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A Flawed USGS Report on Giant Constrictors

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The basis for the action to place the great constrictors and the boa constrictor on the Injurious Wildlife List of the Lacey Act is a report issued by the United States Geological Survey (USGS) titled *Giant Constrictors: Biological and Management Profiles and an Establishment Risk assessment for Nine Large Species of Pythons, Anacondas, and the Boa Constrictor*. This 302-page report was authored by Robert N. Reed and Gordon H. Rodda, biologists employed by the Invasive Species Programs of the USGS; it was issued in December 2009.

The report has been touted as the scientific foundation supporting the controversial hypothesis that the eight large constrictor species and boa constrictor might establish in the continental United States outside of South Florida to become undesirable and invasive exotic wildlife. However, the recent cold weather of the first two weeks of 2010 in the American Southeast and particularly in Florida has illustrated a serious flaw in a fundamental assumption made by the authors, an assumption on which all of the science in the report is based.

Most simply stated, the USGS report is wrong. The report grossly exaggerates the areas in the USA identified as suitable climate for each of the nine species. None of the species can survive in nature in the U.S. mainland outside of the Everglades region of South Florida. The above-mentioned Florida cold snap and the resulting python deaths call into question whether even Burmese pythons are permanently established in the Everglades region.

A Freezing Dose of Reality

During the first two weeks of 2010 an arctic front crashed into the southeastern United States with a cold fury. Temperatures throughout most of Florida were well below freezing. In South Florida, the cold took most of the citrus crop, crashed the tropical fish industry, and badly damaged tilapia aquaculture. Palms and cycads died from the cold. Coral reefs died in shallow Florida Bay. Dozens of manatees and American crocodiles died. Iguanas fell frozen from the trees. During January 2–13, South Florida was colder than it had been in decades. This was a perfect test of the conclusions of the USGS report.

But this was by no means the only cold weather ever to hit Florida. This was not a fluke. Based on data from the National Weather Service, this is a fairly regular occurrence. During the January freeze, Miami experienced an official low temperature of 35°F, but it was just as cold in 1970, and even colder on three previous dates, dating back to 1898. In south Dade County, it was 26°F at the Tamiami Airport on January 11, but it had been that cold there before, in 1940.

West Palm Beach and Naples set records with 10 consecutive days under 45°. Miami and Fort Lauderdale had 10 consecutive days with temperatures below 50°, but the historic record stretch is 13 days. Throughout South Florida, this was the longest uninterrupted period of cold weather since 1940, but in Miami only two records for daily low temperatures were set in that period. Record lows for each date of the first two weeks of January were set in 1898, 1903, 1918, 1919, 1927, 1970, 1981, 1982 and 1997. There are other periods of extreme cold in December and in February scattered back through time. South Florida may be the warmest winter spot in the continental United States, but it gets cold on a fairly regular basis.

It took this hard freeze in Florida to drive home the truth that biologists, keepers, and herpetologists have been stating over and over—the nine species cannot survive in the continental USA. Perhaps the Everglades region is the exception, but elsewhere it's too cold. There is no adequate shelter. The snakes do not have the necessary instincts and behaviors necessary to survive fatal cold.

The Burmese pythons in South Florida froze, and Burmese pythons are the most cold-tolerant of all the nine species. They didn't all freeze; some survived. But if they died in the Everglades at 35°F, there is justifiable skepticism that, as predicted in this USGS report, they could survive in Oklahoma—where it was 5°F with two feet of snow. Even in South Texas, during the January cold spell, the days were 35° and the nights got down to the teens for over a week—those are fatal temperatures for every one of the nine species.

None of the nine species featured in the USGS report will establish in nature in the U.S. mainland outside of the Everglades region, contrary to the conclusion of the report. This statement is not a hypothesis or a prediction; it is based on hard fact. The following close examination of the USGS report reveals just how its alarming and erroneous conclusions were reached.

The Taxon Accounts

The USGS report consists of three main parts. The first part, by far the largest, is comprised of the taxon accounts created for each of the nine species. The authors state: "The core of this work—the biological profiles—are a work of traditional library scholarship. . . . " The chapters largely devoted to reviews of the taxa comprise 202 pages of the 260 pages of text, tables and figures in the report. Chapter 3 also is primarily a literature review—of eradication tools and methods that could be used in the efforts to control or exterminate any of the great constrictor species discovered in incipient populations.

This bulk of the report is based on the References Cited. This part of the report is not itself scientific in nature; as a review and summary, it presents little, if any, original data or insights into the biology of each of the species. None of the herpetological references that comprise the literature search contain data or arguments that would indicate or warn of any potential of large constrictors to colonize the continental USA.

Climate Space and Climate Matching

The second major component of the report is an attempt to quantify the climate in which each species lives in nature, and then identify areas in the USA with similar climatic characteristics.

