial forest obligate.” Their language suggests the standard biological definition of “obligate” as limited to a certain definition of life, a “factor that must be present in order for the organism to survive”

(Calow 1999, p. 88), just as hosts must be present for parasites to survive, for example. Thus, according to this standard biological definition, a “forest obligate” would be an organism for which forests are necessary for survival. Yet Meegan and Maehr confuse necessary and sufficient conditions because, at other times, Maehr suggests that forests alone are sufficient for panther survival. When Maehr evaluated south-Florida lands, for developers who wished to purchase panther habitat, he assigned value only to forest land (Slack 2002 , p. 8) and thus suggested that forests were both necessary and sufficient for panther habitat. On the one hand, Maehr's use of the term “forest obligate” (in assessing south Florida lands for developers) suggests that the Florida panther is limited to forest habitat, which he takes as sufficient for its survival. On the other hand, his claim, that forest is the panther's “only vital habitat” (Maehr 1997 , 2001 ; Maehr and Lacy 2002) suggests that forest habitat is merely necessary, not sufficient, for panther survival. Such language both confuses necessary and sufficient conditions and misleads the reader about the temporal and spatial biases resulting from the authors' ignoring non-forested habitats, non-resting habitats, and the understory that is essential to resting use of forests. The “forest obligate” language also is not warranted because many panthers live in south Florida landscapes dominated by habitat mosaics of non-forested wetlands and grasslands.

The “forest obligate” language likewise is inconsistent with the authors' own language in the same article, (1) because they admit panthers traverse nonforested areas, especially at night (Meegan and Maehr 2002 , p. 222); (2) because the authors themselves both admit that panthers use nonforested rangelands and wetlands, and they assign these rangelands and wetlands a habitat value, in terms of panther movement, of 2 (on a scale of 1 to 3 that goes from least-resistant to most-resistant), after admitting that panthers use them (Meegan and Maehr 2002 , p. 222); (3) because they claim that “prairie, low intensity agriculture, and pasture” are “compatible matrix habitats” (Meegan and Maehr 2002 , p. 224); (4) because the authors say that panthers are “tolerant of sparse forest cover” (Meegan and Maehr 2002 , p. 226); and (5) because they say some panthers do not view “open habitat as movement barriers” (Meegan and Maehr 2002 , p. 227). Given these 5 admissions, it is unclear why the authors claim the panther tends to be a “forest obligate” and why Maehr argues (see next two sections) that developers should pay panther-mitigation costs only for the forested parts of panther habitats they develop. In any case, the authors are using “forest obligate” in a nonstandard, misleading way that may implicitly contradict other claims in their own papers.

Misleading use of language also may occur when Maehr and his coauthor claim 4 Florida panthers “dispersed” across the Caloosahatchee River, into central Florida (Meegan and Maehr 2002 , pp. 219, 221, 222, 227), and that they are examining “dispersal behavior” into this central-Florida region (Meegan and Maehr 2002 , p. 221). Their claims about “dispersal” suggest they are examining natural colonization, but in reality they are trying to develop a least-cost-path model. Their claims also suggest they are discussing panther habitat, but in reality they are discussing land that is a panther conduit. Also, successful panther dispersal requires breeding. Because none of the 4 panthers who ventured into the patchy, human-occupied, central-Florida lands are documented as breeding there, their wanderings appear characteristic merely of transient males in search of a mate. Maehr's repeated claims about his “dispersal model” (really a “least-cost-path model”) and about central-Florida “dispersion” of the panther (Meegan and Maehr 2002 , pp. 217–219, 221–223, 225–228) are at least potentially misleading because only on the conclusion page of their article do Meegan and Maehr (2002, p. 229) mention “successful dispersal.” On all previous pages, what they call “dispersal” is really unsuccessful dispersal in that the dispersing males failed to find mates. In Meegan and Maehr (2002) they never acknowledge that central Florida “dispersal,”

which they discussed in the previous 11 pages, was not “successful,” although this admission was made clearly in another article (Maehr et al. 2002a). Similarly, their use of the term “dispersal model” to refer to a least-cost-path analysis from a predetermined panther source, to a panther dispersal destination (Meegan and Maehr 2002 , p. 222), may be misleading. As thus used, their alleged “dispersal model” does not refer to biologically preferred panther habitat, used for dispersal, but instead to land that is the “least resistant,” or has the fewest barriers, given a panther source and a dispersal destination. In describing their model, Meegan and Maehr (2002, p. 227) speak of “rules that have emerged out of two decades of research,” but they never give these “rules” anywhere and thus have only a black-box model. As such, one wonders how Meegan and Maehr (2002) can speak of a “dispersal model,” in a whole section of that name (pp. 225–226), when they do not provide any rules on which the model is based.

