Smjernice za održivo korištenje poljoprivrednih zemljišta sa gnijezdilištima kornjača

Guidelines for turtle friendly agriculture for landowners

WP2 – D2.3.

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Zajedno čuvamo prirodu

GOVERNMENT OF THE REPUBLIC OF CROATIA
Office for Cooperation with NGOs

Project "*Mauremys rivulata* - conservation of the umbrella species of the Mediterranean wetlands in Dubrovnik -Neretva County" is co-financed by the LIFE Programme of the European Union under contract number 101071737 – LIFE21-NAT-HR-LIFE for Mauremys and co-financed by the Government Office for Cooperation with NGOs and Environmental Protection and Energy Efficiency Fund. The presented content is the sole responsibility of "LIFE for Mauremys" project partners and does not necessarily reflect the views of the European Union, Environmental Protection and Energy Efficiency Fund and Government Office for Cooperation with NGOs.

LIFE
for
Mauremys

PROJ. REF.
LIFE21-NAT-HR-LIFE for Mauremys/101071737

AKRONIM/ACRONYM:
LIFE21-NAT-HR-LIFE for Mauremys

NAZIV PROJEKTA/PROJECT FULL NAME:
Riječna kornjača – očuvanje krovne vrste sredozemnih vlažnih staništa u Dubrovačko-neretvanskoj županiji
Mauremys rivulata - conservation of the umbrella species of the Mediterranean wetlands in Dubrovnik - Neretva County

SKRAĆENO IME/SHORT PROJECT NAME:
LIFE for Mauremys

KOORDINATOR PROJEKTA/PROJECT COORDINATOR:
University of Zagreb, Faculty of Agriculture

PARTNERI/PARTNERS:
Zoological Garden of Zagreb, Hrvatske vode, Association Hyla, Public Institution for Management of Protected Natural Areas of the Dubrovnik-Neretva Countu

Javna ustanova za upravljanje zaštićenim dijelovima prirode Dubrovačko-neretvanske županije

Naslov isporučevine/Deliverable Title:	**Smjernice za održivo korištenje poljoprivrednih zemljišta sa gnijezdilištima kornjača /** Guidelines for turtle friendly agriculture for landowners
Broj isporučevine/Deliverable Number:	**2.3**
Autori/Authors:	**Dragica Šalamon, Ana Štih Koren, Bruna Tariba**
Tip/Type:	**Dvojezični javni dokument/izvješće /** Public dociment/report EN, CRO
Koordinatorica / Supervised by:	**Petra Sisan**
Radni paket / Work package:	**Radni paket 2: Obnova i poboljšanje staništa /** WP2 Restoring and improving habitats
Dissemination level:	
Ugovoreni datum / Due date:	**31. 10 2024.**

Povijest inačica / Revision History

Verzija / Version	Datum / Date	Pregledao / Review	Opaske / Remarks
V1.0	18. 10. 2024.	Petra Sisan (Public Institution for Management of Protected Natural Areas of the Dubrovnik-Neretva County)	Inicijalne tehničke opaske / Initial version technical remarks
V1.1	24.10. 2024.	Ana Štih Koren (Association Hyla) Bruna Tariba (University of Zagreb, Faculty of Agriculture)	Uključiti zaključke treće dioničke radionice / Included conclusions of the third stakeholder workshop WP2
V1.2	2. 12. 2024		Prijevod na hrvatski jezik, dodane reference

Sudionici / List of participants

No.	Role	Short name	Legal name	Country	PIC
1	COO	FAZ	SVEUČILIŠTE U ZAGREBU AGRONOMSKI FAKULTET	HR	999534561
2	BEN	ZOO-Zg	USTANOVA ZOOLOŠKI VRT GRADA ZAGREBA	HR	933554773
3	BEN	HV	HRVATSKE VODE PRAVNA OSOBA ZA UPRAVLJANJE VODAMA	HR	950805835
4	BEN	HYLA	UDRUGA HYLA	HR	919396750
5	BEN	DUNEZ	JAVNA USTANOVA ZA UPRAVLJANJE ZAŠTIĆENIM DIJELOVIMA PRIRODE DUBROVAČKO-NERETVANSKE ŽUPANIJE	HR	897512774

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1. Project LIFE for Mauremys

The "LIFE for Mauremys" project (Project) was designed to preserve the unfavorable conservation status of iconic freshwater turtle species Balkan Terrapin (*Mauremys rivulata*) within all Natura 2000 areas in the Dubrovnik-Neretva County where it has been recorded. In accordance with the The European Green Deal and the EU Biodiversity Strategy for 2030 supported by the European Parliament, the project deals with Mediterranean freshwater habitats that are very important for Balkan Terrapin and biodiversity in general.

To improve the conservation status of *M. rivulata* in Croatia through assisted breeding and population reinforcement, restoring and improving the quality of habitats across its range, addressing the threats and adapting long-term management, we identified the following specific objectives:

1. Restore habitats and mitigate direct threats for 100% of *M. rivulata* Croatian population

Rehabilitate and restore wet habitats (ponds and wetlands) of *M. rivulata* across three Natura 2000 sites designated for its conservation and in one Natura 2000 site where this population was considered locally extinct until 2019, through the following specific objectives:

