

Graptemys studbooks overview



Graptemys pseudogeographica kohnii (Photo by Claus Pfau)

Introduction

The genus *Graptemys* (map turtles and sawback turtles) is the largest genus of North American freshwater turtles, comprising 15 species (LINDEMAN, 2013, VAN DIJK *et al.*, 2014). Within the genus three groups are distinguished: Broad-headed species (of which the adult females are largely molluscivorous), narrow-headed species (with both sexes being mainly insectivorous) and intermediate species. The three smaller, southern map turtle species (*Graptemys flavimaculata*, *G. oculifera* and *G. nigrinoda*) are often called “sawbacks” because of the prominent processes on the first four vertebral shields of their carapace which may look a bit like a saw teeth.



Guadalupe River, Texas, habitat of *Graptemys caglei* (Photo by Beate Pfau)

Map turtles inhabit mainly broad rivers, and their population density correlates with deadwood in the middle of the stream (LINDEMAN 1999), on which they like to bask. Most of the species inhabit only one river drainage, and often we find species pairs in a river, with one species with narrow-headed females co-occurring with a species with broader-headed (and normally bigger) females.

These turtles are very popular pets and they have been exported in great numbers to Europe and Asia, until they have been assigned to CITES appendix 3 in 2006. Even now there is a lively trade in these turtles, but now most of the exported hatchlings come from specialized turtle farms. These very young and small turtles are often bought by amateurs because of their nice coloring and their cute appearance, but later the keepers find out that the turtles can grow rather fast, that they remain rather timid, and that they are prone to diseases if kept in the often-seen small turtle bowls, and in the end they often do not live long.

Many species are rated as endangered now, because they suffer from damming, boating, shooting and other recreation activities on the rivers, and also from mining activities and river pollution. Collection as pets is also still a problem, even if keeping them is restricted and requires permits.

Therefore conservation of the species in Europe through captive breeding seems important for us, and we propose to set up studbooks for some of the *Graptemys* species.

Graptemys taxonomy

There is considerable debate among the scientists on which of the different local forms should be considered a species, a subspecies or a genetic management unit (see for example the comprehensive discussion in LINDEMAN 2103). The actual categorization and the reasons for it should best be taken from the newest IUCN taxonomic checklist which is updated about annually (see VAN DIJK 2014). An illustrated overview of the genus is given by BÖHM (2012).

Short historical review of *Graptemys* taxonomy

Louis Agassiz coined the genus name *Graptemys* in 1857, when he transferred the two already described species *Emys geographica* (Lesueur 1817) and *Emys lesueuri* (Gray 1831), which was later re-named to *pseudogeographica*, to this new genus. In 1890 and 1893 GEORG BAUR described two other species of *Graptemys*, *G. oculifera* and *G. pulchra*. In 1925 the first map turtle from Texas was described, this was *Graptemys versa* (STEJNEGER). The most eastern species, and hitherto the sixth one, *Graptemys barbouri*, was described in 1942 by CARR & MARCHAND. In the 1950's FRED CAGLE was the person who described four new species of map turtles: *Graptemys ouachitensis* and *G. sabinensis* in 1953 and *G. nigrinoda* and *G. flavimaculata* in 1954. In 1974 the second species from Texas was described, *Graptemys caglei* (HAYNES & MCKNOWN). In 1992 there was a first revision of *Graptemys pulchra* with the new species *G. gibbonsi* and *G. ernsti* (Lovich & McCoy), separated from it. In 2010 the first species description which was mainly based on genetic research has been published, it was *Graptemys pearlensis* which had been described by ENNEN *et al.*, 2010.

Species delineation in *Graptemys*

The first species descriptions of map turtles used coloration and markings as distinguishing characters, later also morphometry. A nice example for this approach is the subspecies description for *Graptemys pseudogeographica pseudogeographica* and *G. p. kohnii* by DUNDEE (1974), who used the relative head width of the females for distinguishing populations of the two forms, because color and pattern are not always distinctive. This is the way amateurs identify the species of their pets.

Later researchers tried to define species by color characters and courtship display behavior, regarding sexual selection as the main reason for speciation (MYERS 2008), but the assumption that head pattern and/or courtship display was a reproduction barrier could not be verified in experimental settings. Even in nature species hybrids can be found, which are not just the result of stream captures or the release or escape of pet turtles.

