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Checklist of chelonians from the upper Madeira River and the lower Madeira-Purus interfluvium (Brazilian Amazon), including a range expansion for *Podocnemis sextuberculata* Cornalia, 1849

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Abstract: We present data on occurrence of chelonians for the Madeira River (southwestern Amazon, Brazil). Sampling was undertaken along the BR-319 Highway in the Madeira-Purus interfluvium and along a 125-km stretch of the upper Madeira River. Findings were contrasted with a checklist of species expected to occur in the region according to current distribution maps, and with literature data for the Madeira subbasin. Out of 12 expected species, we recorded five in the Madeira-Purus interfluvium (three other species were registered by other recent voucher-based studies in the region), and eight species in the upper Madeira region. *Podocnemis expansa* (Schweigger, 1812) and *P. unifilis* Troschel, 1848 occurred below and inbetween the upper Madeira rapids. *Podocnemis sextuberculata* Cornalia, 1849 had its range extended by over 700 km, but may be limited upriver by the rapids. *Mesoclemmys gibba* (Schweigger, 1812) and *M. raniceps* Gray, 1855 occurred sympatrically along the river. Chelonian diversity along the lower and upper Madeira appears to be complementary.

Key words: *Chelonoidis*; *Chelus*; conservation monitoring; Neotropics; *Platemys*; river dams

INTRODUCTION

The distribution areas of chelonian species in the Brazilian Amazon frequently are based on scarce locality records spread over huge areas, with the notable exception of the most conspicuous podocnemidids and the terrestrial *Chelonoidis denticulata* (Linnaeus, 1766) (see Iverson 1992 and his updated digital distribution maps in Iverson et al. 2000). A number of factors contribute to this state of affairs, such as the huge extension and logistical difficulty of surveying Amazonian aquatic habitats, the secretive habits of many species, and the fact that many chelonian records stay only in the logbooks of scientific expeditions and lack collected specimens or even photographs of the turtles or tortoises. Also important is the accelerated habitat destruction and alteration in the southeastern Amazon, and increasingly so in its southwestern region (Vieira et al. 2008), which may compromise the environmental integrity of entire watersheds in the region over the next decades (Soares-Filho et al. 2006). Even in this scenario, the Madeira River, the largest tributary of the right margin of the Amazonas River, stands out as surprisingly devoid of chelonian records. The Madeira basin is included, partially or as a whole, in the inferred distribution area of several chelonian species (Rueda-Almonacid et al. 2007). Five of these have no published geographically referenced locations for the Madeira River, while others, including the ubiquitous *Podocnemis unifilis* Troschel, 1848 and *Podocnemis expansa* (Schweigger, 1812), have one or two locations, most of them in the lower portion of the river (Iverson et al. 2000; Berry and Iverson 2001; Schneider et al. 2012). *Podocnemis expansa* is the only species recorded from the upper Madeira (Iverson 1992; Iverson et al. 2000). Only three species (*Platemys platycephala* (Schneider, 1792), *Podocnemis unifilis* and *Podocnemis erythrocephala* [Spix, 1824]) have one record in the region between the Madeira and Purus rivers (Madeira-Purus interfluvium) (Iverson et al. 2000; Schneider et al. 2012).

The upper Madeira River featured one of the most impressive sets of whitewater rapids in the Amazon basin (Cella-Ribeiro et al. 2013), which have been evaluated as a potential historical barrier for fishes (see review in

Queiroz et al. 2013), river dolphins (Gravena et al. 2014), and crocodilians (Hrbek et al. 2008). A biogeographical transition also has been detected in one anuran species inhabiting the left margin of the upper Madeira (Simões et al. 2012). Due to the absence of distribution data, it is unknown whether the rapids act as a barrier and affect chelonian diversity up- and downstream on the Madeira. The sole record of *P. expansa* from the Madeira River (Iverson et al. 2000) is immediately downstream from the rapids, although the species is known to reproduce in the Guaporé River, an upstream tributary (Soares 2000; Cantarelli 2006). Seven other species have been recorded from the headwaters of the Madeira in Bolivia, but none or only one or two records are from the lower Madeira (Ernst 1987; Ernst and Leuteritz 1999; Iverson et al. 2000; Berry and Iverson 2001; Schneider et al. 2012).

In recent years there have been several biodiversity surveys along the Madeira River and the Madeira-Purus interfluvium, such as the PROBIO Project, sponsored by the Brazilian Ministry of Environment (Rapp-Py-Daniel et al. 2007), the environmental impact assessment of the repavement of the Manaus to Porto Velho BR-319 Highway (UFAM/DNIT 2009) as well as other projects associated with the PPBio Program along the highway (http://ppbio.inpa.gov.br), the environmental surveys for management plans of conservation units (NUSEC/UFAM 2014a, 2014b), and the environmental impact assessment and monitoring projects for two hydroelectric powerplants in the upper Madeira River (Santo Antônio http://www.santoantonioenergia.com.br and Jirau http://www.energiasustentaveldobrasil.com.br). These studies produced a considerable amount of information about the occurrence and distribution of the fauna in the Madeira River basin, including chelonians.

Here we report on chelonian species recorded during two field-intensive projects carried out in the Madeira River subbasin: a 2-year chelonian survey for the environmental monitoring program of the Santo Antônio hydropower plant, in the upper Madeira (state of Rondônia, Brazil), and a 4-year research project on foodwebs of small forest streams along the BR-319 Highway in the state of Amazonas (Brazil). We report a qualitative subsample of the total number of chelonians sampled during both studies, namely those specimens that are individually verifyable through physical and/or photographic vouchers with exact geographic coordinates. Quantitative survey data of both studies will be reported elsewhere. The records are contrasted with the scarce information available on the occurrence of chelonians in the lower part of the Madeira River subbasin, as well as the list of expected species in the area, based on the available distribution data from literature. Our objectives were: (a) to assess the distribution of chelonian species expected to occurr in and along the Madeira River; and (b) to evaluate the complementarity of chelonian diversity in the lower and upper Madeira River, considering that the latter is impacted by the construction of two hydroelectric dams and their associated reservoirs.

MATERIALS AND METHODS

Madeira-Purus interfluvium

Surveys in the lower Madeira-Purus interfluvium were carried out on 11 RAPELD sampling modules (Magnusson et al. 2005) of the PPBio Program located in forested areas along approximately 600 km of the BR-319 Highway, between the localities of Careiro da Várzea (03°11′42″ S, 059°52′12″ W) and Humaitá (07°30′43″ S, 063°02′17″ W) (Figure 1). The at present partially impassable highway crosses the interfluvium from northeast to southwest for about 800 km. Sampling modules are 40–80 km apart. Details on the sampling design along the BR-319 Highway can be found at https://ppbio.inpa.gov.br/sitios/br319/infra.

The interfluvium features gentle soil and topography gradients, with altitudes varying between 30–50 m (IBGE 1997), and the occurrence of large tabular interfluves with a flat topography (Radambrasil 1978). Until km 260 of the highway, sampling units are located on a relatively young *palaeo-varzea* deposited by the Amazonas River (Costa et al. 2001; Rossetti et al. 2005), with frequent and subtle micro topographic variations of 1–3 m, which favor the formation of temporary ponds. The mean annual temperature of the region ranges between 24–26°C. The rainy season usually starts in October, reaching its highest peak between January and March. Vegetation cover is dominated by dense to open tropical forests (Radambrasil 1978).

Sampling was undetaken on 250 m stretches of 53 different 1st- to 3rd-order streams. Many of the 1st- and 2nd-order streams sampled dry out completely during the dry season (between June and October). Three sampling campaigns took place between November and February to March from 2012 to 2015, when all streams had enough water. Five fyke nets (Vogt 1980, 2012) were set on each 250 m stretch for 3–5 days (average 3.57 days) and were checked daily. All captured individuals were transported alive to the camping site, where all biometric measurements and photographs were taken.