1.1. Restore and improve the habitat:	
1.1.1.	Complete restoration of the most degraded ponds – three ponds with adjacent canals, at least 36 ha with surrounding landscape, habitat significantly improved for two Croatian populations, or 25 % of total population of Croatia. One of the restored ponds (Ston field project area) will enable 7 % increase in *M. rivulata* population in Croatia ensured by our reinforcement actions during the project, with estimated 45 % long term increase.
1.1.2.	Succession control in ponds, canals and adjacent nesting sites – total of 2850 ha of restored wet habitats in 4 Natura 2000 sites.
1.1.3.	Improving habitat quality by setting up basking sites - (at least 8 basking enhancements at 6 ponds set up) and increasing connectivity (1 tunnel adapted to be a functional ecological corridor between two ponds) in 3 Natura 2000 sites.
1.2. Address other known threats:	

1.2.1.	Secure nesting sites - in collaboration with landowners adapt turtle-friendly land management and agricultural practices at minimum of 6 nesting sites to have at least 10 m2 of nesting site area per population secured for Majkovi, Prljevići and Ston populations (each 20 m^2)
1.2.2.	Removing invasive species and address the potential pathogen threat – remove invasive fish, turtle and aquatic knotgrass from all restored and improved sites: - all of *Gambusia sp*. population from two out of three ponds where it is currently known to be present: one Natura 2000 site 100 % clear, one Natura 2000 site 50 % clear (affecting 25 % of the total *Mauremys r*. population); - capture all currently known IAS turtles in three Natura 2000 sites (Ston, Majkovi, Prljevići 100 % clear of *Trachemys scripta*) and have at least additional 5 removal IAS actions based on volunteer alerts during the project; - pathogen testing of animal IAS and of target species throughout the project; - *Paspalum* knotgrass totally eliminated from all three ponds where it is currently known to be present (two Natura 2000 sites 100% clear, aquatic habitat secured for 25% of the total Mauremys rivulata population).
1.2.3.	Design, build, test, and disseminate the turtle-friendly fyke-traps to eliminate by-catch threat and mitigate illegal fishing – 30 fyke nets built, tested in in three phases and in collaboration with at least 10 local fishermen in Delta Neretve Natura 2000 site and at least 3 research/management experts, across the entire project area, as well as in Albania and Montenegro.
1.3. Improved long-term management	
1.3.1.	Prepare, test, suggest adaptation, and/or adopt the following documents: - Guidelines for restoring and managing Mediterranean ponds and canals; - conservation management plans for NATURA2000 and protected areas of Dubrovnik-Neretva county (Pelješac peninsula (Ston), Sniježnica and Konavle field); - Guidelines for turtle friendly agriculture for landowners, - Guidelines for ex-situ turtle management in Croatia, - Ex-situ program for reinforcement of *Mauremys rivulata* population in Croatia, - Standards for assessment of ecological status and potential for habitat sustainability for *Mauremys rivulata* (HV), - update for Water quality standard, - Volunteering management plan for PI for management of protected areas of Dubrovnik-Neretva county.

2. Reinforcement of the most critically endangered population in Croatia through assisted breeding

Parallel to the activities of the complete restoration of habitat and addressing the threats in the Stone field project area, we will run an assisted breeding programme at ZOO facility. Specific objectives are to:

2.1. Run a breeding program in ZOO Zagreb assisted breeding facility - producing 40 hatchlings
2.2. Establish a reproduction center in Dubrovnik-Neretva county to accept the hatchlings in soft release by the end of the project (restored pond secured from the predators, knowledge transfer from ZOO Zagreb)

3. Raise public perception of M. rivulata as the umbrella species for the healthy Mediterranean wetlands

Working with local schools, the touristic sector, local food producers, volunteer networks, media, and landowners:

3.1.	Organize: - 11 workshops in person, hybrid and on-line (5 habitat management workshops (1 on ponds, 1 on canals; 3 focused on landowners of private agriculture parcels in Natura 2000 with *Mauremys*) at least 100 stakeholders reached; - 3 workshops for *Mauremys* ex situ management (at least 50 stakeholders reached); - 3 workshops sustainable agricultures at nesting sites at Mediterranean wetland days (at least 20 owners reached)); - 3 seminars (at Mediterranean wetland days, at least 500 people reached)
3.2.	Organize 1 educational program - The pond keeper: - 1 picture book (500 distributed), - 1 documentary book (500 re-print), - 3 games (2700 distributed), - 1 documentary movie, - 1 traveling exhibition 30 schools visited with at least 2000 children reached)
3.3.	Organize touristic program: - Mauremys days in ZOO *4, - Mediterranean wetland days *3, at least 8000 people reached
3.4.	Organize: - volunteer program – 1 - volunteer actions – 5 short-term, at least 50 volunteers included

This deliverable is dealing with the Project objectives:

- 1.1.2. Succession control in ponds, canals and adjacent nesting sites – total of 2850 ha of restored wet habitats in 4 Natura 2000 sites; and

- 1.2.1. Secure nesting sites - in collaboration with landowners adapt turtle-friendly land management and agricultural practices at minimum of 6 nesting sites to have at least 10 m2 of nesting site area per population secured for Majkovi, Prljevići and Ston populations (each 20 m^2).

2. Deliverable D2.3. aims and targeted audience

This deliverable D2.3. Guidelines for turtle friendly agriculture for landowners is a document aimed to:

- Define the management requirements of the stripnecked balkan terrapin (*M. rivulata*) nesting sites as an important habitat for favourable species conservation status in Croatia.
- Define the stakeholders and procedures responsible for the management of the land parcels with *M. rivulata* nesting sites.
- Provide the stakeholders responsible for the management of the land parcels with *M. rivulata* nesting sites with sustainable options of use, practices and procedures in primary food and feed production that are in line with *M. rivulata* species biological and eclological requirements.