Questionable use of language likewise occurs when the authors claim that central Florida “has supported other panthers” (Meegan and Maehr 2002 , p. 222). The word “support” is peculiar, given that the 4 panthers (already mentioned) merely crossed there in their wanderings. Moreover, how can a particular habitat “support” panthers if it does not support females and breeding? The authors' language again appears to claim greater benefits for central-Florida forests than the actual evidence seems to bear. The panther obviously needs both protection of its current, south-Florida habitat and additional habitat. The difficulty is that Maehr has not scientifically established that central Florida is the best place to meet the second goal. Moreover, implementing Maehr's least-cost-path model may thwart the first goal, preservation of south Florida panther habitat, if managers allow south Florida development in the hope that untested, central-Florida habitat is sufficient to protect the panther (see last two paper sections). What is needed, to guide management decisions, is a rigorous analysis of panther habitat, dispersal, and least-cost-path models.

No rigorous analyses supporting the least-cost-path model

Although Meegan and Maehr (2002, p. 221) claim that their model is based on 51,861 panther telemetry locations, they do not state any methods used to evaluate these locations. Nor do they state any results linked specifically to these 51,861 locations. Without a single sentence describing their methods and without any tables (and only one sentence) describing their analysis of these 51,861 locations, they qualitatively rank habitats, as least resistant to panther movement, on a scale of 1 to 3. The previous section discussed the biologically problematic, qualitative claim that central Florida was “higher quality panther habitat” than south Florida, despite its being more fragmented, having more private lands, and having more human intrusion (Meegan and Maehr 2002 , p. 222). Similar question-begging, qualitative, and subjective judgments occur when the authors rank habitats for panther movement, on a scale of 1 (least-resistant), 2, or 3 (most-resistant), based merely on whether the land is forest (1); agricultural land, rangeland, or herbaceous wetland (2); or nonforested land having other uses (3). This subjective ranking is questionable, in part, because the primacy given to forests is based only on daytime telemetry and only on panthers north of I-75, as Comiskey et al. (2002) pointed out. Also forests, as such, may be of little value to panthers unless they have the required understory, such as saw palmetto (Serenoa repens), that panthers use for breeding and sheltering. Besides, the authors themselves admit that panthers use all 3 (forest, agricultural, nonforest) land types (Meegan and Maehr 2002 , p. 222). They specifically claim that type-3 land is “rarely used” by the panther. But how much is “rarely used”? What are the statistical parameters? And what is the significance of “rarely used,” given the spatial and temporal biases (one-third of panthers surveyed, only during daytime) in habitat definitions, already noted earlier? None of these questions is addressed in Meegan and Maehr (2002) .

A related difficulty is that the authors tested their least-cost analysis by means of only 3 panthers who, in 1998–2000, ventured into central Florida, north of the Caloosahatchee River (Meegan and Maehr 2002 , p. 218). Yet 76 panthers did not venture out of south Florida, into the fragmented, humanly-disturbed, largely private lands of central Florida. Not only is a “test” based on 3 animals quite small, but presumably many different models could be consistent with such a small data set.

Inconsistent evaluations of roads and agricultural land

A final set of problems with this panther model is that it employs inconsistent treatment of the same data, especially with respect to roads, agricultural lands, and forests. As was argued earlier, the authors may be inconsistent in their claims (a) that the panther has a “tendency as a terrestrial forest obligate” (Maehr 2001 , 1997 ; Maehr and Lacy 2002); (b) that developers need to mitigate only the forested part of panther habitat that they take; and (c) that panthers use other types of habitat (see next section).

Similar problems occur in the treatment of roads in the Maehr model. Meegan and Maehr (2002, p. 221) claim that “roads cause forest fragmentation,” and the panther avoids roads and fragmented forests (Meegan and Maehr 2002 , p. 221). Yet, without explanation of the apparent inconsistency, they rank road-rich, barrier-rich central Florida as a more desirable panther habitat than more barrier-free and more road-free south Florida, the only current range of the Florida panther. At a minimum, the authors need detailed, quantitative arguments as to why other central-Florida advantages offset the apparent disadvantages of the many central-Florida roads. In the absence of such an analysis, one can only conclude that their proposing central-Florida colonization appears based on implicit and unstated assumptions. This is especially disturbing because since 1999, nearly 10 percent of the total documented population of Florida panthers has been killed annually on Florida highways (Land et al. 2002).

