

Panama Pumilio Protection Project



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Table of contents:

Abstract:	4
Resumen:	4
Introduction:	5
Panama Pumilio Protection Project:.....	5
Study organism:.....	5
Scientific significance:	6
Experimental approach:	6
Description of study area:	6
Data analysis:	9
Material:	9
Data Reporting:	10
Project planning:	11
Calculation of costs:	11
Impact:	12
Products:	12
References:	13

LIST OF FIGURES AND PHOTOGRAPHS

Photo front page: *Dendrobates pumilio*, made by Chris van der Lingen

Figure 1.	Bocas del Toro Archipelago7
Table 1.	Project planning11

Abstract:

Currently, a lot of construction work is occurring on the Bocas del Toro Archipelago, Panama. Due to the change of natural habitat into building sites, a decline in the population of *Dendrobates pumilio* has been observed (pers. comm. Chris van der Lingen). Furthermore, the raise of tourism pressure on the natural resources in this region will likely have a negative impact on the tropical rainforest and the animals that depend on it. The different populations of *Dendrobates pumilio* show extreme variation in colour and colour pattern among mainland locations and Islands in the Bocas del Toro Archipelago in Panama. Previous analyses indicate that these different populations are members of a single species (Summers et al. 2003; Summers et al. 2004).

To assign core areas for protection of the different colour morphs of *Dendrobates pumilio*, the Panama Pumilio Protection Project set up a research. This research focuses on factors that influence the stability of *Dendrobates pumilio* populations like population density, population size, number of populations of a specific colour morph, sex ratio, environmental factors, and potential breeding areas.

By doing this study, information will be gathered to make it possible to assign core areas for protection of different colour morphs of this frog species. These areas can be bought by for instance la Autoridad Nacional del Ambiente (ANAM) or the International Union for the Conservation of Nature and Natural Resources (IUCN) to get a high state of protection. These core areas then will minimise the impact of increasing tourism activity on these populations.

Resumen:

Proyecto de la Protección de Panamá Pumilio

Actualmente se está llevando a cabo mucha obra de construcción en el archipiélago de Bocas del Toro, Panamá. Debido al cambio de uso del suelo de hábitats naturales a sitios de construcción se ha observado una reducción en las poblaciones de *Dendrobates pumilio* (comunicación personal, Chris van der Lingen). Adicionalmente, el incremento en la presión que ejerce el turismo sobre los recursos naturales en esta región probablemente resulta en un impacto negativo en el bosque de lluvia tropical y en los animales que dependen de él. *Dendrobates pumilio* muestra una variación extrema en color y patrones de coloración entre las poblaciones continentales y las poblaciones de las islas del archipiélago.

Previos estudios indican que estas distintas poblaciones pertenecen a la misma especie (Summers et al. 2003; Summers et al. 2004).

Para asignar áreas de protección relevantes para los diferentes morfotipos de color de *Dendrobates pumilio*, el Proyecto de Protección de Pumilio de Panamá estableció un programa de investigación que se enfoca en el estudio de los factores que influyen la estabilidad de las poblaciones de *Dendrobates pumilio*, por ejemplo, la densidad de población, el tamaño de población, el número de poblaciones de cada morfotipo, sex ratio, factores ambientales, y áreas potenciales de reproducción.

Este estudio recaudará información que hará posible la asignación de áreas de protección para los diferentes morfotipos de color de esta especie de rana. Estas áreas podrían ser adquiridas por ejemplo, por la Autoridad Nacional del Ambiente (ANAM) o la Unión Internacional para la Conservación de la Naturaleza y los Recursos Naturales (IUCN por sus siglas en inglés) para lograr un alto grado de protección. La protección de estas áreas minimizará el impacto que el incremento de la actividad turística ejerce en estas poblaciones.

Introduction:

Panama Pumilio Protection Project:

The Panama Pumilio Protection Project (PPPP), is a project started by Chris van der Lingen in 2004 who discovered decline of *D. pumilio* populations at the Bocas del Toro Archipelago. This decline is mainly due to the fact that many locations with populations of *D. pumilio* are sold as building sites and frogs are caught for selling to the illegal trade market (pers. comm. C. van der Lingen).

