Appendix I. Studies documenting trends of amphibian populations at the global scale

REFERENCE	STUDY DESCRIPTION GOALS AND FINDINGS	ORDER	STUDY DURATION
Alford & Richards 1999	Collected data over the period 1951-1997 and found amphibian populations decreased more than their model predicted. However, there was no evidence that the agents of decline were becoming more prevalent over time.	Anura Caudata	> 40 years
Houlahan et al. 2000	In this study were examined means of trends for 936 amphibian populations historical data sets and concluded that global declines began in the late 1950s, peaked in the 1960s, and have continued at a reduced rate since.	Anura Caudata	6 years avergage
Stuart et al. 2004	Stuart and his colleagues reported on the status of amphibian species around the globe. They found that 43 percent of the amphibian species are experiencing some form of population decrease, 32.5 percent of the species are globally threatened, and that 122 species are possibly extinct; most of those losses are recent, having occurred since 1980.They also found that the geographic distribution of rapidly declining species was non-random, with neotropical species more affected than species from other areas.	Anura Caudata	Unavailable data

Appendix II. Long-term studies (> 10 years consecutively) documenting trends of amphibian populations at the regional scale [1].

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES [2]	GOALS AND FINDINGS				
Terhivuo 1988	Unavailable data	Using historical data the author describe a pattern for the chronology of the onset of spawning for the common frog in Finland during a period of about 150 years, and demostrated the relationship between spawn dates and temperature and trends towards earlier spawning in a period of climate warming.	*Rana temporaria*	Anura	> 150 years	Finland
Mossman et al. 1998	Unavailable data	The results of this study have helped elucidate the breeding phenology, status, distribution, and long-term population fluctuations of 12 anuran species in Wisconsin county and suggested that some species are in decline.	*Rana sylvatica, Pseudacris crucifer crucifer, P. triseriata, Rana pipiens, Bufo americanus americanus, Hyla versicolor, H. chrysoscelis, Acris crepitans blanchardi, Rana septetrionalis, Rana calamitans melanota, Rana catesbeiana.*	Anura	> 10 years	USA
Petranka et al. 2004	31	This study documented long-term population dynamics of a relative large number of amphibian populations over a broad geographic region and provies novel insights into population synchrony at different spatial scales.	*Rana sylvatica, Ambystoma maculatum*	Anura Caudata	> 10 years	USA

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES [2]	GOALS AND FINDINGS				
Daszak et al. 2005	Unavailable data	This study demonstrates that the causative agent of chytridiomycosis, *Batrachochytrium dendrobatidis*, was present in amphibian populations at the Savannah River Site (SRS), South Carolina during the period 1978-1981, but appaently was not the cause of the decline since like many other pathogens, the outcome of infection can present some variations among individuals and populations depending on their environments and life history.	*Acris crepitans, Acris gryllus, Bufo quercicus, B. terrestris, Gastrophryne carolinensis, Hyla chrysocelis, H. cinerea, H. crucifer, H. gratiosa, R. catesbeiana, R. clamitans, R. grylio, R. sphenocephala, R. virgatipes, Scaphiopus holbrookii, Ambystoma talpoideum, A. tigrinum, Pseudacris ornata.*	Anura Caudata	> 30 years	USA
Loman & Andersson 2007	120	*Rana arvalis* and *Rana temporaria* are species currently not considered threatened in Sweden, however, the study wasn't performed in response to a possible decline but to provide a backround for the future.	*Rana arvalis, Rana temporaria*	Anura	> 10 years	Sweden
Scott et al. 2008	11	This paper examines the UK Environmental Change Network data collected to date for evidence of temporal trends associated with the breeding cycle of *R. temporaria* . The impact of weather variables on the reproduction cycle is also examined, and the likely impact of predicted climate change discussed.	*Rana temporaria*	Anura	> 10 years	UK