The guidelines are prepared for nature conservaton professionals, owners of the land parcels with freshwater turtle or terrapin nests in the Mediterranean habitats, policy makers and enforcers in the sector of nature protection and management, agriculture, forestry and water management. Even though these guidelines are written based on the experience with *Mauremys rivulata* and its habitats in Croatia we believe they can be usefull for other European freshwater turtle and terrapin species in the Mediterranean region.

2.1 Project intervention logic

Activities of the Project working packages *WP2 Restoring and improving habitats* and *WP4 Addressing the other threats* deal with the problems the species is dealing with on its nesting sites. Activities are planned in the *WP 7 Sustainability, replication and exploitation of the project results* to ensure the planned project results and impacts produced in WP 2 and WP4 are sustainable.

Task 2.1 Developing guidelines for restoration and management of Mediterranean ponds and nesting sites is planned to produce Guidelines for turtle friendly agriculture for landowners based on the three workshops organized with the project area stakeholders. Additional input for the guidelines are the trials of wild boar repelent use planned in *T2.5 Provide wetlands and nesting sites enhancements*.

The Guidelines for turtle friendly agriculture for landowners are planned to be used in *T2.4 Control succession at ponds, canals and nesting sites* starting with M30 to control succession on nesting sites and *T4.1 Secure nesting sites in collaboration with the landowners* in securing the nesting site in collaboration with the landowners and supported by *T7.1 Volunteering* and *T7.2 Private land conservation agreements and new actions*.

2.1.1. PACKAGE WP2: RESTORING AND IMPROVING HABITATS

Control of succession on nesting sites is planned in T2.4 based on the knowledge of aquatic and terestrial habitats using the activities of T2.1 where the most suitable methods are chosen together with the owners and users of the land parcels of the Natura2000 area with nesting site of *M. rivulata*.

T.2.1 Developing guidelines for restoration and management of Mediterranean ponds and nesting sites

T.2.2 Prioritizing locations and activities for wetland management in Ston and Konavle field

T.2.3. Restoration of the ponds and canals

T.2.4 Control succession at ponds, canals and nesting sites

T.2.5 Provide wetlands and nesting sites enhancements

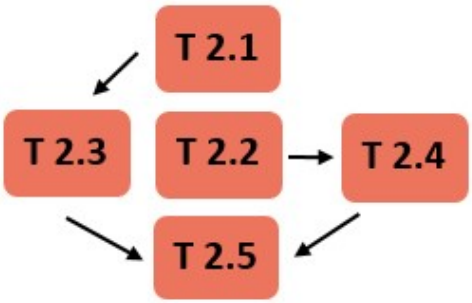

Figure 1. Pert diagram of the WP2 structure and task dependencies.

Table 2. WP 2 Specific objectives and expected results

WP 2 Specific objectives:
Complete restoration of the most degraded ponds.
Control succession in ponds, canals and adjacent nesting sites.
Improve habitat quality in 3 Natura 2000 sites by setting up basking sites and improving connectivity.
WP 2 Expected results:
Three ponds, at least 36 ha (ponds with surrounding landscape) restored, habitat significantly improved for two Croatian populations, or 25% of total population of Croatia.
One of the ponds (in Ston field project area) will enable 7% increase of *M. rivulata* population in Croatia ensured by our reinforcement actions during the project (with estimated 45% gain in the long term)
2850 ha of restored wet habitats across 4 Natura 2000 areas, including canals in Konavle field and Ston field project area.
At least 8 of basking sites across at 6 ponds set up, 1 tunnel adapted to be a functional ecological corridor between two ponds in Majkovi project area.

2.1.2. PACKAGE WP4 ADDRESSING THE OTHER THREATS

In the WP4 task *T.4.1 Secure nesting sites in collaboration with the landowners* aim was to adapt turtle-friendly land management and agricultural practices at minimum of 6 nesting sites to have at least 10m^2 of nesting site area per population secured for all 4 populations. From the list of project supporters and interested parties gatherd trough workshops in T2.1 and prior to contracting 10 years of collaboration on protective management of nesting sites for six nesting-sites in T7.2 or organizig yearly volunteering programs in T7.1., nesting sites were mapped and threats per nesting site assessed.

3. Balkan stripe-necked terrapin habitat requirements

3.1 Balkan stripe-necked terrapin

3.1.1 THE SPECIES

The Balkan Terrapin, *Mauremys rivulata* (Valenciennes, 1833), represents one of the two genera of freshwater turtles of Europe, and it is protected under the Habitats Directive, listed under both Annex II and Annex IV. In Croatia, this is one of the most iconic umbrella species of reptile conservation, and one of the two native freshwater turtle species. It is primarily a Mediterranean species, with its range extending from western Asia to Balkan Peninsula, but with presence also in the Black Sea and Continental biogeographical regions. In Croatia, its distribution is limited to southern part of the country, where it occurs in 4 isolated populations, representing the north-western edge of species' range.

Mauremys rivulata is a semi-aquatic species and it inhabits a wide range of freshwater habitats, from slow flowing rivers, creeks, and canals to springs, ponds, lakes, and swamps. It can tolerate a wide range of temperature, pH, and to some extent also some amount of pollution, but it usually cannot be found in fast currents or brackish waters. The species uses freshwater aquatic habitat as feeding and mating ground but for favourable conservation status nearby breeding grounds must provide safe conditions for summer estivation, winter hibernation, egg laying from May to July and egg incubation until hatching in September to November.

3.1.2 THE THREATS

Despite this seeming ecological flexibility, in recent research drastic population declines were noted for two of the Croatian populations in comparison with the data from the '80-es, and the conservation status for this species was assessed as Unfavourable – bad. For the Mediterranean biogeographical region, it was assessed as Unfavourable - inadequate. The overall unfavourable status of the species has not been addressed in large scale EU/LIFE projects so far.