Upper Madeira region

The upper Madeira River is embeded in a deep valley punctuated by crystalline rock outcrops that form 18 sections of rapids between the cities of Porto Velho and Guajará-Mirim, the latter on the upstream tributary Mamoré River (Cella-Ribeiro et al. 2013). The water current was generally strong and fast flowing, along steep river banks, with only a few small tributary rivers. A

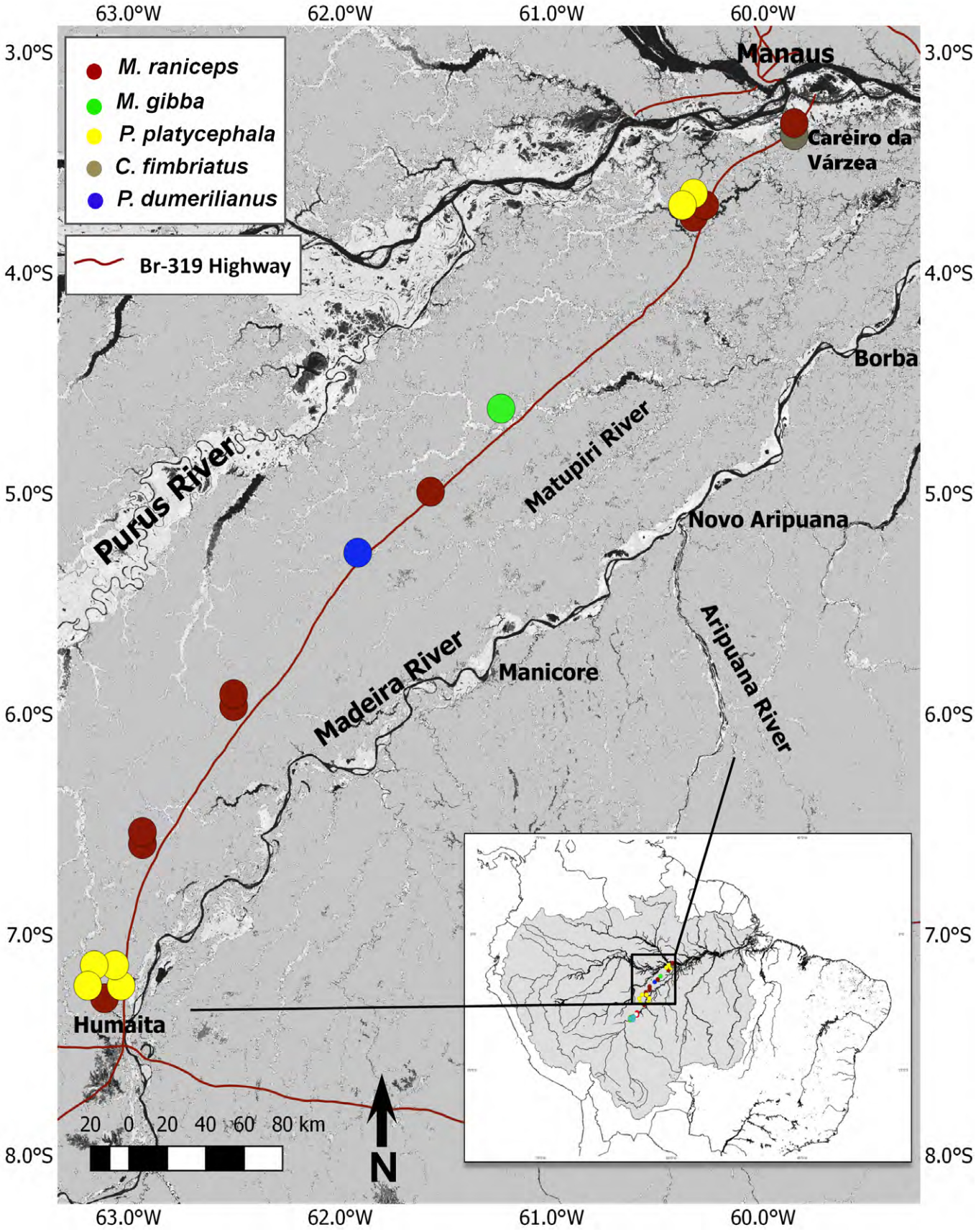

Figure 1. Map of chelonian location records in the area surveyed in the Madeira-Purus interfluvium along the BR-319 Highway, plotted on a JERS-1 image acquired on May/June 1996 (ASF 2015). Location points reflect the coordinates listed for each species for the region (MPI) on Table 1. Coordinates are in datum WGS84. M.raniceps = *Mesoclemmys raniceps*; M.gibba = *Mesoclemmys gibba*; P.platycephala = *Platemys platycephala*; C.fimbriatus = *Chelus fimbriatus*; P.dumerilianus = *Peltocephalus dumerilianus*.

number of islands with sandbanks formed large beaches during the low water season, from July to October, and adjacent pools of lentic water. Near Porto Velho the margins of the Madeira are covered mostly by pasture and small-scale agriculture land, while upstream there are patches of terra-firme forest, seasonally flooded forests and more open, white-sand forests. The flooded forests are restricted to lowland areas near the riverbank. Permanent to semi-permanent lakes also are found along the larger rivers in the area. The climate is tropical humid with average monthly temperatures between 20–30°C, and minimum and maximum temperatures between 18 and 33°C. The dry season extends from June to September, the rainy season from October to May. Monthly rainfall is less than 30 mm in June to July and up to 330 mm in December to January (Horbe et al. 2013). Small streams and pools are present in the forest, and many of these may dry out completely in the dry season.

Surveys were carried out in 2010 and 2011 along a 125 km stretch of the river between the Santo Antônio rapids (08°48'11" S, 063°57'00" W), 10 km upstream from the city of Porto Velho, and the Jirau rapids (09°19'46" S, 064°43'54" W) (Figure 2), as part of the environmental monitoring program for the construction of the hydropower plant of Santo Antônio. This part of the river featured three other rapids: Teotônio, Morrinhos and Caldeirão do Inferno (Figure 2). Teotônio and Jirau used to be the most formidable of the upper Madeira rapids, the only ones that precluded navigation year-round (Cella-Ribeiro et al. 2013). All fieldwork was undertaken prior to the formation of the hydroelectric dam reservoir, which permanently obliterated the rapids up to Caldeirão and flooded lowland areas on the riverbanks in November 2011.

Aquatic surveys were carried out from mid-July to the end of September along a 110 km river stretch between the Santo Antônio and the Caldeirão do Inferno rapids (09°16'05" S, 064°39'45" W). Choice of trapping sites was arbitrary, at suitable points for chelonians in the Madeira river and its main tributaries in the area: until 50 km upstream the Jaci-paraná River (09°12'08" S, 064°23'14" W), 23 km upstream