From 2007 on genetic methods were increasingly used for species discrimination. Mainly the DNA of certain cell corpuscles, the mitochondria, was used, because the method of enriching the DNA and then differentiating the genetic lineages is reliable and rather cheap. In fact some species are defined by mitochondrial DNA genetic distance from other species and a well-known case of the application of this method is the species description of *Graptemys pearlensis* which is to be discerned from *G. gibbonsi* mainly with genetic methods

(ENNEN et al., 2010), while pattern and the occurrence of special markings are not always distinctive. Nevertheless the genetic method is not always suitable for *Graptemys* taxonomy (see for example REID et al. 2011), because in this genus the overall genetic distance within the mitochondrial DNA is rather small. A more distinctive genetic species separation method is the identification of special gene sequences, the microsatellites, within the cell nucleus itself (see for example WIENS et al., 2010). Using this method FREEDBERG & MYERS (2012) suggested that *Graptemys geographica* had hybridized with *G. pseudogeographica* in the region of nowadays Reelfoot lake in Tennessee within the last few hundred thousand years, but later these two species had been separated by geological events.

Within a defined map turtle species or subspecies some researchers discern local forms, which inhabit neighboring rivers or different parts of the same river, as shown by WARD et al. (2013) for *Graptemys caglei*, using genetic methods. Obviously there are also some local forms of *G. sabinensis* which attain different maximum sizes (LINDEMAN 2013) or which show different colorations (SANDERS et al. 2010) but these have not yet been subject to detailed studies. These local forms are not so distinctive that their description could be used for identifying every pet map turtle kept in the EU, and it is not clear whether they could again interbreed in nature if the reason for separation of their habitats (dams, river channels etc.) disappears. Therefore we decided that we include all animals of a certain species or subspecies in the *Graptemys* studbooks and we exclude only obvious hybrids.

In situ situation

Major threats and conservation within the US

Since map turtles are cute and have a pretty coloration they have always been in great demand within the pet turtle market, and that's also why they were exported in large numbers to Europe and Asia. TELECKY (2000) lists the export numbers from 1989 to 1997 from the database of the United States Fish and Wildlife Service's Law Enforcement Management Information System. These numbers are in fact alarming: Within these years the US have exported a total of 288,858 *Graptemys* of unspecified species, and additionally 889 *G. barbouri*, 31 *G. caglei*, 50 *G. flavimaculata*, 16,447 *G. geographica*, 61,032 *Graptemys pseudogeographica kohnii*, 4,605 *G. nigrinoda*, 88 *G. ouachitensis*, 2,729 *G. pseudogeographica pseudogeographica* und 98 *G. versa*. Please remember that the specified numbers are only for legally exported map turtles, and it must be assumed that the real numbers had been much higher. It is likely that most of these turtles had been wild caught, because the large US turtle farms did not produce many map turtle hatchlings at this time.

Since the 14. June 2006 all *Graptemys* species are listed in appendix III of the Washington Convention on International Trade in Endangered Species. This means that exportation of map turtles from the US has been regulated, but there are nevertheless imports from the US to Europe and Asia, where the trade with these turtles is not reglemented. The US Endangered Species Act prohibits trading *Graptemys oculifera* and *G. flavimaculata* between different US states.

Within the US there are even more restrictive laws for catching and possessing certain map turtle species, but these laws are different from state to state and sometimes even within a state. An actual overview of the laws and regulations can be gathered from the database of the US Fish and Wildlife Service. It is also rather difficult to obtain a map turtle in the US, since freshwater turtles can be sold in pet shops only with a carapace length of more than about 10 cm (four inch rule). The ban was brought into effect under the Public Health Services Act by the Food and Drug Administration (FDA) in 1975 to address the problem of *Salmonella* infections in children. These US laws and regulations significantly hamper the husbandry and breeding of map turtles by amateurs.

The big pet turtle production farms in the southern states of the US are subject to special regulations and they still can produce and export large numbers of hatchlings (see REED & GIBBONS 2003).