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES [2]	GOALS AND FINDINGS				
Brodman 2009	11 438	The 14-years study was done in order to report the status of all communities Amphibians in Jasper County, Indiana, USA. The trends of amphibian populations and dynamics from 1994-2007 indicated that habitat characteristics at the landscape scale, climate and biotic variables are important factors of pond-breeding abundance, occupancy, and diversity.	*P. crucifer, P. triseriata, Hyla versicolor, H. chrysoscelis, Acris blanchardi, Bufo americanus, B. fowleri, R. catesbeians, Rana pipiens, R. clamitans, Ambystoma laterale, A. tigrinum, Notophthalmus viridescens, Siren intermedia.*	Anura Caudata	> 10 years	USA
Griffiths et al. 2010	4	In this study Richard Griffiths and colleagues describe how climatic factors influenced the dynamics of an amphibian metapopulation over 12 years through interactions with survival, recruitment and dispersal and emphasize the need of conservation actions at the local scale to compensate for reduced adult survival. Griffiths et al. 2009 study is a good model example of how to gather and apply climate and metapopulation data.	*Triturus cristatus*	Caudata	> 10 years	UK
Maletzky 2010	114	This study aims at an evaluation of the currents status of the species concerning distribution, population size and reproduction in the province of Slazburg, Austria.	*Rana dalmatina*	Anura	> 60 years	Austria

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES [2]	GOALS AND FINDINGS				
Curado et al. 2011	270	Due the fact that ponds and amphibians are important model systems to explore the effect of land use change on habitats and wildlife this study was performed to understand the relationship between land use and its dynamics and the occurrence and condition of amphibian populations in farmlands.	*L. helveticus, L. vulgaris, I. alpestris, T. cristatus, S. salamandra, R.temporaria, B.bufo, B. calamita, H.arborea, A. obstetricans, P. punctatus, P. kl. esculentus*	Anura Caudata	> 30 years	France
Loman 2014	10	This study concerns the start of breeding for *R. temporaria* and *R. arvalis*, in southern Sweden 1990-2010. The purpose was to verify if there has been a trend to earlier breeding in these species, and also analyse the connection of their phenology to some suspected proximal (spring temperature) and preproximal North Atlantic Oscillation causes.	*Rana arvalis, Rana temporaria*	Anura	> 20 years	Sweden

[1] Altrough many of these studies initially were not designed to monitor populations, they clearly establish the fluctuation in numbers of amphibians annually, especially at breeding sites.

[2] Number of sites visited during the study period.

Appendix III. Long-term studies (> 10 years consecutively) documenting trends of amphibian populations at the local scale [1].

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES[2]	GOALS AND FINDINGS				
Jaeger 1980	Unavailable data	This 14 years census of the population fluctuations of *P. cinereus* a *P. shenandoah* shows that after a extreme drought season the *P. cinereus* population was stable, however *P. shenandoah* suffered around 99% mortality, probably due to competiton with *P. cinereus* .	*Plethodon cinereus, Plethodon shenandoah*	Caudata	> 10 years	USA
Pechmann et al. 1991	1	Pechman et al. 2001 carefully monitored the breeding population sizes of four amphibian species at one site in a pristine area of South Carolina for 12 years and showed that the populations of three species fluctuated and one species increased over that time span. The data supported the statement that it may be difficult to distinguish natural fluctuations from human-caused declines.	*Ambystoma opacum, A. talpoideum, A. tigrinum, Pseudacris ornata*	Anura Caudata	> 10 years	USA
Weitzel & Panik 1993	1	With provided historical data and census conducted by the author this study shows the resistence of this species to disturbances and predation in the local level, also to ensure the hypotesis that this species is apparently not declining.	*Pseudacris regilla*	Anura	> 80 years	USA
Hairston & Wiley 1993	7	Observations conducted over 15-20 years on populations of six species of salamanders indicated that despite the fluctuation in numbers over years, declines has not ocurred in the studied areas.	*Plethodon jordani, Plethodon glutinosus, P. hzbrids, Desmognathus monticola, D. ochrophoeus, D. oeneus*	Caudata	> 20 years	USA

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES[2]	GOALS AND FINDINGS				
Sherman & Morton 1993	13	Breeding population size were documented in this study over 20 years. The resulting declines were probably caused by drought, disease, and predation. Although anthropogenic causes were not major factors that led to the decline, there is a presumption that the natural variables are the result (or have) anthropogenic components.	*Bufo canorus*	Anura	> 20 years	USA
Bradford et al. 1994	32	This study consisted of detailed resurveys of two areas within the parks, a park-wide assessment of status based on comparison of historical and recent records, and an assessment of status elsewhere in the Sierra Nevada, also based on a comparison of historical and recent records. Results indicated that *R. muscosa* has disappeared from about half of its historical localities in Sequoia and Kings Canyon National Parks during the past three decades. The causes of these declines remaind unclear.	*Rana muscosa*	Anura	> 20 years	USA
Semlitsch et al. 1996	1	16 years of census data were examined on the amphibians in a natural pond, this study documented the effects of competition, predation, and disturbance are mechanisms that interact and regulate the abundance and distribution of species at the local level.	*A. opacum, A. talpoideum, A. tigrinum, N. viridescens, P. ornata, Bufo terrestris, G. caroliniensis, P. crucifer, R. calamitans, R. urticulata*	Anura Caudata	> 10 years	USA