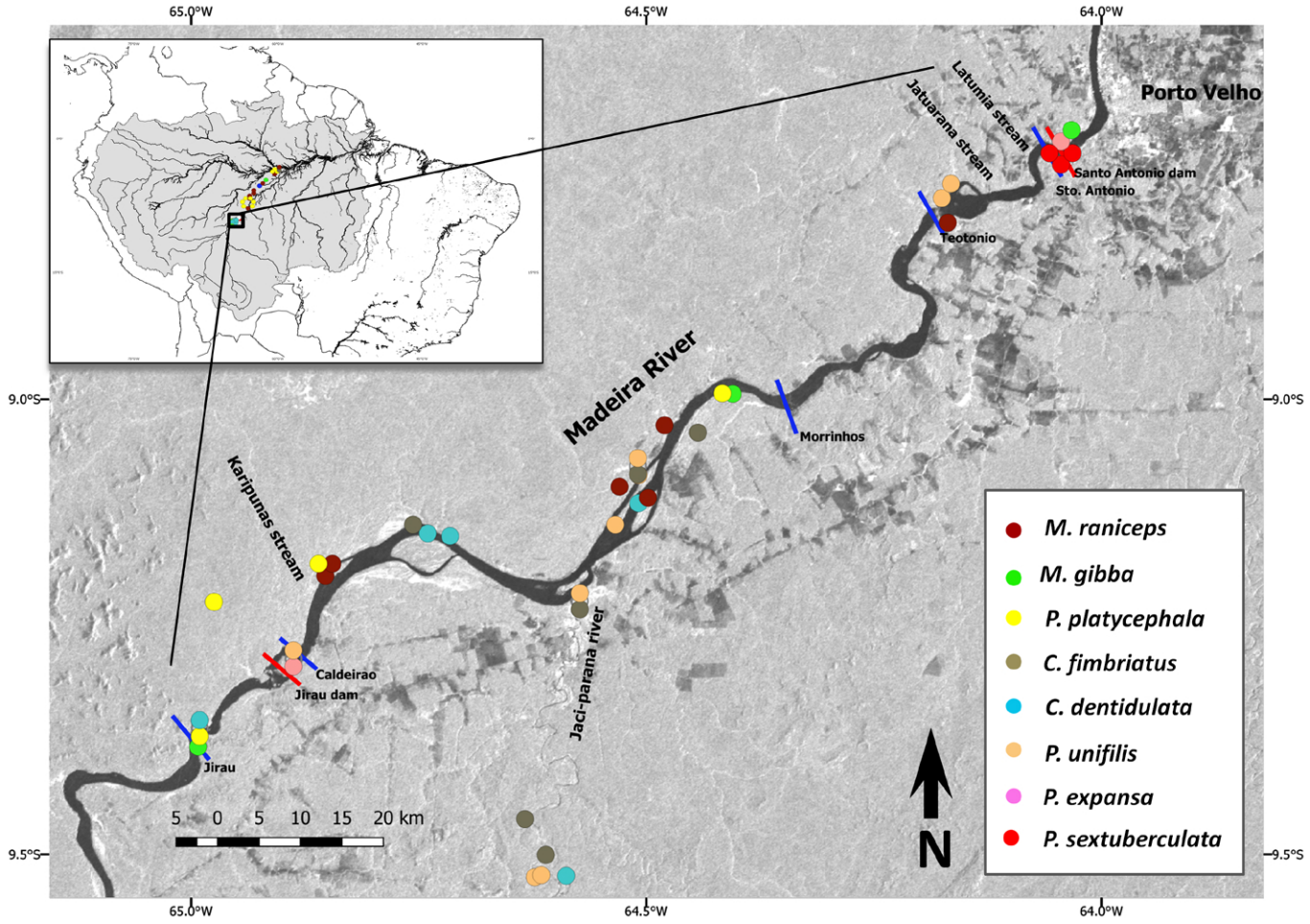

Figure 2. Map of chelonian location records in the area surveyed in and along the upper Madeira River, between Porto Velho and the Jirau rapids, plotted on a JERS-1 image acquired on May/June 1996 (ASF 2015). Location of the rapids (now obliterated by hydrodam reservoirs) is indicated by a blue line. Location of the Santo Antônio and Jirau dams is indicated by red lines. Location points reflect the coordinates listed for each species for the region (UM) on Table 1. Coordinates are in datum WGS84. M.raniceps = *Mesoclemmys raniceps*; M.gibba = *Mesoclemmys gibba*; P.platycephala = *Platemys platycephala*; C.fimbriatus = *Chelus fimbriatus*; C.denticulata = *Chelonoidis denticulata*; P.unifilis = *Podocnemis unifilis*; P.expansa = *Podocnemis expansa*; P.sextuberculata = *Podocnemis sextuberculata*.

to the rapids of the large blackwater Karipunas Stream (09°11′30″ S, 064°37′27″ W), 3 km upstream the white-water Jatuarana Stream (08°49′54″ S, 064°02′56″ W) and 1 km upstream the black/clearwater Latumia Stream (08°50′00.7″ S, 063°59′48.1″ W) (Figure 2). Lakes near the river margins also were surveyed. We used fyke nets, trammel nets and seine nets (Vogt 1980, 2012) for trapping turtles, choosing the most suitable method in each case according to water depth and current velocity. Fyke nets were exposed for three days at each location and checked every 24 hours. Trammel nets were usually exposed for 9 hours at each location and checked every 3–4 hours. Net seining was used exclusively in the Madeira River to capture *Podocnemis* spp. in deep-water pool aggregations, usually in the proximity of nesting beaches. More details about the trapping devices and effort can be found in Keller et al. (2013).

Records from terrestrial and small-scale aquatic habitats (forest streams and pools) were obtained from third-party surveys along 125 km of the river margin from the Santo Antônio to the Jirau rapids (Figure 2). Sampling was carried out in standardized RAPELD modules (see Fraga et al. [2014] for a description of the terrestrial sampling infrastructure in the area) or during faunal rescue operations in areas to be flooded by the Santo Antônio dam reservoir and therefore subjected to deforestation. We had access to rescue animals brought to the wild animal screening center of the Santo Antonio hydroelectric power plant.

Permits, animal handling and data availability

Chelonian capture and handling was in accordance with Brazilian conservation and animal welfare laws, and was undertaken under capture, collection and transport licenses from the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis IBAMA/SISBIO (permits #067/2010 and #138/2011 [proc. #02001.000965/2008-83], proc. #02001.000508/2008-99, #29069-1 and #28648-1, #28648-2, #28648-3 and #28648-4).

Species identification and scientific nomenclature follows Rueda-Almonacid et al. (2007), who provide identification keys, diagnoses, descriptions, and biological and distributional data for all species in this study. The identification of *Mesoclemmys* specimens was confirmed by Richard Vogt (INPA). Both projects were planned to base their records of chelonian species on a photographic registry and to limit physical vouchers to a representative minimum. Physical vouchers were produced via sedation and subsequent lethal overdosis of a lidocaine chlorhydrate/epinephrine anesthetic for veterinary use (Anestésico L, Eurofarma®). Animals that died accidentally during trapping or handling were preserved as physical vouchers whenever possible. All whole bodied specimens were fixated in 10% formalin and permanently preserved in 70% ethanol. Tissue samples (interdigital membrane skin preserved in 70% ethanol) have been obtained as indicated in Table 1 and are deposited in the tissue collection of INPA (Instituto Nacional de Pesquisas da Amazônia). Physical vouchers were deposited in the Zoological Collection of INPA.

All data are available for free download in the data repository of the Programa de Pesquisa em Biodiversidade (PPBio) and can be accessed at https://ppbiodata.inpa.gov.br/metacatui/#view/PPBioAmOc.50.30 or https://search.dataone.org/#view/PPBioAmOc.50.30.

Literature review

We reviewed available records and general inferred distribution areas of Amazonian chelonians in Rueda-Almonacid et al. (2007), the updated digital distribution maps of Iverson (1992) in the World Turtle Database on EmySystem http://emys.geo.orst.edu/ (Iverson et al. 2000) and the species accounts from the on-line version of the Catalogue of American Amphibians and Reptiles (https://www.zenscientist.com/index.php/pdflibrary2/Open-Access-Journals/caar/; available species accounts

Table 1. List of chelonian specimens collected and/or recorded photgraphically along the BR-319 Highway (state of Amazonas, Brazil), in the Madeira-Purus interfluvium along the lower and middle Madeira River (east of Humaitá), and in and along the upper Madeira River (state of Rondônia, Brazil), between the city of Porto Velho and the locality of Cachoeira do Jirau. na=not available or not applicable; Column "Sex": M=male, F=female, J=juvenile; "SCL"= straight carapace length (decimal positions are indicated according to measurement resolution); "Region": UM=upper Madeira River, MPI=Madeira-Purus interfluvium; "Margin": R=right, L=left; "Voucher nr"=registration code of the physical voucher in the herpetological collection of INPA; "Photo voucher nr"=code that relates the specimen to its photographs in Appendix 2; "Tissue sample code"=registration code of the tissue sample of this individual in the tissue collection of INPA.

Species	Sex	SCL (mm)	Region	Madeira margin	Municipality	Geographic coordinates	Date of capture	Voucher nr	Photo Voucher nr	Tissue Sample code
Chelonoidis denticulata	na	420.0	UM	L	Porto Velho	09°08′54.1″ S, 064°29′55.8″ W	10Mar2010	na	CD-01	na
Chelonoidis denticulata	F	299.0	UM	na	Porto Velho	09°08′45.2″ S, 064°31′07.9″ W	01Aug2010	na	CD-02	na
Chelonoidis denticulata	J	na	UM	R	Porto Velho	09°27′12.9″ S, 064°23′40.3″ W	21Oct2010	na	CD-03	na
Chelonoidis denticulata	na	na	UM	L	Porto Velho	09°19′03.7″ S, 064°43′37.2″ W	22Jan2011	na	CD-04	na
Chelonoidis denticulata	M	333.0	UM	na	Porto Velho	09°07′07.8″ S, 064°19′46.3″ W	20Aug2011	INPA-H 35446	na	na
Chelus fimbriatus	M	279.0	MPI	L	Careiro da Várzea	03°21′03.4″ S, 059°51′15.4″ W	29Mar2011	na	CF-01	na
Chelus fimbriatus	M	429.0	UM	na	Porto Velho	09°08′16.8″ S, 064°31′55.6″ W	08Aug2010	na	CF-02	HT-6618