To stop these negative developments the PPPP has set up a research programme to protect these areas.

The goals of the Panama Pumilio Protecting Project:

- To identify the most important geographic areas and habitats of the Bocas del Toro Archipelago that need to be conserved to avoid further extinction of *Dendrobates pumilio*.
- To involve local Panamanians into protecting the areas which the PPPP has pointed out as areas that need special attention.
- To find out why in some suitable areas no *D. pumilio* occur.

Study organism:

Dendrobates pumilio is a diurnal dendrobatid and is commonly known as the strawberry poison dart frog. This frog is found from southeast Nicaragua to Laguna de Chiriquí in northwest Panama, including the Islands of the Bocas del Toro province (Pröhl, 1996). *D. pumilio* inhabits primary and secondary rainforest, as well as plantations and pastures (Haase et al. 2002), to a maximum elevation of 1000 meters above sea level.

The species has an aposematic colouration associated with alkaloid skin toxins (Haase et al. 2003). Females are generally bigger than males. Also individuals between different populations can differ in size. (15-22 mm).

Males are territorial, defending good calling sites. Mating success appears to be correlated to calling frequency and the height of the calling site. Egg deposition is in leaf litter. Males guard and moisten the eggs (Donnely, 1989a,b) till females return to carry the tadpoles to a water filled leaf axil. (Pramuk et al. 1999). *D. pumilio* is an obligate oviphage frog (Pramuk et al. 1999). (Females deposit unfertilized eggs as nutrition for the tadpole (Weygoldt, 1980)).

There are many different colour morphs of *D. pumilio*, especially on the different Islands of the Bocas region. Summers et al. (2003) did a study on spectral reflectance among populations and concluded that there is extreme polymorphism among different populations of *D. pumilio* in the Bocas del Toro Archipelago. According to Daly & Myers (1967) there are at least 16 populations of *D. pumilio* in this region, exhibiting surprising geographic variation in colour. The basic dorsal colour is red, orange, green, olive green, blue or black; venters are yellow, red, white or blue; the limbs are frequently black or blackish; the dorsums are unicoloured, speckled, boldly spotted with black or in one instance black with whitish longitudinal marks (Daly & Myers 1967; Summers et al. 2003; Poelman 2004).

Scientific significance:

The natural beauty of the Bocas del Toro province attracts an increasing amount of tourists to this area. This increases the pressure on the natural resources in the region. Unless these are protected in some way or the other, these tourist activities will likely have a negative impact on the tropical rainforest and the animals that depend on it. One of the animals that will greatly be influenced by human activity is the amphibian *Dendrobates pumilio*. *D. pumilio* populations are also already declining due to pollution and climatic change (Morehouse et al. 2003, Ouellet et al. 2005). The results of this research will be used to assign core areas for protection of different colour morphs of this frog species. These core areas then will minimise the impact of increasing tourism activity on these populations.

The different colour morphs of *D. pumilio* are endemic to small areas on the Boas Islands. So the habitat for these colour morphs are limited and therefore susceptible to greater proportional losses than the habitat of more widespread species.

Experimental approach:

Description of study area:

The field experiments will be done on the islands Isla Colon, Isla Bastimentos and Isla Solarte (Cayo Nancy) of the Bocas del Toro province (See fig1.). This province is bordered by Costa Rica to the west, the Caribbean Sea to the north, Chiriquí Province to the south, and Veraguas Province to the east.

Four problem areas are pointed out with the help of C. van der Lingen (See fig 1.).

1. The north-side of the Bocas Island (Isla Colon). This is probably a small isolated population with a distinctive colour pattern.
2. The north-side of Bastimentos Island. This area consists of poison dart frogs with various colour patterns within the population.
3. The middle of Bastimentos Island. This area is threatened by the building of houses in the surrounding area.
4. The north-side of Nancy Cay (Isla Solarte). This area is also under threat of building sites in the surrounding area.