The national Management plan with the action plan for *Mauremys rivulata* for the period of 2020 – 2031 (MPAP) (Class: 612-07/20-47/07 Reg.No: 517-10-1-1-21-4), for which the expert study was developed by conservation experts identifies requirement to mitigate the following threats:

1) habitat loss and degradation caused by channelization of watercourses and ecological succession due to land abandonment;
2) illegal use of fish traps in some localities resulting in high mortality of both *M. rivulata* but also other freshwater turtle species, *Emys orbicularis*;
3) predation by invasive alien species (wild boar and mongoose) on the nesting sites;
4) competition and pathogen transmission from invasive terrapin species *Trachemys scripta*; and

5) potentially, mineral and organic pesticide residues in soil and water.

3.1.3 INTERNATIONAL AND NATIONAL PROTECTION OF THE SPECIES

The EU legislative considers the Balkan stripe-necked terrapin as strictly protected species Article 6(3) and (4) of Habitats directive (92/43/EEC) as well as Croatian legislative: “Nature Protection Act” (OG 80/13, 15/18, 14/19, 127/19), “Regulation on ecological network and responsibilities of public institutions for managing ecological network areas” (OG 80/19), and „Ordinance on strictly protected species“ (OG 144/13, 73/16).

Currently, total Croatian *Mauremys rivulata* population is situated in Natura 2000 ecological network areas. The species inhabits five Natura 2000 sites (in total of 49.150 ha) in Dubrovnik-Neretva County of Croatia. The four Natura 2000 sites that are designated for protection of this species are SCI HR2000947 Majkovi and SCI HR2000555 Prljevići (for both of these sites the population estimate is >142 animals), SCI HR2000946 Sniježnica and Konavle field (>416 estimated), and SCI HR5000031 Delta Neretve (during population estimate trial in 2019 no individuals have been confirmed). In addition, previously important site for this species, where the species was suspected to be locally extinct, is Natura 2000 site SCI HR2001364 JI dio Pelješca. At this locality 6 animals were counted in the recent field investigations during 2018 and 2019.

One population in Croatia is considered locally extinct due to dams and water management and use and urbanisation. Even though Rijeka Dubrovačka and river Ombla are protected as significant landscape, this category of nature protection was not sufficient in preserving minimal required habitat for the species in the previous 60 years.

3.1.4 IMPORTANCE OF SUSTAINABLE MEDITERRANEAN AGRICULTURE

More than 46% of the Balkan stripe-necked terrapin terrestrial habitat in Croatia is classified as agricultural surfaces, followed by mosaics of cultivated areas (10%) and Mediterranean karstic pastures (7.10 %). Both terrestrial and aquatic part of the species habitat in Croatia has current landscape features due to the primary food production activities in this Mediterranean area. Depending on the specific sub-population in Croatia these areas are socio-economically either in the process of:

- abandonment of agricultural production, or
- development of orchids, olive groves and vineyard production or
- development of horticultural production for non-commercial use.

Abandoned agricultural land is leading to succession of the nesting sites and feeding ground. Most of the aquatic *M. rivulata* habitats in Croatia are secondary anthropogenic water bodies designed and maintained for traditional agricultural practices. However, with the cessation of the use of surface water bodies for water supply, irrigation, and watering livestock, canals and ponds are left to natural succession, degradation, and in the end complete disappearance due to the lack of maintenance. Currently, all the ponds and canals where the target species occurs in Croatia are threatened by some level of succession, eutrophication, and general habitat deterioration (including by being used for waste disposal).

Agricultural use in this area is characterised by the Mediterranean climate (Cs) and temperate warm humid climate with hot summers (Cfa) and dictated by the sustainable water supply with higher average rainfall than in the central Dalmatia. The rainy season from October to February with rain maximum in February results in torrent watercourses managed for the purposes of

flood defence and arable land amelioration. The agricultural land of the *M. rivulata* habitat is especially valuable and valuable arable land, and in certain locations in the aquifer zones determined for ecological agriculture. In the region of Konavle consolidation of land parcels is planned affecting open watercourses. Mineral and organic pesticide residues in the soil over the Balkan stripe-necked terrapin habitat were not investigated so far.

3.1.5 IMPORTANCE OF INCLUDING THE LOCAL COMUNITY STAKEHOLDERS

In the last 15 years several small-scale projects have been conducted investigating the distribution, habitat, ecology, genetics, and population dynamics of this species, working on habitat management and raising public awareness. Engagement of local stakeholders through all the previous projects a good relationship with local community was established, and the species is recognized as an important part of natural heritage of southern Croatia. These previous projects have not significantly addressed the long-term habitat management, nor revitalized decimated populations. However, with the engagement of local community of Majkovi and Dubrovačko Primorje Slano municipality and the work of Association HYLA the special herpetological reserve was declared on Majkovi ponds in 2022 (Official Gazette 80/13, 15/18, 14/19, and 127/19) as first of this type in Croatia.

Ownership of the land parcels across the Balkan stripe-necked terrapin habitat in Croatia is, with few exceptions, private in the terrestrial part of the habitat and in the aquatic part of the terrapin habitat there are only few examples of private owned ponds or amelioration canals the population uses as feeding and mating areas. Other aquatic habitats have either a cultural value and municipality or other local level ownership, or they have other functions such as preparedness measures in case of fire and are managed by the legal entities for water or forest management e.g. Croatian forests or Croatian waters.