Continued

Table 1. *Continued.*

Species	Sex	SCL (mm)	Region	Madeira margin	Municipality	Geographic coordinates	Date of capture	Voucher nr	Photo Voucher nr	Tissue Sample code
Chelus fimbriatus	M	289.0	UM	R	Porto Velho	09°03′19.2″ S, 064°16′34.0″W	20Aug2010	INPA-H 35460	na	HT-6620
Chelus fimbriatus	F	385.0	UM	L	Porto Velho	09°05′07.8″ S, 064°19′48.6″W	29Aug2010	INPA-H 35459	na	HT-6627
Chelus fimbriatus	M	320.0	UM	R	Porto Velho	09°26′05.5″ S, 064°24′46.0″W	16Sep2010	INPA-H 35458	na	HT-6628
Chelus fimbriatus	M	284.0	UM	R	Porto Velho	09°12′24.7″ S, 064°22′55.8″W	08Aug2011	na	CF-03	na
Chelus fimbriatus	M	390.0	UM	R	Porto Velho	09°24′09.3″ S, 064°25′53.6″W	2011	INPS-H 35447	na	na
Mesoclemmys gibba	F	176.3	MPI	L	Beruri	04°37′01.7″ S, 061°14′24.0″W	21Nov2014	na	MG-01	na
Mesoclemmys gibba	na	na	UM	R	Porto Velho	09°01′14.0″ S, 064°14′41.6″W	Nov2009	na	MG-02	na
Mesoclemmys gibba	F	na	UM	L	Porto Velho	08°47′00.4″ S, 063°56′26.3″W	27Jun2010	na	MG-03	HT-6632
Mesoclemmys gibba	F	185.0	UM	R	Porto Velho	09°20′15.7″ S, 064°43′30.4″W	Feb2011	na	MG-04	na
Mesoclemmys gibba	F	131.0	UM	R	Porto Velho	09°20′15.7″ S, 064°43′30.4″W	Feb2011	na	MG-05	na
Mesoclemmys raniceps	F	255.0	MPI	L	Careiro da Várzea	03°21′09.7″ S, 059°51′05.9″W	30Mar2011	INPA-H 28043	na	na
Mesoclemmys raniceps	F	152.0	MPI	L	Careiro Castanho	03°41′43.2″ S, 060°19′47.4″W	03Apr2011	na	MR-01	na
Mesoclemmys raniceps	F	242.0	MPI	L	Humaitá	06°33′54.8″ S, 062°55′41.8″W	18Nov2011	na	MR-02	na
Mesoclemmys raniceps	na	287.0	MPI	L	Humaitá	06°33′50.4″ S, 062°56′08.8″W	19Nov2011	na	MR-03	na
Mesoclemmys raniceps	M	278.0	MPI	L	Tapauá	05°56′20.2″ S, 062°30′16.4″W	28Nov2011	na	MR-04	na
Mesoclemmys raniceps	F	277.0	MPI	L	Tapauá	05°57′38.0″ S, 062°29′02.5″W	29Nov2011	na	MR-05	na
Mesoclemmys raniceps	J	73.4	MPI	L	Careiro Castanho	03°40′23.5″ S, 060°18′29.4″W	03Mar2013	INPA-H 33226	na	na
Mesoclemmys raniceps	F	199.2	MPI	L	Manicoré	04°59′39.6″ S, 061°34′24.5″W	01Dec2014	na	MR-06	na
Mesoclemmys raniceps	F	275.9	MPI	L	Humaitá	07°12′27.3″ S, 063°06′54.7″W	05Mar2015	na	MR-07	na
Mesoclemmys raniceps	J	113.0	UM	L	Porto Velho	09°10′22.4″ S, 064°36′50.2″W	27Jul2010	INPA-H 35451	MR-08	HT-6631
Mesoclemmys raniceps	F	277.0	UM	na	Porto Velho	09°06′50.0″ S, 064°19′15.3″W	06Sep2011	na	MR-09	HT-6633
Mesoclemmys raniceps	F	316.0	UM	R	Porto Velho	08°51′60.0″ S, 064°03′06.0″W	Dec2011	na	MR-10	HT-6634
Mesoclemmys raniceps	na	225.0	UM	L	Porto Velho	09°02′55.4″ S, 064°18′21.9″W	2011	na	MR-11	HT-6636
Mesoclemmys raniceps	J	57.0	UM	L	Porto Velho	09°06′14.3″ S, 064°20′48.0″W	2011	na	MR-12	na
Mesoclemmys raniceps	M	na	UM	L	Porto Velho	09°10′36.3″ S, 064°36′38.8″W	18Nov2012	na	MR-13	na
Peltocephalus dumerilianus	F	392.0	MPI	L	Beruri	05°16′15.3″ S, 061°55′03.7″W	04Jul2011	na	PD-01	na
Platemys platycephala	M	166.4	MPI	L	Humaitá	07°12′35.2″ S, 063°06′49.5″W	01Mar2012	na	PP-01	na
Platemys platycephala	F	142.5	MPI	L	Humaitá	07°12′35.0″ S, 063°06′49.7″W	01Mar2012	na	PP-02	na
Platemys platycephala	M	165.3	MPI	L	Humaitá	07°12′46.9″ S, 063°06′24.8″W	03Mar2012	na	PP-04	na
Platemys platycephala	F	142.6	MPI	L	Careiro Castanho	03°41′06.0″ S, 060°19′33.1″W	02Mar2013	na	PP-03	na
Platemys platycephala	F	145.0	MPI	L	Careiro Castanho	03°40′59.7″ S, 060°19′37.1″W	04Mar2013	INPA-H 33223	na	na
Platemys platycephala	M	113.0	MPI	L	Careiro Castanho	03°41′06.0″ S, 060°19′33.1″W	04Mar2013	INPA-H 33222	na	na
Platemys platycephala	F	155.8	MPI	L	Humaitá	07°12′34.6″ S, 063°06′48.0″W	05Mar2015	na	PP-05	na
Platemys platycephala	M	164.0	MPI	L	Humaitá	07°12′34.6″ S, 063°06′48.0″W	05Mar2015	na	PP-06	na
Platemys platycephala	F	133.5	MPI	L	Humaitá	07°12′34.6″ S, 063°06′48.0″W	05Mar2015	na	PP-07	na
Platemys platycephala	na	na	UM	L	Porto Velho	09°19′15.5″ S, 064°43′25.6″W	28Jan2008	na	PP-08	na
Platemys platycephala	F	142.3	UM	R	Porto Velho	09°12′27.0″ S, 064°42′39.0″W	23Feb2010	INPA-H 33224	na	na
Platemys platycephala	F	137.5	UM	R	Porto Velho	09°01′12.4″ S, 064°15′15.3″W	09Nov2010	INPA-H 33225	na	na
Platemys platycephala	F	131.0	UM	L	Porto Velho	09°10′36.3″ S, 064°36′38.8″W	05May2012	INPA-H 35444	na	na
Podocnemis expansa	F	667.0	UM	na	Porto Velho	09°15′27.6″ S, 064°38′22.6″W	26Jul2010	INPA-H 35445	na	na
Podocnemis expansa	F	651.0	UM	na	Porto Velho	08°48′07.7″ S, 063°57′06.9″W	08Sep2010	INPA-H 35462	na	na
Podocnemis expansa	M	483.0	UM	na	Porto Velho	09°15′23.9″S, 064°38′45.5″W	09Aug2011	na	PE-01	na
Podocnemis expansa	M	404.0	UM	na	Porto Velho	09°15′23.9″S, 064°38′45.5″W	09Aug2011	na	PE-02	na
Podocnemis expansa	F	620.0	UM	na	Porto Velho	09°15′15.0″S, 064°38′40.2″W	09Aug2011	na	PE-03	na
Podocnemis expansa	F	536.0	UM	na	Porto Velho	09°15′25.1″S, 064°38′45.3″W	10Aug2011	na	PE-04	na
Podocnemis sextuberculata	M	184.0	UM	na	Porto Velho	08°48′15.0″ S, 063°57′00.1″W	20Sep2011	na	PS-01	HT-6637
Podocnemis sextuberculata	F	286.0	UM	na	Porto Velho	08°48′13.9″ S, 063°57′01.9″W	22Sep2011	na	PS-02	HT-6638
Podocnemis sextuberculata	F	251.0	UM	na	Porto Velho	08°48′05.7″ S, 063°57′00.4″W	23Sep2011	na	PS-03	HT-6640
Podocnemis sextuberculata	F	289.0	UM	na	Porto Velho	08°48′05.7″ S, 063°57′00.4″W	23Sep2011	na	PS-04	HT-6639
Podocnemis unifilis	J	72.0	UM	L	Porto Velho	08°49′52.1″ S, 064°02′52.5″W	20Aug2010	na	PU-01	na
Podocnemis unifilis	J	104.0	UM	na	Porto Velho	09°05′02.1″ S, 064°19′44.0″W	27Aug2010	INPA-H 35450	na	na
Podocnemis unifilis	F	410.0	UM	na	Porto Velho	09°05′36.5″ S, 064°19′46.0″W	07Sep2010	INPA-H 35461	na	na
Podocnemis unifilis	F	117.0	UM	na	Porto Velho	09°27′10.6″ S, 064°25′00.7″W	17Sep2010	INPA-H 35449	na	na
Podocnemis unifilis	F	293.0	UM	na	Porto Velho	09°27′17.1″ S, 064°25′21.8″W	27Sep2010	INPA-H 35456	na	na
Podocnemis unifilis	M	231.0	UM	na	Porto Velho	09°12′24.7″ S, 064°22′55.8″W	08Aug2011	INPA-H 35453	na	na
Podocnemis unifilis	M	217.0	UM	na	Porto Velho	09°15′29.5″ S, 064°38′22.4″W	11Aug2011	INPA-H 35454	na	na
Podocnemis unifilis	M	255.0	UM	na	Porto Velho	09°08′16.9″ S, 064°21′01.3″W	23Aug2011	INPA-H 35457	na	na
Podocnemis unifilis	M	225.0	UM	na	Porto Velho	08°50′40.8″ S, 064°03′25.4″W	05Sep2011	INPA-H 35455	na	na
Podocnemis unifilis	M	250.0	UM	na	Porto Velho	08°50′40.8″ S, 064°03′25.4″W	05Sep2011	INPA-H 35452	na	na

by Ernst 1981a, 1981b; Ernst 1987; Ernst and Leuteritz 1999a, 1999b; Berry and Iverson 2001; Iverson and Vogt 2002; Schneider et al. 2012). We also considered comments on habitat and distribution of species in Vogt (2008) and Vogt et al. (2007). From the evaluation of all data sources, we determined the list of chelonian species expected to occurr in or along the Madeira River.