Map turtles live in pristine or at least semi-natural rivers, which are often included in protected natural areas in the US, which means a specially protected status to them, too, but there seems to be no natural park or other protected area which has been founded to protect the map turtle population living there. Outside the protected areas map turtles are protected for example by hunting regulations, but this does not prevent them being used as practice targets by recreational hunters who injure or even kill large numbers of basking turtles only for fun. Of course there are laws for environmental impact assessments before a large construction project can be started. These EIA's list the impact on plant and animal species in the affected area, but normally the projects will be carried out even if they seriously threaten the existing habitat of rare turtle species. Sometimes replacement and compensatory measures have to be implemented but there is normally no control of their effect.

Map turtle situation in important river systems

Guadalupe River:

In this river *Graptemys caglei* is the rarest turtle species. Basking turtle counts have resulted in a population estimate of about 13,500 animals for this species (report by PETER LINDEMAN to the IUCN 2009). Main threats are loss of habitat and recreational activities.

Pearl River:



Basking females of *Graptemys oculifera* (Photo by Bob Jones)

Graptemys oculifera is number 6 in rarity of the map turtles, their population density is 90 – 340 turtles per river km. The sympatrically occurring *Graptemys pearlensis* suffered a loss 80 – 98% since the 1950's, in 2009 the species complex *G. pearlensis* / *G. gibbonsi* had been rated as number 2 in rarity of the map turtles. A basking turtle count of both species (LANDRY & GREGORY) has shown a further reduction of population density of both species since 1999. Main threats for *Graptemys oculifera* and *G. pearlensis* in this river are channelization, removal of deadwood and general habitat loss, and also illegal collection for the pet trade and illegal shooting by recreational hunters. For the broad-headed females of *Graptemys pearlensis* the decrease of the mollusc populations seems to be an additional problem.

Pascagoula River:

Graptemys flavimaculata is number 3 in rarity of the map turtle species, the population density exceeds 44 turtles per river km in the Pascagoula river itself and 22 in its tributaries Leaf and Chickasawhay river. The overall population estimate is 50.000. *Graptemys gibbonsi* is even rarer (see also above). The species ratio of these two sympatrically occurring map turtles is between 1.62:1 and 16.38:1 (SELMAN & QUALLS 1990). Main threats to the map turtles in this river system are pollution, impoundments, dredging, channelization, and removal of deadwood. It is not clear whether the spreading of the invasive mussel *Corbicula fluminea* in this river system will have a positive effect on both species, since it is a food item for both species and it is more resistant to pollution and habitat alterations than the indigenous mollusc species.

Apalachicola River system:

Graptemys barbouri is number 4 in the map turtle species rarity list, the population has been estimated as 1000 – 10.000 turtles in possibly 20 separate sub-populations (FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION 2013).

Ex situ Situation

Within the US there are, due to the laws and regulations, only few hobbyists who specialize on map turtle breeding, but in the large commercial turtle breeding farms enormous numbers of map turtle hatchlings are produced and subsequently exported (see for example WEISSGOLD 2010) as documented in the CITES-Database. Since about 2007 almost only map turtles specified as *Graptemys pseudogeographica* and *Graptemys ouachitensis* have been exported in large numbers, but these turtles are in fact quite often hybrids of different map turtle species and / or subspecies (Lee 2012) and therefore not suitable for the inclusion into studbooks.

The market value of map turtles is still quite high, therefore large farms for breeding map turtles have been built up outside the US, mainly in China (ZHOU *et al.* 2008), and thus it is not astonishing that China is the main exporter of the rarer *Graptemys* species into Europe. China exported for example 60 living *Graptemys versa* into Germany in the years from 2010 to 2012 – and please note that there are only legalized imports into the EU! Of course one has to be cautious when buying these rare *Graptemys* specimens from turtle farms, too, since it is not clear whether the breeding groups are homogeneous or whether there is the same risk of acquiring hybrids as from the commercial US turtle farms.

There is also a vivid trade of *Graptemys* specimens in the other direction, since in the last few years Germany and Austria export for example *Graptemys nigrinoda*, *G. oculifera* and *G. flavimaculata* to Japan, China and Hong Kong. The main reason for this export is probably the exorbitant price the purchasing agents in these countries pay for hatchlings and sexed individuals of the species which are highly demanded. This decreases the possibility that more European breeders will participate in the map turtle studbooks, since this means a lesser profit margin compared to exporting all hatchlings.