To improve the unfavourable conservation status of this protected species, a well-planned, large-scale endeavour is necessary, with strategic involvement of the local community and focused interdisciplinary actions over different levels and sectors of policy makers to address all the threats.

The negative anthropogenic impact on the Balkan stripe-necked terrapin and its habitats is planned in MPAP to be reduced by the implementation of educational activities and cooperation with other sectors.

To enable the long-term preservation of all populations in Croatia several activities are planned in MPAP and the selection of those dealing with nesting sites is shown in Table 3.

Table 3. Nesting sites related activities planned in MPAP to meet the ecological needs of the species and to enable the long-term preservation of all populations Balkan stripe-necked terrapin in Croatia

MPAP Activities 2020-2031	
1.3.1.	Prepare guidelines for the maintenance of nesting grounds based on participative process with land owners;
1.3.2.	Maintain nesting area near water habitats (10 m^2 per locality in Majkovi, Prljevići, at two newly renovated ponds in Stonsko polje, Konavosko polje and Rijeka Dubrovačka (minimum 40 m^2 in total), ensured habitat connectivity in Majkovi with appropriate infrastructure
1.3.1.	Protect ponds and nesting sites from the negative impact of wild boars in key locations (Majkovi)
1.3.2.	Strengthen cooperation with hunting authorities in the area of distribution of *M. rivulata* in order to remove wild boars and mongooses in accordance with other action plans
1.3.3.	Control the mongoose population (*Herpestes javanicus auropunctatus*) in the ecological network of the Neretva Delta in accordance with other action plans
1.3.1.	Organize and hold volunteer actions to clean water bodies and nesting sites of *M. rivulata* for the local population
1.3.2.	Activities to preserve *M. rivulata* habitats should be included in existing and/or future volunteer programs and implement those programs
3.2.1.	Hold public forums or seminars on the *M. rivulata* and the importance of its habitats, as well as on the negative impacts of pesticides, sustainable agriculture, irrigation, the use of non-selective fishing tools, and the maintenance of puddles and canals
3.2.2.	Strengthen cooperation with Local Action Groups and local farmers with the aim of encouraging sustainable food production

3.2 Management requirements for the nesting sites

3.2.1 BIOLOGICAL REQUIREMENTS OF THE FRESWATER TURTLES AND TERRAPINS

Biology and ecology of the freshwater turtles and terrapins defines the requirement to have nesting sites:

- **available in the land parcels at safe distance** (in immediate proximity of several hundred meters) and adjacent to water bodies to provide juveniles with food and shelter in the aquatic part of habitat upon emergence without minimizing breeding success,
- **safely approachable for females and juveniles** to safely migrate from the aquatic part of habitat to the nesting site without exhauster or direct threat due to barriers and habitat fragmentation (such as roads) to reduce female and offspring mortality,
- **available as constant nesting ground** from one breeding season to another (within 40 m of one specific nest) to minimize energy required for females to search new site adequate for nesting and reducing mortality of gravid females as well as to have successful incubation due to oviposition site choice,
- **as open habitat (sunny area with low plant cover and no surface water retention)** that enables warmth and moisture for incubation of the eggs because canopy can modify these conditions as well as physical, chemical and biotic properties of the soil (soil condition) and influence sex ratio and or incubation success,
- **free of invasive species predating on nests** and hatchlings, such as mongoose
- **safe from intensive predation of omnivorous wild species under human management**, such as wild boars,
- **safe from mechanical, physical, chemical interventions of the soil** during egg laying (May to August in case females are nesting twice in the same year), incubation (May to November) and hatching season (September to November) when juveniles are emerging from the nests. In case of second nest in the season it is possible for juveniles to overwinter in the nests and emerge from end of February or early March. Depending on the species and the temperature and rainfall characteristics of the breeding season the number of owerwintering hatchlings can reach up to 40%.
- **monitored for use** in case long-lived females change nesting location due to microhabitat parameters change over time.

3.2.2 FRESHWATER TURTLES AND TERRAPINS NESTING SITE MANAGEMENT PLANNING

Table 4. To propose practical measures to reduce the negative anthropogenic impact on the Balkan stripe-necked terrapin nesting sites following steps are recommended:

1.	Identify and map the nesting sites.
2.	Evaluate specific threats on the nesting site areas.
3.	Evaluate the use and ownership of the land parcels within the mapped nesting areas as well as other stakeholders impacting the solution perspectives on the larger scale than individual owners (policy makers and enforcers).
4.	Organise educational outreach to the local community to register interest in collaboration on targeted areas. Contract short-term trials with the landowners in Natura 2000 areas. Organise monitoring of the implementation and efficiency of the introduced management.
5.	Ensure long-term impact of successful measurements with all the stakeholders. Prioritize management solutions in a participative manner with the local community and the landowners of the Natura 2000 sites and defined other stakeholders. Include monitoring of the implementation and efficiency of the introduced management in the long term as well.
6.	Organise education on management requirements and dissemination of working practices to wider audience over the species area.

Step 1

Identify and map the nesting sites.

Identification of the nesting sites can successfully be preformed in collaboration of the species field experts and inhabitants and users of the area (e.g. landowners, fishermen, hunters, hikers) by using a combination of the following techniques:

In **the 100 m buffer area around the water bodies open and schrubby microhabitat** is investigated to

- **identify depredated nests by visual scan** for the remaining egg shells;
- identify turtle nests **using scent-detecting dogs**;
- identify turtle nests using **e-DNA** techniques;
- identify turtle nests using tracking of females during nesting season;
- collect information on turtle nests **asking for information from stakeholders** using the area.