RESULTS

Overall we were able to produce 66 new voucher-based and georeferenced records of nine chelonian species for the Madeira River basin (Appendix 1; Table 1). Forty-two are exclusively photo vouchers (Appendix 2) recorded by the authors or as occasional encounters by other field crews. Twenty-four are physical vouchers, of which nine were sacrificed to obtain collection vouchers of *Chelus fimbriatus* (Schneider, 1783), *Mesoclemmys raniceps* (Gray, 1855) and *Platemys platycephala*. All other physical vouchers (including all *Podocnemis* spp) either (a) died accidentally by drowning when entangled in trammel nets or fyke nets or due to stress during handling of unhealthy individuals, (b) were found dead in abandoned fishing nets by local fishermen, or (c) were found as dried out carapaces in the field. No physical vouchers were obtained for *Mesoclemmys gibba* (Schweigger, 1812), *Peltocephalus dumerilianus* (Schweigger, 1812), and *Podocnemis sextuberculata* Cornalia, 1849 due to logistical circumstances or because they were only recorded by third parties. A brief diagnostic description of each species recorded is given in Appendix 1.

Madeira-Purus interfluvium

Sampling effort was of 39,400 effort-hours (1 effort hour = one trap of any kind exposed in the environment for 1 hour). Five chelonian species were recorded along the Madeira-Purus interfluvium (*Chelus fimbriatus*, *Mesoclemmys gibba*, *Mesoclemmys raniceps, Platemys platycephala* and *Peltocephalus dumerilianus*), resulting in 21 vouchers (Figure 1; Table 1; Appendix 2). One juvenile *M. raniceps* (INPA-H 33226, Table 1) was collected by a third party. Three species occurred mainly in small forest streams (*M. raniceps, P. platycephala* and *C. fimbriatus*). *Mesoclemmys gibba* were found in ponds in areas of open vegetation. One gravid female of *P. dumerilianus* (Appendix 2, photo voucher PD-01; Table 1) was captured opportunistically on land while it was possibly searching for a suitable nesting site. Egg-bearing status was established through inguinal palpation.

Upper Madeira region

The aquatic survey consisted of 751 sampling points over the two years, distributed over the whole study area, resulting in 12,887 effort-hours. Further details on sampling effort and capture yield can be found in Keller et al. (2013). Including third-party records, we recorded the occurrence of eight chelonian species (*Chelonoidis denticulata, Chelus fimbriatus*, *Mesoclemmys gibba*, *Mesoclemmys raniceps, Platemys platycephala, Podocnemis expansa, Podocnemis sextuberculata* and *Podocnemis unifilis*), resulting in 45 new voucher-based and geographically referenced location points for the upper Madeira region (Table 1; Figure 2; Appendix 2). *Podocnemis expansa* and *P. unifilis* occurred both downstream and upstream of the largest Teotônio rapids. Four individuals of *P. sextuberculata* were captured immediately downstream from the first rapids (Santo Antônio). One of the *C. denticulata* individuals (Appendix 2, photo voucher CD-02; Table 1) was found swimming across the main channel of the Madeira River, at a point were it was approximately 700 m wide. One *M. gibba* had an unusually brown colloration and dorsal vermiculations on the head (Appendix 2, photo-voucher MG-05).

Checklist and up/downstream complementarity of chelonian fauna

Based on the literature review, 12 species were expected to occur in the Madeira River basin (Table 2), of which three (*Podocnemis erythrocephala*, *Podocnemis sextuberculata* and *Peltocephalus dumerilianus*) were expected to occur only in the lower and middle Madeira and/or its smaller tributaries, and one (*Phrynops geoffroanus* [Schweigger, 1812]) was expected to occur only in the upper Madeira. All four *Podocnemis* species are expected to occur in the lower to middle Madeira, but the small water bodies sampled were not suitable for any of them because they inhabit larger rivers.

Of the 12 expected species, we confirmed the presence of five in the Madeira-Purus interfluvium, and eight in the upper Madeira region (Table 2), including an unexpected record of *Podocnemis sextuberculata* in the upper Madeira. *Mesoclemmys raniceps* was found in both study areas and had no previous voucher-based record for the Madeira River, apart from one record at the confluence of the Madeira with the Amazonas River (Iverson et al. 2000). We did not find *Phrynops geoffroanus*, *Kinosternon scorpioides* (Linnaeus, 1766), nor *Podocnemis erythrocephala* in either survey areas. Apart from *Chelonoidis denticulata* and the already mentioned non-verifiable *Podocnemis* spp, all species found in the upper Madeira also were present in the Madeira-Purus interfluvium along the lower flow of the Madeira.

DISCUSSION

Our surveys confirmed the current occurrence of *Podocnemis expansa* and *P. unifilis* in the upper Madeira River, both immediately downstream from the first rapids and in between rapids. Quantitative surveys in the same study area confirmed the presence of both species (Keller et al. 2013), as well as the genetic homogeneity of *P. expansa* (Vieira 2015) between all rapids in the

Table 2. Checklist of chelonian species expected to occur in one or both areas surveyed: Madeira-Purus interfluvium along the low and middle Madeira River (east of Humaitá) and in and along the upper Madeira River (between Porto Velho and Cachoeira do Jirau). Species marked with a hyphen were expected to occur in the region, but not in the type of aquatic habitats surveyed. "other studies" refers to species records by other recent surveys that produced voucher based material in the lower Madeira region and corresponding area of the Madeira-Purus interfluvium ([1]Vogt et al. 2007; [2]UFAM/DNIT 2009).

Family	Species	Upper Madeira	Madeira-Purus interfluvium	Other studies
Chelidae	*Chelus fimbriatus*	✓	✓	✓[1]
Chelidae	*Mesoclemmys gibba*	✓	✓	✓[1, 2]
Chelidae	*Mesoclemmys raniceps*	✓	✓	not found
Chelidae	*Phrynops geoffroanus*	not found	not found	not found
Chelidae	*Platemys platycephala*	✓	✓	✓[2]
Podocnemididae	*Podocnemis expansa*	✓	-	not found
Podocnemididae	*Podocnemis erythrocephala*	not found	-	not found
Podocnemididae	*Podocnemis sextuberculata*	✓	-	✓[1]
Podocnemididae	*Podocnemis unifilis*	✓	-	✓[1, 2]
Podocnemididae	*Peltocephalus dumerilianus*	not found	✓	✓[1, 2]
Kinosternidae	*Kinosternon scorpioides*	not found	not found	not found
Testudinidade	*Chelonoidis denticulata*	✓	not found	✓[1]

110 km river stretch. This indicates that the rapids do not act as an impermeable barrier for the species. The presence of both species was also confirmed among the rapids upstream of the Jirau hydropower dam (ESBR 2012; Vieira 2015). Both species were known to occur in huge numbers in the Madeira River and the Guaporé River, an upstream tributary, but stocks crashed due to large-scale overexploitation, especially in the late 19th to early 20th centuries, fueled by the Amazon rubber boom, the Madeira-Mamoré railway construction, and the growing demand of consumer markets in Manaus and Belém, specially for *P. expansa* (Vianna 1973; Smith 1979). *Podocnemis expansa* nesting has been recorded since 2001 in the lower flow of the Madeira (Manicoré municipality), although in very few numbers (Andrade et al. 2011). Likewise, RAP surveys near Manicoré failed to observe individuals and/or nesting signs of *P. expansa*, which was attributed to the historic overexploitation of chelonians in the region (Vogt et al. 2007). *Podocnemis unifilis* has been recorded on nesting beaches in the lower Madeira and its tributaries (Andrade et al. 2011), and as a preferred consumption item in local communities (Vogt et al. 2007; NUSEC/UFAM 2014a, 2014b).