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES[2]	GOALS AND FINDINGS				
Beebee 1997	33	A replicated, before-and-after study in 1977–1996 of ponds on chalkland in England, UK found that pond restoration and creation resulted in increased occupancy by amphibians but not species richness/pond. Despite restoration, 17 of 33 original ponds were lost by 1996.	*Rana temporaria, Bufo bufo, Triturus vulgaris, T. helveticus, T. cristatus*	Anura Caudata	> 20 years	UK
Meyer et al. 1998	3	Three populations of *Rana temporaria* were analyzed for a period of 23-28 years. The populations lay in an agricultural landscape where there were no obvious changes in land use for several decades, which made them ideal to test for a possible decline caused by factors other than direct negative human impacts.	*Rana temporaria*	Anura	> 20 years	Switzerland
Reading 1998	1	In the present 19-year study has demonstrated that the timing of breeding activity in *B. bufo* is dependent on at least two factors: climatic temperature and daylength. The occurrence of early breeding in *B. bufo* during the last decade compared with the previous decade reflects their ability to respond to the occurrence of milder winters over the same period and makes them a suitable indicator species for studying some aspects of climate change.	*Bufo bufo*	Anura	> 10 years	UK
Green 1999	1	This 11-year demographic study of *Bufo fowleri* at Long Point, Ontario illustrates stochastic and deterministic factors influencing severe population size fluctuation.	*Bufo fowleri*		> 10 years	Canada

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES[2]	GOALS AND FINDINGS				
Gibbs & Breisch 2001	Unavailable data	Using historical data, the authors found that four out of six anuran species in New York State were breeding earlier at the end of the twentieth were also significantly correlated with climatic warming century than at its start. These changes were also significantly correlated with climatic warming.	*Bufo americanus, Pseudacris crucifer, Rana sylvatica, Rana catesbeiana, Hyla versicolor, Rana clamitans.*	Anura	> 10 years	USA
Blaustein et al. 2001	6	This study showed a close relationship between temperature before breeding and the timing of first breeding for three species, while only the western toad (*Bufo boreas*) displayed a tendency to breed earlier (at one site) and Fowler's Toad (*Bufo fowleri*) to breed later.	*Rana cascadae, Bufo boreas, Pseudacris crucifer, Bufo fowleri*		> 10 years	Canada
Brodman 2002	2	The purpose of this study was to provide baseline data on coexisting salamander populations and to provide insight on whether these populations of salamanders are in decline, fluctuate with climate, or maintain a stable coexistence.	*Ambystoma maculatum, A. jeffersonianum*	Caudata	> 10 years	USA
Wheeler et al. 2003	4-18 sites in each of 5 rivers	Over the 20+ years of this study of *Cryptobranchus alleganiensi,* populations declined by an average of about 77%. This decrease was consistent for all five populations and both subspecies, characterized by a shift in size (age) structure, with a disproportionate decrease in numbers of young individuals in all the populations and indicated that the decline was not limited to one or two local populations, but was at least a regional phenomenon.	*Cryptobranchus alleganiensi subsp. C. a. alleganiensis and C. a. bishopi*	Caudata	> 20 years	USA

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES[2]	GOALS AND FINDINGS				
Richter et al. 2003	1	Richter and his colleagues studied variations in the reproductive biology of an isolated population of *R. sevosa* from 1988 to 2001. Given the apparently high rate of extinction probabilities at this site, resulting of this study, the authors emphasizes the need of a detailed recovery plan defining critical habitat.	*Rana sevosa*	Anura	> 10 years	USA
Jensen et al. 2003	2	The pupose of this study was to investigate the relationship between breeding by a rare species *R. capito* and the rainfall over a period of 13-years. Since this kind of long-term studies are scarce, this may serve as a basis for conservation success of other species of amphibians with similar environmental requirements.	*Rana capito*	Anura	> 10 years	USA
Muths et al. 2003	4	The objectives of the monitoring were to investigate population processes in a metapopulation of *Bufo boreas* that had not declined, and to provide Rocky Mountain National Park with information on the status of this species and the ecosystem where it occurs. Eleven years of population data suggested that this metapopulation of toads is in danger of extinction, pathological and epizootiological evidence indicates that *B. dendrobatidis* has played a proximate role in this process.	*Bufo boreas*	Anura	> 10 years	USA
Tryjanowski et al. 2003	50-100	The purpose of this study was to describe the changes in spawning times during the 25 year period and identify the possible relationships between spawning dates and climatics factos such as ambient temperatures and precipitacion.	*Rana temporaria, Bufo bufo*	Anura	> 20 years	Poland