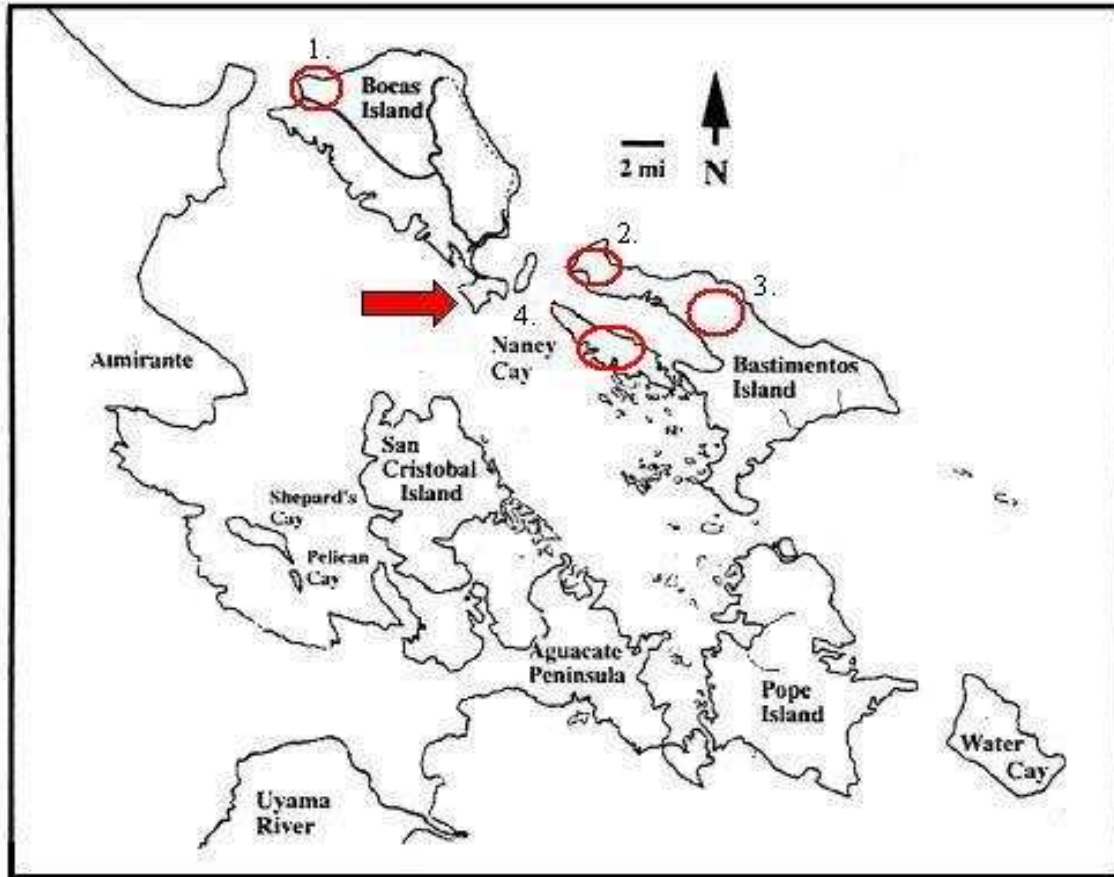


Fig 1: Bocas del Toro Archipelago. Red arrow indicates location of base camp and red circles indicate research areas.

Weather conditions are rather constant with maximum temperature ranging from 30,7 degrees Celsius in February to 32,0 degrees Celsius in June, and minimum temperature ranging from 20,2 in February to 22,2 degrees Celsius in May and June. Mean monthly rainfall ranging from 83,8 mm in February to 563,6 mm in December. (Climatological information is based on monthly averages for the thirty years period 1971-2000 for Bocas del Toro (www.worldweather.org) visited 15-01-2007).

The vegetation varies from primary and secondary tropical rainforest, small plantations of cacao plants, banana trees and coco palms, pastures and other vegetation.

The research will start 22nd of March until 22nd of July 2007. The main goal of this research is to identify different populations of *D. pumilio*. Monitoring of the locations will be done from 0700-1500 hours when calling and courtship activity is most intense (Pröhl 1996; Wijngaarden van & Brink van den 2000; Pröhl and Berke 2001; Bee 2003).