To enchance the reach of the reports from the stakeholders using the area it is useful to have **outreach program (awareness raising campaign)** in that communities and the area in question rather than organizing a new enedeavour. It is usefull to **build the database of interested indivduals** for further habitat and species management requiremets.

Indentified nest locations can be used to map the nesting area for the freshwater turtle or terrapin by buffering area of 40-50 m around each specific nest finding to accommodate for the microhabitat choice during nesting.

Nesting area mapped in such a way can further be analysed with respect to the size of population estimated to be using the closest waterbody. Depending on the species, dense nesting sites can be considered to have 10 clutches over 10 m^2 area (*E. orbicularis*). Therfore, using the appropriate available information on nesting density of the species and the sex ratio, the total estimated required nesting area size (Formula 1) can be compared with the nesting area size given by the obtained data on specific nests.

Formula 1.

$$Nesting\ area = Population_{estimate} * \frac{F_{ratio}}{F_{ratio} + M_{ratio}} * \frac{Surface}{Nests_{perSurface}}$$

Threats that can be discovered in Step 1 and the actions towards their characterization and mitigation are given in Table 5.

Table 5. Cases of discovered nesting site suitability in Step 1 and actions towards discovery and mitigation of thereats

Cases	Actions
Case 1. The nesting area mapped is smaller than the estimated required nesting area size	A) Indentification of the individual nesting sites can be repeated with additional effort and techniquies, or over the wider buffer area surrounding the water bodies B) Assess unsuitable nesting microhabitat or barriers in the 100 m buffer area around the aquatic part of the habitat. If the area has abandoned plots define the owners and the plot purpose to discover the responsibility in maintaining the overgrowth or removal of invasive or other shrub or tree species.
Case 2. Nests are found at more than 200 m distance from the nearest watter body, or females are traveling more than average distancesreported for the species to nesting site.	A) Identify the barriers possibly affecting that choice of the nest (e.g. intensive human use of surface, buildings, roads, or geographical feacures such as precipice, etc.) B) Assess unsuitable nesting microhabitat as in Case 1 Action B).
Case 3. Depredated nests are found.	Determine the predator species on the nests in the nesting area. A) In case the predator is an invasive species see the actions proposed for Case 1 in Table 6. B) In case the predator is not an invasive species see the actions proposed for Case 2 in Table 6.
Case 4. Reports of accidentally dug-out nests are documented.	A) Pick-up service for incubation ex-situ can be organized. B) Flagged the area for mitigation measures depending on the land use.
Case 5. High nesting site densities are recorded over suitable microhabitat.	A) Define the potential areas for opening the habitat as in Case 1 B). B) If no such areas are available, consider artificial nesting options.

Step 2

2.	Evaluate specific threats on the nesting site areas.

If the nesting site area is providing enough space of suitable nesting microhabitat for the species inside the species relevant buffer zone around the water habitat few threats are remaining to be assessed:

- invasive species predating on nests and hatchlings;
- intensity of predation of omnivorous wild species under human management, such as wild boars;
- mechanical, physical, chemical interventions of the soil in the period end of Februarry/March to October/November depending on biology of the species and climate affecting success of nesting, incubation or hatching.

Table 6. Cases of discovered nesting site suitability in Step 2 and actions towards discovery and mitigation of thereats

Cases	Actions
Case 1. The nesting area has recorded invasive species negatively affecting the incubation and hatching.	A) Erradicate or control the predator population. In these activities focus the trapping effort on the nesting ground and during the egg laying season (May to end of July, depending on the species). B) Protect the nests using sutitable metal grid cover, nets or nest protector / nesting box over the nest in period of nesting.
Case 2. Visual inspection or camera traps show wild boars are affecting the nesting site by digging during the incubation period May to November.	A) Protect the nesting site where possible using or reparing the existing fencing or drywalls. Beware of electrical fencing which may be dangerous for the terrapin females depending on the tarrain and details in montage. Define the stakeholder or owner responsible for fencing activity. B) Apply repelents during the nesting season. Define the stakeholder or owner for arranging, financing and preforming this activity. C) Discuss wild boar population management possibilities affecting the size of the wild boar population on the nesting area, such as culling, repelents, providing feeding, wallowing and watering habitat features luring

	the wild boars away from the nesting area with appropriate stakeholder contact.
Case 3. Nesting area is agriculturally active, and nests are present in the grassland edge zone of the cultivated plot.	A) Approach the owners/users using the available open data ownership repositories, or in-field. Communicate the possibility to mark the nesting area with visible markers to ensure the agricultural machinery is not used to access the cultivated plot over the nesting site. B) If pick-up service for incubation ex-situ can be organized arrange the information protocol with the owner/user in case of accidental nest disturbance occurs. **C)** Determine possible chemical stress on the nesting using soil analysis or interviews with the owner/user of the plot and propose alternatives where required and possible.
Case 4. Nesting area is agriculturally active, and nests are present in the cultivated plot.	A) Approach the owners/users using the available open data ownership repositories, or in-field. Communicate the possibility to mark the nesting area with visible markers to ensure the agricultural activity disturbing the soil (ploughing, tilling, sowing, plant care, harvesting of such cultures that require soil disturbance) are avoided if the nesting area is not significant compared to the size of the cultivated plot. B) If the cultivated plot is a significant part of the nesting area and soil disturbance can not be avoided with spatial, temporal or crop choice and crop rotation arrangements with the owner/user, alternative nesting should be provided for the females by arrangement with the owner to limit the animal access to the cultivated plot and providing adequate neighbouring plot or artificial nesting site. C) If pick-up service for incubation ex-situ can be organized arrange the information protocol with the owner/user in case of accidental nest disturbance occurs. D) Determine possible chemical stress on the nesting using soil analysis or interviews with the owner/user of the plot and propose alternatives where required and possible.