Adult female of *Graptemys oculifera* (Photo by Günter Kalter)

We have mainly made contacts to German speaking map turtle breeders until now. We know of more breeders in France and Italy where the map turtles can be kept and bred in outside ponds year-round, because the necessary high summer temperature as can be attained there. In middle and northern Europe the map turtles have to be kept indoors, best in large, heated greenhouses or winter gardens, to supply enough summer warmth for successful reproduction.

Keeping map turtles indoors is a challenge, since these riverine species are strong swimmers and need a very good water quality. If they are kept under crowded conditions or inadequate temperature or in water low in oxygen due to overfeeding, they are prone to eye infections and shell diseases. Map turtles do need high quality lighting if it is not possible to keep them in a greenhouse-like setting. Especially young map turtles can get soft shells and all kinds of infectious diseases rather quickly and then they often do not survive. Even if they have a good vitamin supply via their food they remain frail under inadequate lighting.

Since map turtles are very active swimmers they need a lot of space in their tanks. The females of many map turtle species are really large, which means that they cannot be kept adequately in normal custom aquaria, but they normally need specially constructed large tanks or indoor ponds.

Diseases like viruses, mycobacteria and other bacteria, protozoans and parasitic diseases seem to be more a problem in map turtles than in other pet turtles, since the map turtles are especially prone to stress, which is conducive to developing strong infestations. On the other hand well-kept map turtles can have similar diseases without showing symptoms, so it is mandatory to keep newly acquired specimens in quarantine and have them checked

regularly by experienced turtle veterinarians, and after forming new groups it is necessary to observe the turtles very closely to detect stress signs as early as possible, and remove the troublesome animal as soon as possible.

Well-kept map turtle males will always want to mate and thus they can stress the females considerably. On the other hand adult females are much bigger than the males and they tend to bite strongly to defend themselves against annoying males. Keeping all-female groups of one species or even of mixed species is often possible, but it is necessary to observe all map turtle groups closely. It may even be possible to keep all-male groups of mixed species, but the keeper must be aware that keeping map turtle males together is always a risk.

Map turtles do hybridize easily under captive conditions (LEE 2012) and hybrids are not always easy to determine. Therefore all map turtle studbook participants should know the origin of their animals and they must check new studbook animals very closely, not only for diseases, but also for signs of hybridisation.

5 Graptemys studbooks

***Graptemys barbouri*, Barbour's Map Turtle, ESF Category B**



Graptemys barbouri (Photo by Tina Hahnert)

IUCN Red List Category & Criteria: Vulnerable A2bcde. *Graptemys barbouri* has been assessed as Vulnerable due to an inferred population decline resulting from overharvesting,

habitat degradation, predation and disease. The global population is estimated to be between 1,000 and 10,000 individuals, restricted to a maximum of 20 subpopulations.

Within the US this species is not categorised, see on the internet page of the Fish and Wildlife Service.

The ESF classification of the situation in captivity (ex situ) in the EU would be B, because we could actually identify 14 different bloodlines (but not all of the owners participating in the studbook), and incidental imports of additional animals into the EU seem possible. Within the studbook group of 5 participants we have 13 animals of this species. There is no indication that animals from the Pea or Choctawhatchee Rivers, where this species seems to hybridize with *G. ernsti* (Lechowicz 2014), have ever come to the EU. Therefore all European *G. barbouri* seem suitable for inclusion in the studbook.

The goal of the studbook for this species is building up a stable population within the EU, and of course conservation of as much of the bloodlines as possible.

This is a large map turtle species with very broad-headed females, and it is quite attractive for pet turtle keepers, because the females can be kept peacefully with conspecifics or with other similarly peaceful species, and they grow rather slowly compared to the sawback species. The males can also be kept in groups with conspecifics or males of other species (especially sawbacks), but the sexes should be kept apart and the groups should be closely watched and animals that annoy the others should be kept separately.