In Section 3 of each taxon account, the "climate space" of each species is calculated. Climate space is described to be the combination of conditions under which each taxon survives in nature. The calculation used in this paper is identified as a bivariate characterization of the climate where a species is found. The two variables used to characterize climate space are mean monthly temperature and mean monthly precipitation.

Herein lies the fundamental error of the report. The authors chose to use the "mean monthly temperature" as the unit of temperature used to define climate space. The point was to find the lowest temperature at which these species can survive. Maximum mean temperature is not a particular concern, since all of these animals come from areas with predominantly warmer mean monthly temperatures than the continental USA.

The authors chose the lowest monthly mean temperature within the natural range of each species and treated it as if it were the critical minimum temperature. In fact, they acknowledge that the actual minimum temperatures disguised within their winter average temperatures might be too low. Reed and Rodda state: "We chose mean monthly precipitation and mean monthly temperature as adequately representing the climate attributes best associated with giant constrictor range limitations." They go on to defend their choice of monthly mean temperatures, saying: "We do not believe that daily values [temperatures] are appropriate for snakes that have access to natural refugia, as the low metabolic demands of reptilian physiology, as well as the huge meals eaten by giant constrictors, insures that they do not need to venture out every day or even every week in order to maintain a net positive energy balance."

In other words, they predict that daily low temperatures are not important—they predict that the nine species have the necessary physiological adaptations, behaviors, and instincts to successfully shelter during inclement weather. This is an a priori assumption of the authors that is incorrect. They do not offer any suggestion as to where or in what a population of 100-pound snakes might find suitable shelter from winter cold in any area of the southern USA.

They chose wrong. Temperatures in the tropical areas that are home to these animals are far less variable than in the significantly more seasonal continental USA. A mean monthly temperature of 55°F can be a month of daytime highs of 56° and nights of 54°; it also can be 20 days with high temperatures of 70°and nighttime lows of 60, and 10 days of 40°highs and 30° nights, similar to what happened during the first two weeks of January 2010 in Florida.

Using monthly mean temperatures from the natural ranges of the nine species to estimate climate space serves to mask deleterious minimum temperatures when superimposed over the monthly mean temperatures of the far more seasonal and variable climate of the USA.

The choice to use mean monthly temperatures as the variable in determining the climate space obscured critically low temperatures. The climate space estimated in each taxon account, when matched to current U.S. climate, consequently included areas actually subject to far cooler extremes than occur in the natural range. When this incorrectly calculated climate space was matched to the current U.S. climate, the resulting maps showing the areas of suitable climate in the USA were grossly exaggerated.

The authors do not include the weather data on which their climate space predictions are based. They do not cite what temperatures they arbitrarily chose as the lowest acceptable monthly mean temperatures for each species.

Most of the climate data used for seven species are not even based on actual weather reporting stations. Instead the authors used "climate estimates" provided by the WorldClim data base (Hijmans et al., 2005).

As in the previous "Burmese map paper" (Rodda et al., 2009), the authors do not reveal the geographic locations and elevations from which data are derived and on which their climate space estimations are based. That is particularly relevant to this report and the discourse it has generated, as further examinations of weather data from those stations would show exactly what minimum daily temperatures exactly had been recorded at each reporting station, and what was the range of the reported monthly mean temperatures over the period of years from which they had been reported.

The reporting stations that supplied data used in determining the climate spaces of the nine species are described as being located, when possible, close to a specific locality where a species is reported to occur, and matched to the exact elevation. The key words here are "when possible."

In the Case of the Burmese Python

A recently published paper recognizes the Burmese python as a full species, *Python bivittatus*, with two subspecies, *P. b. bivittatus* and *P. b. progschai* (Jacobs et al., 2009). One of the co-authors of that paper, Mark Auliya, is mentioned in the acknowledgments of Reed and Rodda (2009) as having provided "valuable unpublished data." Apparently Auliya didn't mention that he was elevating *bivittatus* to species rank, because Rodda et al. (2009) state (without giving reasons) that the Burmese python is "a questionable subspecies."

As a result of their assumption about the questionable validity of the taxon, the authors chose to treat the Burmese python as the Asian python, *Python molurus*, lumping it with its former conspecific and ignoring the fact that it is only the Burmese python that is of any concern in the matter of established exotic species in the USA. Of course the effect of this was to increase the estimated climate space of the species, and thereby significantly increase the area in the continental USA predicted to be suitable climate.

The climate space graph for the Asian python, *Python molurus*, in this report is based on the data from 149 weather reporting stations, as reported in Rodda et al. (2009). In fact, no such data is provided in this USGS report for any of the species—however, we are able to make this assumption about the source of data for the Asian python account in this report because the graph and map in this report are copied from that previous paper.

That being the case, of the 149 tallied, 43 stations, 28.8% percent, are in China at the northern extent of the range of the species, even though the Chinese range of the species constitutes a significantly smaller percentage of the total range of the species. Additionally an unspecified number of reporting stations can be assumed to be located in Assam, Bhutan, Nepal, northern Myanmar, and northern India—the most northerly and cool portions of the range of the Asian python—to further emphasize the coolest areas in which the species is known to occur.