Similar inconsistencies occur in the treatment of agricultural lands. On the one hand, Meegan and Maehr (2002) give agricultural and range land a value of “2,” on a scale of 1 through 3 (where 1 is highest, and 3 is lowest) for the quality of Florida-panther movement that this land type permits (Meegan and Maehr 2002 , p. 222). When Maehr assessed agricultural lands in Florida, proposed by developers to mitigate panther-habitat losses in south Florida, Maehr assigned them positive value as panther habitat (see Slack 2002 , Agripartners 2001). On the other hand, when Maehr assessed current panther habitat value, as a consultant for western Everglades developers, he inconsistently assigned no value whatsoever to “agricultural land” used by the panther for hunting prey and assigned value only to forest land (Slack 2002 , p. 8). As a result of Maehr's inconsistent scientific claims (valuable for mitigation, not valuable for habitat) about agricultural land, developers were able to obtain permits to develop panther habitat in south Florida, yet they had to pay mitigation only for the small forested portion of panther habitat they bought (Slack 2002 , pp. 8–10; see Agripartners 2001). How could the same type of land have both positive and negative value as panther habitat? If the same type of land is good enough for panther mitigation, then why is it not good enough for panther habitat in the first place? Similarly, in their model Meegan and Maehr (2002, p. 222) require non-forested “buffer” land “that may be important to panthers, panther prey, or panther travel.” Yet when Maehr provided analysis to support Florida Rock Industries' successfully permitting more than 6000 ha of western Everglades panther habitat, in February 2003, he denied the need for any buffer or easement. Instead Maehr argued that the developer should be responsible for “impacts to panther habitat (forested cover types only)” (Slack 2002 , p. 8; Agripartners 2001). Such apparent inconsistencies lead one to doubt the science on which the Maehr model rests.

Practical consequences of panther management using poor science

If the science underlying the Maehr model is questionable, then it ought not be

used in habitat-mitigation decisions. Yet it has been used repeatedly. In the Daniels Road extension and development case (Corps Permit No. 199130802), impacts to the Florida panther were assessed for a 2000 ha project area in western Everglades. The U.S. Fish and Wildlife Service requested compensation of 252 ha and a wildlife highway underpass, but Maehr's testimony enabled developers both to avoid building the underpass and to avoid paying additional compensation for loss of Florida panther habitat (Maehr 2001 , pp.1, 6; Slack 2001). Yet in the recent article in the Southeastern Naturalist, Maehr (who as a consultant defended the Daniels highway construction) argued against roads and other “disturbances that limit use by Puma concolor.” He said roads and urban areas are fragmenting panther habitat that would “otherwise be preferred habitat” (Meegan and Maehr 2002 , p. 221), and claimed that “potential [panther] crossing zones can be enhanced with highway underpasses, a technique that appears to reduce local panther mortality” (Meegan and Maehr 2002 , p. 226). Maehr likewise has testified for many other successful development projects in western Everglades. He argued, for example, that although a developer was receiving permits affecting more than 6,000 acres of western Everglades panther habitat (Slack, 2002 , p. 8), the developer should pay for panther mitigation for only the 82 acres of forested wetlands, only about 1% of the total acreage impacted (Slack, 2002 , p. 8–10).

It seems inappropriate for Maehr to argue against the suitability of south Florida habitat, the only current panther habitat, in part on grounds that it is being developed, while his testimony and panther models promote this very development. If there is reason to question Maehr's basic panther science and models, there also are grounds for questioning their use in allowing permitting and development of current, western Everglades (south Florida) panther habitat. Maehr (1990) admits that development of western Everglades habitat, in turn, is putting pressure on the panther for expansion into areas such as the forests of central Florida. Currently, U.S. taxpayers are spending $ 8 billion to restore the eastern Everglades. Yet, since 1993, the U.S. Army Corps of Engineers (ACE) and the U.S. Fish and Wildlife Service (FWS) have turned down no permits for developing the Florida panther's only current habitat in the western Everglades of south Florida. As a result, the ACE and FWS have given permits to develop more than 60,000 acres of southwest Florida panther habitat. This successful permitting is occurring in part because it relies on Maehr's scientifically flawed claims that denying these permits is not necessary to protect the panther's only existing habitat, and that better habitat lies elsewhere (Agripartners 2001 , p. 11; Maehr 1997 , 2001 ; Maehr and Lacy 2002 ; Slack 2002).

CONCLUSION Return to TOC

If the seven arguments discussed earlier are right, then although central Florida pine forests may be potential panther habitat, nevertheless Maehr and his coauthors have not given quantitative, unbiased, consistent, empirical arguments for this claim. Their flawed assumptions, questionable measurement methods, and incomplete data cast doubt on their conclusions. They rely on unsubstantiated, forest-centered definitions of panther habitat. Yet, as Comiskey et al. (2002) show, these definitions fail because of spatial, temporal, and resolution biases that look at only part of the panther population; that ignore the importance of the forest understory; and that minimize the significance of the patchy south Florida landscape. Meegan's and Maehr's (2002) model also relies on stipulative and misleading uses of key biological terms, such as “forest obligate” and panther “dispersal.” They likewise employ question-begging value judgments, instead of rigorous analyses, to support their model rankings. Maehr and his coauthors also are inconsistent in their evaluations of forests, agricultural lands, and highways. Given these

difficulties, panther managers should not use the Maehr model to allow permitting of the panther's only current, tested, south Florida habitat, and they should not assume that a corridor to untested habitat in central Florida is sufficient to protect the panther. Panther dispersal and colonization in central Florida is desirable and may be possible, but the Meegan and Maehr (2002) least-cost-path model provides inadequate scientific warrant for doing so. Indeed, if Maehr's arguments against south Florida panther habitat (such as too few large forests) are correct, they also could be used against central-Florida panther habitat.

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