No locality records exist for *P. sextuberculata* in the reviewed databases, but the species has been cited as nesting in large numbers on beaches in the lower Madeira (Andrade et al. 2011). One single individual was captured in the Aripuanã River, a tributary of the middle Madeira (Vogt et al. 2007), coinciding with the southern limit of this species' distribution as inferred by Rueda-Almonacid et al. (2007). Thus, our record of *P. sextuberculata* in the Madeira River at Porto Velho extends the known distribution of the species by approximately 730 km to the boundaries of the upper Madeira. Despite our considerable sampling effort, and having captured both *P. expansa* and *P. unifilis* in the inter-rapids sections of the river, we only recorded four individuals of *P. sextuberculata* below the rapids. Chelonian surveys in 2012 and 2013, after the flooding of the reservoir, also failed to capture *P. sextuberculata* upstream from the Santo Antônio dam (the former location of the first rapids) (Felix-Silva and Sábato 2014). It is possible that the Madeira rapids acted as a dispersion barrier for this species, although Felix-Silva and Sábato (2014) claim to have detected a single oviposition of atretic eggs of *P. sextuberculata* on a beach above the former Morrinhos rapids in 2013 (see Figure 2).

Podocnemis erythrocephala has two records from the lower Madeira region (Iverson 1992; Iverson et al. 2000) and was cited for this region as nesting in significant numbers along small blackwater tributaries of the Matupiri River in the municipality of Borba (Andrade et al. 2011). Suitable habitats for *P. erythrocephala* (small rivers and streams of black/clear water) were surveyed in the upper Madeira, but the species was not captured. Provided that the species occurs upstream of the lower Madeira, its dispersion may have been hindered by the rapids, as may be the case for *P. sextuberculata*.

In this study, *Peltocephalus dumerilianus* has been recorded in the Madeira-Purus interfluvium in the municipality of Manicoré (middle Madeira). Three previous voucher-based records exist for this region, but their georeferenced location has not been published so far. One carapace was found along the Mariepauá River, on the right margin of the Madeira (Vogt et al. 2007), and two individuals were captured between km 300 and km 450 of the BR-319 Highway (UFAM/DNIT 2009). The species also frequently was mentioned as a preferred consumption item by local inhabitants in the same region (NUSEC/UFAM 2014a, 2014b). Although we failed to capture *P. dumerilianus* in the upper Madeira, the species was described very accurately by fishermen as occurring in lakes and streams further inland from our survey area. Thus its occurrence remains possible, but still to be confirmed, in the upper Madeira region.

The occurrence of *Chelus fimbriatus* was confirmed

both in the lower Madeira-Purus interfluvium and in the upper Madeira River, indicating that the species is likely to be present in tributaries and lentic aquatic habitats along the whole Madeira River. This is further confirmed by the record of a *C. fimbriatus* carapace near the Aripuanã River, on the right margin of the middle Madeira (Vogt et al. 2007). Interestingly, one individual of *C. fimbriatus* (CF-02, Table 1) was captured by fyke net on the main channel of the upper Madeira River, in a section where the bank is steep-sloped, the channel is around 30m deep (Tizuka 2013), and there is no nearby tributary. The species is usually associated with lentic and shallow water bodies (Rueda-Almonacid et al. 2007; Vogt 2008). One individual (Table 1, INPA-H 35460) was found estivating alongside other conspecific individuals that were buried in a dried floodplain lake.

Both *Mesoclemmys gibba* and *M. raniceps* had no published voucher-based records for the Madeira River, apart from one location each at the Madeira-Amazonas confluence (Ernst 1981a; Iverson et al. 2000). *Mesoclemmys raniceps* appeared in almost all sampling sites along the Madeira-Purus interfluvium and was captured more frequently than *M. gibba* (13 overall records of *M. raniceps*, including the nine listed in Table 1, and one *M. gibba*). Other voucher-based records of *M. gibba* exist for the same area, but their georeferenced location has not been published so far. Two individuals were captured along the BR-319 Highway between km 250 and km 535 (UFAM/DNIT 2009) and some individuals were found along the Aripuanã River (Vogt et al. 2007). The faunal rescue in areas to be flooded by the Santo Antônio dam, which lies entirely within our study area in the upper Madeira, listed 116 individuals of *Mesoclemmys* on both margins of the Madeira (Keller et al. 2013), including five of the ten *Mesoclemmys* in Table 1 (photo vouchers MG-03, MR-09,10,11 and 12 in Appendix 2). All rescued *Mesoclemmys* were identified as *M. gibba* by the rescue team (Marçal et al. 2011). However, four of five rescued individuals we were able to examine in the screening center were *M. raniceps*, not *M. gibba*. Both species may be easily mistaken for each other (see Appendix 1) by non-specialized researchers, as is often the case with rescue crews. Therefore, it is likely that an unknown proportion of the *Mesoclemmys* identified as *M. gibba* during rescue operations actually were *M. raniceps*. The available data indicate that both *M. raniceps* and *M. gibba* occur in sympatry along the Madeira River and in the Madeira-Purus interfluvium. In the upper Madeira basin, only records of *M. raniceps* exist along the Mamoré-Guaporé River (Iverson et al. 2000). It is still not clear whether both species occur syntopically. In the lower Madeira region, *M. gibba* has been found in ponds and temporary pools, while *M. raniceps* were captured in small streams. However, in the upper Madeira, two *M. gibba* were found in a forest stream (Appendix 2, photo vouchers MG-04 and 05), while all other *Mesoclemmys* were found in igapó (flooded forest) areas.

No georeferenced record of *Phrynops geoffroanus* has been published so far for the Madeira River, including our surveys. The species is listed for the upper Madeira in the initial environmental impact assessment report for the Santo Antônio and Jirau dams (Lima et al. 2005), and also for the upstream area of Costa Marques, on the Guaporé River, in the ecological zoning report for the state of Rondônia (Tecnoslo/DHV/EPTISA 1998). Lima et al. (2005) claim to have recorded two basking individuals of *P. geoffroanus* during visual surveys along a 297-km transect (380 km travel distance) in an area corresponding to the future reservoirs of both the Santo Antônio and Jirau powerplants (no voucher exists to support these records). We performed visual surveys along a 346-km transect (2,837 km travel distance) (Keller et al. 2013), but only in the area of the Santo Antonio reservoir, where we failed to record *P. geoffroanus*. Thus, its presence in the upper Madeira remains probable but in need of confirmation.

Platemys platycephala generally is expected to be found in rainforest ponds and pools throughout the Amazon, although georeferenced records are few in contrast with its perceived ubiquitous presence (Ernst 1987; Iverson et al. 2000). Some old records for this species exist in the Bolivian part of the Madeira basin, but only one in the lower Madeira region and two in the Madeira-Purus interfluvium (Ernst 1987; Iverson et al. 2000). *Platemys platycephala* was the most frequently found species in the Madeira-Purus interfluvium survey (19 records overall, including the seven voucher-based specimens in Table 1). It was also the second most common chelonian species found during fauna rescue in the area of the Santo Antônio dam reservoir (100 records listed for both margins of the Madeira) (Keller et al. 2013) and the Jirau dam reservoir (12 individuals, NATURAE 2012). The available data indicate that *P. platycephala* likely occurs continually on both margins along the middle and upper Madeira River.

Two records of *Kinosternon scorpioides* for the Madeira basin in Iverson (1992) have been withdrawn in the updated digital version of its distribution map (Iverson et al. 2000), but one older record remains in the lower Madeira-Purus interfluvium (Berry and Iverson 2001). Egg-laying sites of the species were recorded in mangrove areas along the blackwater Matupiri River, a tributary of the lower Madeira River (Andrade et al. 2011) and scattered records were mentioned from the interior of Rondônia state (Vogt 2008). All recent voucher-based surveys along the Madeira and the Madeira-Purus interfluvium (Vogt et al. 2007; UFAM/DNIT 2009; this study) have failed to record the species. Likewise, it was not found during faunal rescue for the Santo Antônio

and Jirau dam reservoirs (Marçal et al. 2011; NATURAE 2012).

The absence of *Chelonoidis denticulata* in the Madeira-Purus interfluvium was surprising, especially considering that 80% of the sampling modules were located in well preserved and sparcely inhabited forested areas. Informal surveys with local inhabitants confirmed the absence of this species in forests along the BR-319 Highway. Likewise, during RAP surveys along the middle flow of the Madeira between Borba and Manicoré, no tortoises were found in the wild; they were recorded only as captive individuals in one local community (Vogt et al. 2007), or mentioned as collected, kept as pets and consumed in questionaires to local inhabitants (NUSEC/UFAM 2014a, 2014b). This scarcity might be due to habitat unsuitability, as well as overexploitation. As expected, the species occurred in forested areas along the upper Madeira. Faunal rescue yielded 115 *Chelonoidis* individuals on both margins of the Madeira in the area now under the Santo Antônio reservoir (Keller et al. 2013), and six individuals in the area of the Jirau dam reservoir (NATURAE 2012); these were all identified as *C. denticulata* (Marçal et al. 2011; NATURAE 2012).