Further, we are not aware of 43 different published Chinese localities for Burmese pythons. The few published localities of which we have record are mostly not exact and very few have elevation data. That presents the likelihood that the authors have arbitrarily chosen some of the weather stations and also the elevations of those localities. The criteria used to make these choices are not specified in this report.

The authors have chosen to discount the fact that none of the Burmese pythons imported into the USA have been collected from the northern portion of the range (Barker and Barker, 2008). Additionally, none of the countries at the northern extremes of the range allow exports of pythons, so no Burmese from northern populations are likely to enter this country.

Based on scattered anecdotal accounts in the literature, the authors accept the premise that Burmese pythons "hibernate." Rodda et al (2009) and this report both cite Minton (1966) as the main reference for hibernation of the Asian python. However, close examination of that reference shows that Minton (1) was referring only to his area of study at the extreme eastern limit of the range of the species; (2) only the Indian python, *Python molurus molurus*, was referenced—no mention is made of the natural history of the Burmese python; (3) most or all of the information regarding natural history is based on stories told to Minton by local collectors and professional snake collectors, and as such must be regarded as second-hand and anecdotal; (4) Minton never mentions pythons undergoing "hibernation," stating only that pythons are "largely torpid" for the winter months; (5) the sole use of the word "hibernation" in the python account of Minton (1966) is a quote from Smith (1943) who is, in turn, citing Walls (1912), to say that in northern India pythons mate during hibernation. Generally speaking, animals do not mate if they are in a true state of hibernation; the state of seasonal quiescence referred to as hibernation by the authors would be more correctly identified as brumation or dormancy. None of the nine species in this report hibernate, despite the conjecture of the authors to the contrary.

Certainly there are a few records of Burmese pythons at the northern periphery of the range at elevations exceeding 1000 m where in order to survive, they might be expected to brumate. In these cases, we would suggest that there is an unexplored possibility that the species might seasonally migrate to lower elevations and more temperate conditions. This possibility is supported by observations of Burmese pythons in the Everglades that have been radio-tracked moving distances exceeding 50 miles in the space of a few months (Harvey et al., 2008).

It's also possible that small populations of Burmese pythons at the northernmost limits of their range have evolved metabolic adaptations and behaviors that allow them to survive exceptional low temperatures.

However, beyond those conjectures, what has been clearly demonstrated is that Burmese pythons in cold conditions in the USA have not shown any particular cold-hardiness or any behavior to protect themselves from cold extremes (Barker, 2008). This fact was particularly well illustrated by the extreme die-off of almost all Burmese pythons that were radio-monitored and in outdoor enclosures in Florida as a result of the cold weather of the first two weeks of January 2010.

It would be a gross mistake to assume that a Burmese python can survive anywhere in the continental USA except possibly in the Everglades region. Even that is currently uncertain.

The Establishment Risk Assessment

The third part major part of this report is the establishment risk assessments created for the nine species, found in Chapter 10 of the report. This is done following the guidance established by the Aquatic Nuisance Species Task Force (ANSTF, 1996).

The risk assessment is comprised of two parts. In the first part there are four factors that together evaluate the risk of establishment. The second part considers three factors to evaluate the consequences of establishment.

The authors provide a section to discuss each of the factors and provide their arguments for scoring each species as they have. A table summarizes and illustrates the choices made for the components of each of the factors.

It is our observation that the entire process of creating the risk assessments in this report is fatuous because of the lack of quantifiable and objective data that is required by the process.

In the absence of data required by the process to create the risk analyses, the authors exercise their apparent a priori assumption that all nine species in fact do pose a threat of colonizing areas of the continental USA. In some cases the authors have left blank some of the components rather than provide answers that would be deleterious to their argument; in others they have chosen answers that are based on their a priori assumptions, and on their biased opinions of the issue. Many of their choices that form the bases of the risk assessments are open to argument; there are several that are, in our opinion, clearly incorrect.

However, it is not necessary to review the tables line-by-line. The fact now established that the climate matching performed in this report is incorrect and false makes moot any argument that these species pose any quantifiable risk.

Climate matching has been identified as one of the most important factors to predict the invasive potential of exotic reptiles and amphibians (Bomford et al., 2009). In this case, there is no climate match and there is no potential of any of these nine species existing anywhere in the U.S. mainland except possibly the Everglades region of South Florida.

In Conclusion

The USGS report is invalid for many reasons (Barker and Barker, 2010). However, it took the Florida freeze of January 2010 to show just how unrealistic are the climate matches illustrated with the attractive multi-colored maps. There is now a conclusive answer to the question posed in the title of the paper by Rodda et al. (2009), "What parts of the US mainland are climatically suitable for invasive alien pythons spreading from Everglades National Park?" The answer is "none."

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