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES[2]	GOALS AND FINDINGS				
Hachtel et al. 2003	*5*	The aims of this project includes the knowledge on population sizes and dynamics of native amphibian species including sex ratios and reproductive output to serve as a possible scientific contribution for species and nature conservation in Germany.	*Triturus alpestris, Bufo bufo, Rana dalmatina*	Anura Caudata	> 10 years	Germany
Whiteman & Wissinger 2005	Unavailable data	With data collected from 1989–1999 the authors analyze the possible causes for the declines of the salamander *Amystoma tigrinum nebulosum* and discussed the ability of long-term demographic studies to provide the background information necessary to distinguish natural fluctuations from human induced.	*Ambystoma tigrinum nebulosum*	Caudata	> 20 years	USA
Lyapkov et al. 2006	Unavailable data	This study was carried out to estimate the variation in the body size, age and reproductive characteristics of frogs from the same population over time, to analyze the reproductive characteristics and rate, to compare the birth rate and the relationship between density dependent and independent, how can affect during different phases of their aquatic and terrestrial phases of life cycle.	*Rana arvalis*	Anura	> 10 years	Russia
Puky et al. 2006	5	Eleven years of population data were collected to determine the possible effects of water level fluctuations and water chemistry on the dynamics of the *R. dalmatina* population and its management implications in a locally protected but anthropogenically influenced habitat.	*Rana dalmatina*	Anura	> 10 years	Hungary

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES[2]	GOALS AND FINDINGS				
Pellet & Schmidt 2006	1	The response of a natural population to negative anthropogenic impacts, depends crucially upon density-dependent population responses. In this study was investigated the relative importance of intrinsic (density-dependent) and extrinsic (climatic) factors impacting the dynamics of a *Hyla arborea* population over 22 years.	*Hyla arborea*	Anura	> 20 years	Switzerland
Fellers et al. 2007	856	For this study were used data from four unpublished reports and surveys to sumarize the current status of *R. cascadae* , to assess causes for the decline of this species, to identify research needs and arouse interest and alarm about the need for formal protection.	*Rana cascadae*	Anura	> 10 years	USA
Hartel 2007	81	This study suggest that both permanent and termporary ponds and the landscape connectivity is crucial for the maintenance of rich amphibian communities. Moreover, this study presents the long-term fluctuations of the populations and the correlation between the start of the breeding seaons and climatic variables.	*Hyla arborea, Bufo bufo, Pelobates fuscus, Rana temporaria*	Anura	> 10 years	Romania
Bosch et al. 2007	242	The analysis of this study shows a significant link between change in local climatic variables (rising temperature) and the occurrence of chytridiomycosis supporting the chytrid-thermal-optimum hypothesis. Meteorological conditions have significantly changed in the studied area and over the period for which chytrid-related mass mortalities have occurred.	*Alytes obstetricans, Salamandra salamandra, Bufo bufo*	Anura Caudata	> 20 years	Spain

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES[2]	GOALS AND FINDINGS				
Whitfield et al. 2007	Unavailable data	Amphibians have been sampled over 35 years at La Selva Biological Station. The data of this study raise the possibility that systematic declines in amphibian populations do not occur only in cool climates, but that because declines occurring in cooler sites occur more quickly, these are the only habitats where they are detected; also indicate that even populations of amphibians for which specific threats have not been identified may nonetheless be suffering dramatic decline, and that such populations may be considered stable because of lack of long-term data, not lack of threats.	26 species of frogs and 2 species of salamanders, but also 13 species of lizards and many species of snakes	Anura Caudata	> 30 years	Costa Rica
Petranka et al. 2007	10	Although mitigation projects have created or restored small freshwater wetlands for amphibians, there is still a lack of basic information on population persistence and long-term changes in amphibian biodiversity following site restoration. This study provided a rare opportunity to examine the long-term responses of amphibians to wetland creation and environmental stressors at an isolated breeding site.	*Rana sylvatica* *Ambystoma maculatum*	Anura Caudata	> 10 years	USA
Lyapkov 2008	Unavailable data	This long-term study provide information of the dynamics of individuals born between 1982 and 2000, and the evaluation of the relationships of demographic and reproductive characteristics with the estimated recruitment, as well as the dynamics of the reproductive part of the population.	*Rana arvalis*	Anura	> 10 years	Russia