Of the 16 or 17 species of chelonians listed for the Amazon region by Vogt (2008) and Rueda-Almonacid et al. (2007), respectively, 12 have been found to occur or expected to occur in or along the Madeira River. Records in the Madeira-Purus interfluvium were in accordance with the findings of other voucher-based surveys in the area (Vogt et al. 2007; UFAM/DNIT 2009). *Podocnemis expansa* and *P. unifilis* occur in the inter-rapids sections of the upper Madeira. *Podocnemis sextuberculata*, which had previously been recorded only in the lower Madeira (downstream of the confluence with the Aripuanã River), is now known to occur as far as the lower limit of the rapids sections of the upper Madeira. *Chelus fimbriatus*, *Mesoclemmys raniceps*, *Mesoclemmys gibba*, *Platemys platycephala* and *Chelonoidis denticulata* likely occur along the whole river and the adjacent Madeira-Purus interfluvium. *Peltocephalus dumerilianus* is confirmed to occur in the middle Madeira region, with its possible presence in the upper Madeira requiring confirmation. To our knowledge, there is still no voucher-based and georeferenced published record for *Phrynops geoffroanus* or *Kinosternon scorpioides* for the Madeira River, although anecdotal information suggests these species occur at least in part of the river basin. *Podocnemis erythrocephala* was not confirmed either, although previous records exist for the species in the lower Madeira region (Iverson et al. 2000), including important breeding sites (Andrade et al. 2011).

Despite the scarcity of publicly available records of chelonians from the Madeira River, the diversity of species in and along the Madeira is high by Amazonian standards. Vogt et al. (2007) concluded that there is a generally low abundance of chelonians in the middle Madeira region. While this seems to be true for historically overexploited mass-breeders like *Podocnemis expansa* and *P. unifilis*, and also for the highly appreciated and easily collected *Chelonoidis denticulata*, it may have been a misleading impression for other, more secretive species. The available data indicate that *Mesoclemmys raniceps* and *M. gibba*, as well as *Platemys platycephala*, may actually be frequent and relatively abundant along the Madeira. The phylogeographic relation and possible niche segregation of *M. raniceps* and *M. gibba* are among the interesting questions that follow from their distribution pattern along the Madeira.

With the possible but unconfirmed exception of *Phrynops geoffroanus*, the available data indicate that the chelonian species found in the areas affected by the Santo Antônio and Jirau reservoirs in the upper Madeira also are found downstream from the dams. Moreover, chelonian diversity seems to be higher in the lower Madeira region, with the additional presence of *Podocnemis sextuberculata*, *P. erythrocephala* and *Kinosternon scorpioides*. Therefore, the impact of the hydropower plants probably will not be on overall chelonian diversity in the Madeira subbasin but more importantly, will affect the connectivity of populations up- and downstream from the dams of the species that depend on main river channels for dispersal and migration, mainly *Podocnemis expansa* and *P. unifilis*.

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APPENDICES

APPENDIX 1

Species diagnosis of the chelonians recorded along the BR-319 Highway (state of Amazonas, Brazil), in the Madeira-Purus interfluvium along the lower and middle Madeira River (east of Humaitá), and in and along the upper Madeira River (state of Rondônia, Brazil), between Porto Velho and Cachoeira do Jirau. Unless otherwise stated, diagnostic characteristics are based on the species descriptions in Rueda-Almonacid et al. (2007) and Vogt (2008), highlighting those aspects that were more useful in field identification. Some attributes are referred to photo vouchers in Appendix 2. SCL = straight carapace length (maximum straight-line measurement). Common names in English [E] and Portuguese [P] are provided.

Suborder Pleurodira
Family Chelidae

Chelus fimbriatus (Schneider, 1738) (Matamata Turtle [E], matamatá [P])

The species is easily identified by its large, flattened and triangular head (due to supra-tympanical dermal outgrowths and a long and fine cylindrical snout); the neck is long and thick, as broad as the head, and covered with tubercules; the carapace is marginally serrated with conspicuous dorsal and costal protuberances (see Appendix 2, photo-vouchers CF-01,02 and 03). It reaches about 50 mm SCL.

Mesoclemmys raniceps (Gray, 1855) (Black-lined Toadhead Turtle [E], lalá [P])

Adults of this species are up to 330 mm SCL. The most striking attribute is its massive head (about 25% of SCL), with conspicuously large masseter muscles, dark on the dorsal side, and yellowish-rimmed jaws on the lateral and ventral side. The plastron is dark or interspersed with yellowish areas (Appendix 2, photo-vouchers MR-01 to 07, 09 to 11 and 13). Juveniles have dark vermiculations or spots on the head and/or neck (MR-08 and 12).

Mesoclemmys gibba (Schweigger, 1812) (Keel-back Sideneck Turtle [E], cágado-de-poças-de-floresta [P])

M. gibba is smaller than *M. raniceps* (adults < 230 mm SCL). In comparison with *M. raniceps*, it has a narrower, pointed and uniformly dark-colored head (dorsal and ventral sides), carapace and plastron (Appendix 2, photo-vouchers MG-01 to 04). A subtle keel runs along the central dorsal carapace (best seen in MG-03). The individual of photo voucher MG-05 had unusually light brown pigmentation.

Platemys platycephala (Schneider, 1792) (Twistneck Turtle [E], jabuti-machado [P])

This small chelid (adults < 180 mm SCL) is found only in shallow forest pools and swamps. The narrow head is streamlined with the neck and is variably bright orange-yellow on the dorsal side; this pigment extends along the neck. Two conspicuous dorsal parallel keels run along the carapace, which also has broad black stripes on brown background (Appendix 2, photo-vouchers PP-01 to 08).

Family Podocnemididae

Podocnemis spp. have a characteristic interorbital groove, well developed interdigital membranes, and inhabit large to medium-sized rivers.

Podocnemis expansa (Schweigger, 1812) (South American Giant River Turtle [E], tartaruga-da-Amazônia [P])

This species has the most hydrodynamic morphology among *Podocnemis*, with a flat, posteriorly broadened carapce (Appendix 2, photo vouchers PE-01 to 04), strong limbs with stoutly developed interdigital membranes (see PE-01, bottom left) and eyes in dorsal position (best seen in PE-01 and 04). Adults can be distinguished by size alone (up to 900 mm SCL). In our samples, SCL were > 400 mm for males and > 500 mm for females (Keller et al. 2013). Carapace and limbs tend to be uniformly gray; the plastron is cream-colored or intermingled with black. Juveniles have large whitish spots on the head, which survive in adults as two post-orbital whitish spots with two black ocelae (best seen in PE-01 and 04).

Podocnemis unifilis Troschel, 1848 (Yellow-spotted River Turtle [E], tracajá [P])

This species has a more oval, domed gray-brown-olive carapace in comparison with *P. expansa*. Adult males vary from 200–370 mm and females from 300–470 mm SCL. Juveniles have bright yellow spots on the head (Appendix 2, photo-voucher PU-01) that persist in adult males, while adult females have a brownish head. The interorbital groove is rather subtle.

Podocnemis sextuberculata Cornalia, 1849 (Six-tubercled Amazon River Turtle [E], iaça, pitiú [P])

This is the smallest of the three *Podocnemis* recorded, with adults less than 350 mm SCL. The six plastral tubercules, on which the English name is based, are present only in juveniles. The interorbital groove is well marked and black colored; the head is brownish-gray with diffuse black pigmentation, and the general coloration is grayish-white, similar to *P. expansa* (Appendix 2, photo-vouchers PS-01 to 04).

Peltocephalus dumerilianus (Schweigger, 1812) (Big-headed Amazon River Turtle [E], cabeçudo [P])

This species is predominantly known from blackwater medium-sized lakes and rivers. It is stout and large-bodied (adults up to 400–500 mm SCL) with a highly domed carapace. No interorbital groove is present and the head is massive and barrel-shaped, with a pronounced snout and hooked jaws (Appendix 2, photo-voucher PD-01). The carapace is uniformly olive-brown to black or gray, and the plastron yellow to cream.

Suborder Criptodira
Family Testudinidae

Chelonoidis denticulata (Linnaeus, 1766) (Yellow-footed Tortoise [E], jabuti amarelo [P])

This terrestrial species inhabits forested landscapes. Adults may reach 800 mm SCL, but nowadays are seldom found larger than 400 mm. The carapace is medium brown with large diffuse yellow-cream spots that radiate from the center of the vertebral, coastal and marginal scutes; head and forelimb scales are covered with yellow to light orange spots on brown background (Appendix 2, photo-vouchers CD-01 to 04). The frontal and prefrontal scales are divided (best seen on CD-02).