To describe the four different areas, the following methods will be used:

Identification of location of population and measuring population size.

The location of the population will be identified using a Global Positioning System (GPS, Geko 301 Navigation system), to determine the population size. Every 50 meters a visual inventory of the presence of *D. pumilio* will be made to measure the population area size. Also distance between calling males will be measured during these measurements.

Demarcating suitable plots.

To measure the density of *D. pumilio* present in a population, a suitable representative plot of 100m² will be demarcated. According to Buckland et al (2001) it is the absolute size of the sample that is important, not the fraction of the population. As a practical minimum, the number of animals caught should usually be at least 60-80 for reliable estimation of average density within a stratified study area. Earlier research on *D. pumilio* yielded up to 30 individuals per 100 m², with an average between 8 and 15, depending on the study area. In this study, the amount of plots made per population depends upon the amount of individuals caught so that at least 60 individuals are recorded in the total study area. Plots of 100m² (10 x 10 m.) will be made using a rope to determine the scanning area.

If possible, plots will not be closer than 150 m to each other (Doan 2003).

Measuring distance between calling males.

First the territorial size of male *D. pumilio* is estimated by scanning through the whole plot. We will spent 20 min. of every observation for localizing the frogs (Pröhl and Berke 2001; Pröhl 2003). This will be done by localizing as many male *D. pumilio* as possible acoustically as well as visually. Males can be distinguished from females by throat coloration (males have darker throats) (Donnelly 1989a; Haase and Pröhl 2002).

Measuring environmental variables and microhabitat.

When a plot is demarcated, elevation, temperature, Relative Humidity (RH %), m² bromeliad's and leaf litter depth in this plot will be measured. The temperature and RH% will be measured at ground level.

Also elevation will be measured using a GPS system. Furthermore the canopy closure will be estimated and categorized in the following classes: 0-20%; 20-40%.....80-100%. Leave litter depth will be measured in every plot as egg deposition is often in leave litter.

*Catching all *Dendrobates pumilio*.*

After estimating territory size of the calling males, plots are searched thoroughly for any *D. pumilio*. All vegetation, logs, and leaf litter will, if possible, be turned over and searched thoroughly to reveal all *D. pumilio* up to 2 m. in height within the plot (Doan 2003). Individuals of *D. pumilio* will be captured and stored in plastic bags during the search through the plot (these plastic bags are marked for later identification). All individuals will be counted to measure the number of frogs per unit area in that particular location.

Counting tadpole rearing sites.

All potential tadpole-rearing sites up to 5 m height (Pröhl 2002), which are bromeliads (diam.>20cm.). bananas, *Heliconia* sp., *Calathea* sp., *Dieffenbachia* sp. (all > 1m. height) (Pröhl 2001), little tree or liana holes and other small water pockets, will be counted (Limerick 1980; Donnelly 1989b; Wijngaarden van & Brink van den 2000; Pröhl and Berke 2001). Diameter of all trees greater than 10 cm at breast height, are also recorded (Doan 2003, Wijngaarden van & Brink van den 2000).

Photographing individuals, SVL measurements and sex determination.

After the search through the plot dorsal and ventral photographs of the *D. pumilio* will be made, at a neutral background, to quantify different colour morphs. Also the Snout-vent length (in mm.) and male/female ratio of the captured *D. pumilio* will be measured. After these measurements the captured frogs will be released at the same location they were captured.

To quantify the different habitat types where the different populations are found, 5 types of habitats are distinguished: Primary forest, secondary forest, small plantations, pastures and other vegetation. Primary forest: big trees with little undergrowth of mainly shrubs and young trees; Secondary forest: most trees are of the same age with dense undergrowth of shrubs and herbs; Small plantations: small areas with cacao plants, banana trees and coco palms (Wijngaarden van & Brink van den 2000).