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES[2]	GOALS AND FINDINGS				
Hartel 2008	1	Surveys were made between 1997 and 2007 to determine if the start of breeding activity is related to weather variables, the relationship between climatic variables and egg mass number, and the rate of change in the egg mass number.	*Rana dalmatina*	Anura	> 10 years	Romania
Kusano & Inoue 2008	2	Long-term data sets were analyzed for the dates of first spawning and here report on trends toward earlier breeding and correlations between the timing of breeding and climatic factors. This study study was conducted at two sites in the suburbs of Tokyo, Japan, and demonstrated that all the amphibian populations examined showed significant trends toward earlier breeding.	*Hynobius tokyoensis, Rana ornativentris, Rhacophorus arboreus*	Anura Caudata	> 30 years	Japan
McMenamin et al. 2008	49	The authors observed severe reductions in the number and diversity of amphibian populations in northern Yellowstone National Park over the past 16 years. It was documented that amphibian decline is linked to regional changes in the hydrologic landscape and overall groundwater condition, which is driven by long-term, large-scale climatic trends.	*Ambystoma tigrinum, Pseudacris triseriata, Rana pretiosa, Bufo boreas*	Anura Caudata	> 60 years	USA
Neveu 2009	39	The present study explores some the direct effects of climate on breeding phenology and indirect effects on energy allocation on the *Rana temporaria* from 1984 to 2007. It was proposed that climate change has led to more drastic conditions than in the past. In such a context extreme climatic events seem more detrimental than the long-term global warming trend.	*Rana temporaria*	Anura	> 20 years	France

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES[2]	GOALS AND FINDINGS				
Berven 2009	3	The aim of this study was confirm the potential importance of terrestrial stage vital rates to population stability. It was determine the density dependence of terrestrial stage vital rates, including juvenile and adult survival, age and size at first reproduction, and reproductive traits, for a population of Wood Frogs, *Rana sylvatica* , in Michigan.	*Rana sylvatica*	Anura	> 20 years	USA
Raithel et al. 2011	18	This 16-years monitoring of *R. sylvatica* was conducted to verify the effectiveness of the egg-mass count method, to evaluate the fluctuations in annual breeding success, to determine if ponds monitored for longer time series exhibited greater annual fluctuations, to ascertain whether smaller populations exhibited greater annual fluctuations and whether ponds exhibited synchronous annual fluctuations or tended to behave independently.	*Rana sylvatica*	Anura	> 10 years	USA
Scheele et al. 2012	335	The present study highlights the emerging threat posed by climate extremes to amphibians. For *P. pengilleyi* this could involve remediation at the site level rather than at finer scales. It was anticipated that increasingly intense droughts are likely to disproportionately threaten seasonal pool-breeding amphibian species, exacerbating the global amphibian biodiversity crisis.	*Pseudophryne pengilleyi*	Anura	> 10 years	Australia

REFERENCE	STUDY DESCRIPTION		TARGET SPECIES	ORDER	STUDY DURATION	COUNTRY
	N - BREEDING SITES[2]	GOALS AND FINDINGS				
Pickett et al. 2013	Unavailable data	This case study highlights the complexity of dealing with habitat offsets for a species which is perceived to be based on its biology and habitat requirements, and demonstrates that the level of effort required to successfully construct and monitor habitat offset may be drastically underestimated for most infrastructure projects.	*Litoria aurea*	*Anura*	> 10 years	Australia
Tiberti 2015	30	Long-time series were conducted to evaluate the status quo of the *R. temporaria* populations after being affected by an infectious bacteria caused *by Aeromonas sp*, and to assess *R. temporaria* use of modern artifical ponds compared to tradicional transhumance ponds.	*Rana temporaria*	Anura	> 10 years	Italy

[1] Altrough many of these studies initially were not designed to monitor populations, they clearly establish the fluctuation in numbers of amphibians annually, especially at breeding sites.

[2] Number of sites visited during the study period.