Case 5. Nesting area is overgrown with canopy or situated in mosaic habitat with grassy areas exchanging with shrubs and trees.	If the area has abandoned plots with no apparent human activity define the owners/users and the plot purpose (e.g agriculture, forestry, building plots…) to discover the responsibility in maintaining the overgrowth or removal of invasive shrub or tree species.
Case 6. Nesting area is approachable trough migration routes used by agricultural machinery.	A) Define alternative bypass roads for agricultural machinery. B) Define alternative routes acceptable to owners/users.

Step 3

3.	**Evaluate the use and ownership of the land parcels within the mapped nesting areas as well as other stakeholders impacting the solution perspectives on the larger scale than individual owners (policy makers and enforcers).**

Over the defined nesting site area and for immediate, cost-effective, conflict free and long-term mitigating of the evaluated threats the following information about the nesting location has to be collected:

1. Number and size of parcels
2. Number and contacts of parcel owners (private and public ownership)
3. Contacts of parcel users: contracted users and activity stakeholder societies (e.g. hunters, hikers, local NGOs…)
4. Local government: local committee, municipality
5. Purpose of the parcels (forestry, agriculture, infrastructure…)
6. Policy makers and policy enforcers for purpose sectors of the nesting site parcels (e.g. municipality, inspection…)
7. Policy concerning parcel use, purpose and re-purposing of the parcels
8. Existing management plans (of concerning sectors of use) for the area

Step 4

4.	**Organise educational outreach to the local community to register interest in collaboration on targeted areas. Organise monitoring of the implementation and efficiency of the introduced management.**

Depending on the complexity of the management requirements for the nesting sites, organize workshops for the targeted groups of stakeholders optimizing reach in such a way to group different stakeholders of the same location or grouping stakeholders with similar interests.

These kinds of meetings can help with steps 1 to 3 and offer practical solutions for some of the issues on nesting sites. They are also important to obtain the register of owners and stakeholders interested to work on this conservational issue, to arrive to agreement to some of the easier solutions or trials and to register consent of the owners to change some of their activities on the nesting area or allow for simple and

non-conflicting activities on their plots. It is important to document individual agreements using the consent forms or short-term contracts.

Do not forget to include requirements to monitor the success of the contracted activities or measure the performance and the impact of the registered agreement on change of the activities.

Step 5

5.	**Ensure long-term impact of successful measurements with all the stakeholders. Prioritize management solutions in a participative manner with the local community and the landowners of the Natura 2000 sites and defined other stakeholders. Include monitoring of the implementation and efficiency of the introduced management in the long term as well.**

In evaluating short-term contracts, agreements and individual consents it is important to find patterns that can be streamlined using the existing policy or creating new policies.

Some of the activities can be financed in already existing protocols of different sectors, interdisciplinary. For activities in areas with small population size, or areas with predominantly old population, it is important to build the volunteering capacity of the institutions designated for managent of Natura 2000 areas.

Step 6

6.	**Organise education on management requirements and dissemination of working practices to wider audience over the species area.**

Awareness raising campaigns can ensure new generations are up to date with sustainable management of an area and regular educational activities can widen the proportion of stakeholders included in change of practices. It is important to target such events to the stakeholder groups with minimal response in previous steps of setig up the nesting management plan.

4. The stakeholders and procedures responsible for the management of the land parcels with *M. rivulata* nesting sites in Croatia

Maping of the nesting sites of the Balkan stripe-necked terrapin in Croatia identified nesting areas in Majkovi, Prljevići, Ston field and Konavle field using information on depredated nests and reports of the parcel owners on individual nests found. Additional data will be gathered using tracking of females during the following nesting seasons.

4.1 Mapping and characterisation of the *M. rivulata* nesting grounds in Croatia

Adequate open and dry nesting microhabitat approachable to the animals is available within 50 m around the aquatic part of the habitat (ponds in Majkovi and Prljevići, ponds and canals in Ston field and Konavle field). According to the population size and sex ratio estimated for each population 70 m^2 of protected nesting area should be sufficient for population using the Majkovi ponds, 10 m^2 of protected nesting area should be sufficient for population using the Prljevići pond, 20 m^2 of protected nesting area should be sufficient for the females produced for Ston field during this Project, and 105 m^2 of nesting area should be sufficient for the females in Konavosko field. Parcels within the nesting area provide open and mosaic habitat.

4.1.1 MAJKOVI NESTING AREA

Possibility of safe approach to the nesting sites from the ponds is hindered for the one of the Majkovi ponds which is surrounded by road in about half of its circumference. The tunnel below the road was built to mitigate this fragmentation and enable safer migration from this pond to the other one at 140 m distance and with more suitable microhabitat for nesting. Within 40 m of identified nests in Majkovi several land parcels were identified as perspective nesting area and the owners were approached. One parcel of about 425 m^2 is being contracted for short-term collaboration in the Project. Approachability of females and juveniles to this parcel requires additional inestigation and possibly arrangement of alternative bypass roads for agricultural machinery. The contracted parcel and other parcels are small (up to 500 m^2) privately owned used for

agricultural production of crops for personal use or not actively used. Most of them are surrounded by damaged drywalls or ameliorative canals. Depredated nests were identified as well as wild boar presence and mogoose on the nesting area. No pesticide residues or PAH and PCB residues or concerning heavy metal concentrations were found on contracted nesting sites.