To avoid any disturbance of the frogs which could influence the measurements, the following order of measurements is given:

1. Identification of location of population.
2. Measuring population size.
3. Demarcating suitable plots.
4. Measuring distance between calling males.
5. Catching all *Dendrobates pumilio*.
6. Photographing individuals, SVL measurements and sex determination.
7. Releasing frogs to original location.
8. Measuring environmental variables.
9. Measuring microhabitat.
10. Counting tadpole rearing sites.

Data analysis:

Density estimation will be done using Distance 5.0 release 2 software. Environmental variables will be analysed with SPSS statistical program using Multiple regressions. Vortex 9.70 will be used to quantify population stability and sustainability.

Material:

- Global Positioning System (GPS)
- Measuring tape
- Plastic zip lock bags (for storing frogs temporary)
- Photo equipment
- Rope
- Sliding callipers
- Stop watch
- Temperature & Relative Humidity (RH%) meter
- Writing material

Data Reporting:

At every location this form will be filled in:

Location: Surface area (m ²):	Primary forest <input type="text"/>	Secondary forest <input type="text"/>	Small plantation <input type="text"/>	Pasture <input type="text"/>	Other <input type="text"/>
--	--	--	--	---------------------------------	-------------------------------

Plot	1	2	3
GPS S			
GPS E			
Accuracy GPS			
Elevation			
# Trees D>10cm			
Surface area Bromeliad's (m ²)			
# Bromeliad's D>20cm			
# Tadpole rearing sites			
Canopy closure (%)			

Plot	Date	Time	Temp (°C)	RH%	# Males	# Females	# Frogs	# Tadpoles	# Frogs unable to catch	Leaf litter depth (cm)	Comments
1											
2											
3											

Project planning:

The research will be conducted from the 22nd of March until the 22nd of July 2007. First a pilot study will be conducted, to find suitable locations with populations of *D. pumilio*. Until the 22nd of July field studies will be executed. During the pilot study the technique of sampling will be standardized, in order to get results that are comparable in most relevant respects.

A day in the field consists of transportation to the location, a plot will be made of 100m², and then the first 20 min. of every observation will be spent localizing the male *D. pumilio*.

We will need approximately 1½ hour to complete the rest of our measurements per plot (Doan 2003). Several plots will be investigated per day depending on the distance between the different plots.

To get an even better insight in populations of *D. pumilio*, some data analysis will be done during this research (see table 1).

To do list	Jan. & Feb.	March	April	May	June	July	August
Literature study & project proposal	■						
Preparation to departure		■					
Pilot study		■	■				
Field work			■	■	■	■	
Data analyses				■	■	■	■
Writing report					■	■	■
Holiday						■	■
Arriving in The Netherlands							■
Accomplish project							■

Table 1. Project planning, January 2007 to the end of August 2007

After data analysis a report will be written and handed over to the Panama Pumilio Protection Project.

Calculation of costs:

The calculation is based on two persons:

	\$	€
Vaccination:	453	350
Ticket:	2224	1720
Taxi boat ¹ :	714	553
Accommodation ² :	2000	1547
Scientific instruments ³ :	130	100
Total:	5521	4270

1. Based on \$3 pppd, for 17 weeks.
2. Based on \$500 per month, for 4 months.
3. Rope, sliding calipers, zip lock bags, etc.

Impact:

The natural and anthropogenic impact of this research is negligible. There will be no use of chemical, hazardous or other dangerous substances which can have influence on the environment. Effect on other animals than *Dendrobates pumilio* will be minimized.

All specimens are immediately released back into the plot after sampling, approximately one hour (Doan 2003), and processing, logs and other large substrates will be replaced in their original locations.

No markings (toe-clipping) will be used to identify the different frogs individuals. So disturbance is restricted to a minimum.

Products:

The purpose of this project is to produce a written report for the Panama Pumilio Protection Project, describing a uniform method for investigating population density and factors influencing population dynamics of *Dendrobates pumilio* on the Islands of the Bocas del Toro Archipelago, Panama.

This method will first be tested in the field and, if necessary, modified.

First results of *D. pumilio* population investigations using this method will be analyzed and provided in a written report to the Panama Pumilio Protection Project. In this report an advice will be given which of the investigated populations are most fragile and need most attention for protection.

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