Adult females need very large basins with a minimum 700 l of water, because they may grow up to 30 cm carapace length and 2.5 kg of weight. Additional info on the husbandry can be found on www.zierschildkroete.de

Studbook keeper Tina Hahnert

Co-studbook keeper Leo Schober

***Graptemys caglei*, Cagle's Map Turtle, ESF Category A**



Graptemys caglei (Photo by James R. Buskirk)

IUCN Red List Category & Criteria: Endangered A2c+4c; B2ab(iii), which indicates a population size reduction of $\geq 50\%$ over the last 10 years or three generations and additionally the area of occupancy has been estimated to be less than 500 km² and is declining due to habitat quality. *Graptemys caglei* warrants Red List status as Endangered as its range has reduced by half to two-thirds since 1974, and the species is now restricted to a single stretch of about 120 km of the lower Guadalupe river, where the population appears to be under continuing threat from habitat degradation, disturbance and water diversion. Further distribution and population trend data may document that the species warrants listing as Critically Endangered. *Graptemys caglei* was considered the rarest of all *Graptemys* by Lindeman (pers. comm. 6 Aug 2009) based on extensive basking surveys.

Within the US this species is not categorised, see on the internet page of the Fish and Wildlife Service.

The ESF classification of the situation in captivity (ex situ) in the EU would be A, because we could actually identify only four different bloodlines, but we suspect that there is one (perhaps even two) additional breeding groups with different bloodlines in the EU. Within the studbook group of 2 participants we have 4 animals of this species.

For the studbook we are still trying to contact more breeders or people interested in keeping this species so that we can build up different breeding groups.

This species with its distinctive reticulating network of circles and lines on the carapace is not a large map turtle species, females growing up to about 20 cm carapace length and males up to only 13 cm, and therefore making quite attractive pets. Nevertheless these turtles are quite aggressive towards other turtles and each Cagle's map turtle should be kept singly in a separate aquarium, except for (supervised) mating once a year.

Studbook keeper Leo Schober

Co-studbook keeper Michael Richter

***Graptemys flavimaculata*, Yellow-Blotched Sawback, ESF Category A**



Graptemys flavimaculata (Photo by Tina Hahnert)

IUCN Red List Category & Criteria Vulnerable A2bce+4ce. *Graptemys flavimaculata* has been of long-term concern due to declining populations, having declined historically in the Chickasawhay River and in the Leaf and upper Pascagoula rivers more recently, which together represent 80% of the range of the species; further population declines were observed following the impacts of hurricanes Ivan in 2004 and Katrina in 2005.

This species is categorized as „vulnerable“ within the US, see on the internet page of the Fish and Wildlife Service and in the species overview by Selman & Jones (2011).

The ESF classification of the situation in captivity (ex situ) in the EU would be A, because we have only four different bloodlines within our studbook group, and additionally there might be one or two additional bloodlines within the EU. The actually 8 participants of the planned studbook have 10,14,11 animals of this species.

Since most of the animals are males born to one breeding group (the Stuttgart Zoo), we try to bring all the females (still some wild caught animals and rather few captive bred females) into our groups as to retain as much of the original bloodlines as possible, and we try to distribute the animals within our breeding groups as to avoid genetic bottlenecks and to minimize genetic loss within the EU. These turtles are searched for in the Asian pet market, so it is important to erect studbooks to avoid that too many animals are exported and thus lost to our breeding stock.

Yellow-blotched sawbacks are very popular pets for advanced turtle keepers, since they do not grow too large and are not prone to diseases, and they can even be kept with conspecifics and in mixed species groups. Nevertheless the sexes should be kept separate.

Studbook keeper Michael Richter

Co-studbook keeper Tina Hahnert

***Graptemys oculifera*, Ringed Sawback, ESF Category A**



Graptemys oculifera (Photo by Tina Hahnert)

IUCN Red List Category & Criteria Vulnerable B2ab(iii). *Graptemys oculifera* occurs in two rather small drainage basins (875 and 90 km river length occupied, respectively), where populations appear stable or in some decline, and remain under actual or potential threat from pollution and sedimentation, habitat degradation and loss including channelization, hurricane impacts, and further minor impacts.

This species is categorized as „threatened“ within the US, see on the internet page of the Fish and Wildlife Service and in the species overview by Jones & Selman (2009).