APPENDIX 2

Photo vouchers of chelonian specimens recorded along the BR-319 Highway (state of Amazonas, Brazil), in the Madeira-Purus interfluvium along the low and middle Madeira River (east of Humaitá), and in and along the upper Madeira River (state of Rondônia, Brazil), between Porto Velho and Cachoeira do Jirau. Codes on each voucher relate to the specimens on Table 1. Location points are plotted on Figures 1 and 2.

CD-01. *Chelonoidis denticulata* (photos: Albertina Lima).

CD-02. *Chelonoidis denticulata* (photos: Rafael Bernard).

CD-03. *Chelonoidis denticulata* (photos: Priscila Pereira).

CD-04. *Chelonoidis denticulata* (photos: Albertina Lima).

CF-01. *Chelus fimbriatus* (photos Francisco Villamarín).

CD-02. *Chelus fimbriatus* (photo: Rafael Bernard).

CF-03. *Chelus fimbriatus* (photos: Claudia Keller).

MG-01. *Mesoclemmys gibba* (photos: Francisco Villamarín).

MG-02. *Mesoclemmys gibba* (photos: Raquel Moura).

MG-03. *Mesoclemmys gibba* (photos: Claudia Keller).

MG-04. *Mesoclemmys gibba* (photos: Zilca Campos).

MG-05. *Mesoclemmys gibba* (photos: Zilca Campos).

MR-01. *Mesoclemmys raniceps* (photos: Francisco Villamarín).

MR-02. *Mesoclemmys raniceps* (photos: Francisco Villamarín).

MR-03. *Mesoclemmys raniceps* (photos: Francisco Villamarín).

MR-04. *Mesoclemmys raniceps* (photos: Francisco Villamarín).

MR-05. *Mesoclemmys raniceps* (photos: Francisco Villamarín).

MR-06. *Mesoclemmys raniceps* (photos: Francisco Villamarín).

MR-07. *Mesoclemmys raniceps* (photos: Francisco Villamarín).

MR-08. *Mesoclemmys raniceps* (photos: Claudia Keller).

MR-09. *Mesoclemmys raniceps* (photos: Claudia Keller).

MR-10. *Mesoclemmys raniceps* (photos: Cleiton Souza).

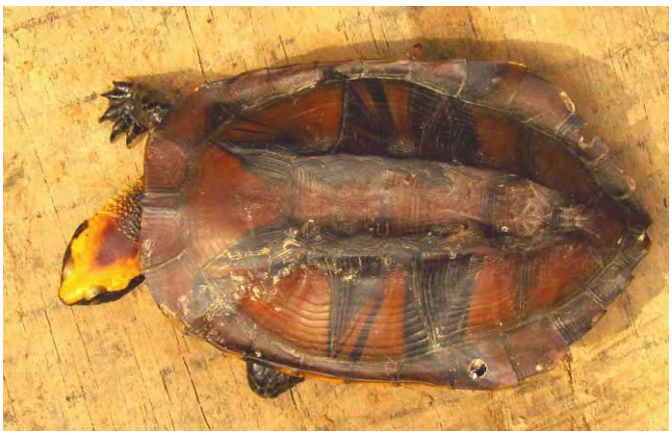
MR-11. *Mesoclemmys raniceps* (photos: Claudia Keller).

MR-12. *Mesoclemmys raniceps* (photos: Claudia Keller).

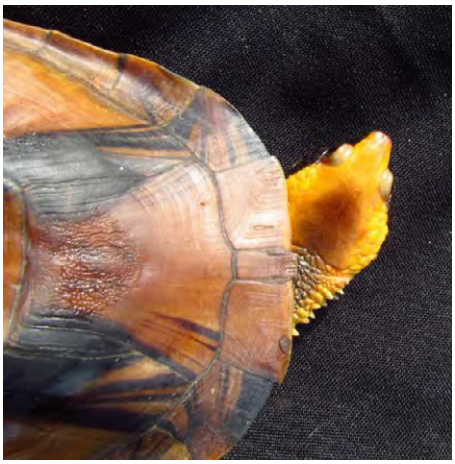
MR-13. *Mesoclemmys raniceps* (photos: Jussara Dayrell).

PD-01. *Peltocephalus dumerilianus* (photos: Francisco Villamarín).

PP-01. *Platemys platycephala* (photos: Francisco Villamarín).



PP-02. *Platemys platycephala* (photos: Francisco Villamarín).



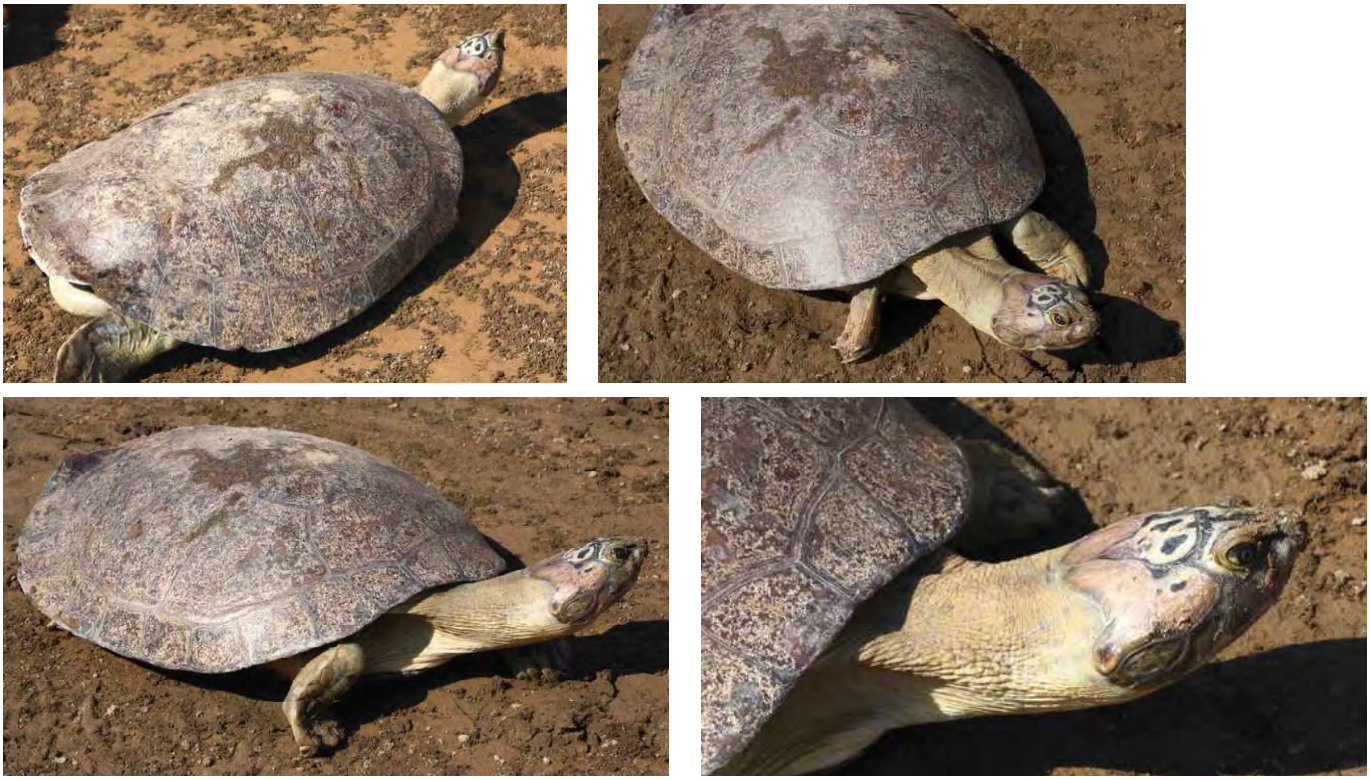
PP-03. *Platemys platycephala* (photos: Francisco Villamarín).

PP-04. *Platemys platycephala* (photos: Francisco Villamarín).

PP-05, PP-06, PP-07. *Platemys platycephala* (photo: Francisco Villamarín).

PP-08. *Platemys platycephala* (photos: Pedro Ivo Simões).

PE-01. *Podocnemis expansa,* individual with carapace scute malformations (photos: Claudia Keller).



PE-02. *Podocnemis expansa* (photos: Claudia Keller).

PE-03. *Podocnemis expansa* (photos: Claudia Keller).

PE-04. *Podocnemis expansa* (photos: Claudia Keller).

PS-01. *Podocnemis sextuberculata* (photos: Claudia Keller).

PS-02. *Podocnemis sextuberculata* (photos: Claudia Keller).

PS-03. *Podocnemis sextuberculata* (photos: Daniely Félix da Silva).

PS-04. *Podocnemis sextuberculata* (photos: Claudia Keller).

PU-01. *Podocnemis unifilis* (photos: Rafael Bernhard).