The ESF classification of the situation in captivity (ex situ) in the EU would be B, according to the classification rules of the ESF pages, because we know of 11 different bloodlines which had formed one breeding group (Hertwig 2001). Three of these bloodlines seem to have survived and are represented within our studbook, which has actually 8 participants who keep in sum 14 males and 15 females of this species. Nevertheless we propose to the ESF category A for *Graptemys oculifera*, which means more close monitoring, because the species is in high demand, which would eventually lead to breeders producing offspring with animals of unknown descent, and thus there is obviously a risk of getting hybrids into our studbook population.

In our studbook we are trying to build up several different breeding groups from animals known to be pure *G. oculifera*, as to minimize the risk of further loss of bloodlines.

Ringed sawbacks can be kept like their close relatives, the yellow-blotched sawbacks. The problem of preventing the selling-off of too many animals of this species to Asia is the same for both species.

Studbook keeper Günter Kalter
Co-studbook keeper Leo Schober

***Graptemys sabinensis*, Sabine Map Turtle, ESF Category B**



Graptemys sabinensis (Photo by Leo Schober)

There is no separate IUCN Red List Category & Criteria classification for this species. It has long been regarded as a subspecies of *Graptemys ouachitensis*, which has the IUCN category “least concern” due to its large area of occupancy and its large-scale production within the US turtle farms.

Detailed research of skull morphology (Ward 1980) seemed to justify the separation of the Sabine Map turtle from the Ouachita Map turtle, but this dissertation was never published and the examined skull sample was small. Therefore this species separation was not accepted. Lindeman (2013) assembled all the later research on this species and concluded that it should be elevated to full species rank, which classification was tentatively followed by Van Dijk et al. 2014.

Graptemys sabinensis has a rather small area of occupancy which is impacted by damming and mining etc. and therefore we think it might be categorized as “near threatened” in near future.

The ESF classification of the situation in captivity (ex situ) in the EU would be A, because of the 10 known bloodlines only 4 seem to have survived.

Within our studbook with 3 participants we have 4 surviving imports (2 pairs) and one female offspring, and two juveniles. Of course we are trying to build up more breeding groups from captive bred hatchlings from these animals to diminish the risk of further loss of bloodlines.

Sabine map turtles have a funny appearance “(pencil-necked geek” as Lindeman (2013) put it for the males), and even the females are not too large, up to a maximum of 20 cm carapace length, but usually considerably smaller. These turtles can be kept in mixed groups with conspecifics and other turtles of similar compatibility, but the sexes should be kept separate.

Studbook keeper Leo Schober

Co-studbook keeper Tina Hahnert

Assessment of the studbook suitability for the other *Graptemys* species / subspecies



Graptemys nigrinoda (Photo by Claus Pfau)

	IUCN	Trend	Ex situ EU	No studbook at the moment because...	
<i>Graptemys ernsti</i>	Near threatened	decreasing	A	Not enough animals / participants	
<i>Graptemys geographica</i>	Least concern	stable	A	Not enough animals / participants, many misidentified animals which in fact belong to other species	
<i>Graptemys gibbonsi</i>	endangered	decreasing	A	Possible hybrids with <i>G.</i>	

	IUCN	Trend	Ex situ EU	No studbook at the moment because...	
				<i>pearlensis</i> , no information about pure <i>G. gibbonsi</i> available	
<i>Gratemys nigrinoda nigrinoda</i>	Least concern	stable	C	Too many imports	
<i>Gratemys nigrinoda delticola</i>	Least concern	stable	C	No clear distinction from nominate subspecies, see ENNEN <i>et al.</i> , 2014	
<i>Gratemys ouachitensis</i>	Least concern	stable	C	Too many imports incl. possible hybrids	
<i>Gratemys pearlensis</i>	endangered	decreasing	A	Possible hybrids with <i>G. gibbonsi</i> , no information about pure <i>G. pearlensis</i> available	
<i>Gratemys pseudogeographica pseudogeographica</i>	Least concern	stable	C	Too many imports incl. possible hybrids	
<i>Gratemys pseudogeographica kohnii</i>	Least concern	stable	C	Too many imports incl. possible hybrids	
<i>Gratemys pulchra</i>	Near threatened	unknown	A	Not enough animals / participants	
<i>Gratemys versa</i>	Least concern	stable	A or B	Not enough animals / participants	

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