4.1.2 PRLJEVIĆI NESTING AREA

Safe approach to the nesting site from the pond is possible from 50% circumference of the pond because it is situated in the natural depression. Parcels adjacent to the pond that offer suitable open and mosaic nesting area and where nests were identified are partially fenced of towards the pond with functional drywalls. Both parcels are privately owned and are being contracted for short-term collaboration in the Project. The parcels are used as holliday house with yards of crops for personal use and cover more tha enough of nesting area (1108 and 3187 m^2). Wild boar presence was reported to damage the crops and and mogoose have been seen near the parcels. No pesticide residues or PAH and PCB residues or concerning heavy metal concentrations were found on contracted nesting sites.

4.1.3 STON NESTING AREA

Two private parcels are being contracted for short-term collaboration in Ston field area, both with small nesting areas adjacent to the ponds, privately owned. One is used as orchid and is affected by wild boar activity and has depredated nest records (1303 m^2). The other is next to the refugium pond that is being restored in the Project and will have constructed nesting site unapproachable to wild boars. Possibly protection measures from mongoose will be required for the Ston field nesting areas. No pesticide residues or PAH and PCB residues or concerning heavy metal concentrations were found on contracted nesting sites.

4.1.4 KONAVLE FIELD NESTING AREAS

Nesting areas are mapped within privately owned parcels used for agricultural production of crops and pasture primarily for personal use. In Konavle field comercial vinyards and orchids are in the targeted nesting area. Most of suitable nesting area next to ponds and canals in Konavle fields are meadows used as horse and cow pasture and as horse backriding touristic activity locations. Two parcels are being contracted with canal surrounding meadows with ponds (1500 – 1800 m^2). Wild boar activity was not reported for these two parcels. Possibly protection measures from mongoose will be required for the Konavle field nesting areas. No pesticide residues or PAH and PCB residues or concerning heavy metal concentrations were found on contracted nesting sites.

4.2 Required management activities on the *M. rivulata* nesting grounds in Croatia

After individual meetings with the owners of targeted parcels for contracting and workshops with local stakeholders including local committees, municipalities, agricultural advisoiry agencies, agricultural Local Action Groups, hunter societies, local agricultural and heritage NGOs as well as interested local residensts organised at separate locations (Majkovi, Konavle and Ston) to get higher response, required activities for nesting site management were proposed and prioretized as shown in Table 7.

Agricultural land that is inactive was proposed for volunteer maintenance. For the active plots predator repelling (wild boars) needs were assessed, type of current and planned agricultural production (land and water use) as well as soil health and plant feeding potential. Type of current and recommended agricultural intervention is assessed with regard to mechanical, physical, chemical and biological interventions in and on agricultural land dealing with:

- increasing/maintaining soil fertility and improving soil quality;
- **prevention or reduction of soil and land degradation or reducing erosion;**
- to ensure food security, adaptation and mitigation of climate change,

to increase water holding capacity and drought resistance.

Table 7. Prioritized *M. rivulata* nesting site management activities on private land parcels in Natura 2000 network

Threat	Actions required on nesting areas or migration routes	Priority and acceptability
Safe migration of females and hatchlings between aquatic part of the habitat and the nesting site	A) Artificial nesting options. B) Mark the nesting area with visible markers to ensure the agricultural machinery is not used to access the cultivated plot over the nesting site. C) Define alternative bypass roads for agricultural machinery.	Majkovi

Owergrowth of open habitat available for nesting	A) Maintaining the overgrowth of shrubs and trees annually. B) Removal of invasive or other shrub or tree species.	Majkovi, Prljevići, Konavle field, Ston field
Mongoose predating on nests	A) Trapping of invasive species on the nesting ground. **B)** Protect the nests using sutitable metal grid cover, nets or nest protector / nesting box over the nest in period of nesting.	end of February to November in Majkovi, Prljevići, Ston field, Konavle field
Wild boars disturbing the nests	A) Protect the nesting site where possible using or reparing the existing fencing or drywalls. Avoid electrical fencing which may be dangerous for the terrapin females depending on the tarrain and details in montage. B) Use repelents during the nesting season. C) Protect the nests using sutitable metal grid cover.	In Makovi and Prljevići drywall fences are considered more acceptable than repelents. In Ston metal grid cover is the most suitable solution.
Agricultural mechanical interventions to soil	A) Pick-up service for incubation ex-situ can be organized. B) Mark the nesting area with visible markers to ensure the agricultural machinery or crop choice does not disturb the nest. C) If the cultivated plot is a significant part of the nesting area and soil disturbance can not be avoided with spatial, temporal or crop choice and crop rotation arrangements with the	

	owner/user, alternative nesting should be provided for the females by arrangement with the owner to limit the animal access to the cultivated plot and providing adequate neighbouring plot or artificial nesting site.	
All	Monitoring: set camera traps, sample soil, collect information on nesting events on the plot.	

4.3 Relevant policies affecting long term solutions on *M. rivulata* nesting sites in Croatia

Some of the threats require management of the area and not only a parcel. In Majkovi and Proljevići wild boar population management possibilities affecting the size of the wild boar population on the nesting area were discussed with stakeholder groups. Culling was not acceptable solution, repelents are considered as in-affective and complicated to regulary maintain. Providing feeding, wallowing and watering habitat features luring the wild boars away from the nesting area were considered viable options.

Ordinance on agrotechnical measures defines the decision on agrotechnical measures are given by the municipalities. Most of the obligations regarding sustainable use of agricultural land as defined by the Law on agricultural land and the Rulebook on agrotechnical measures are regarding the owners or authorized persons of agricultural land. Nevertheless, some of the issues with owergrowth on abandoned parcels, required maintenance of the approaching roads or canals can be defined by such municipality decisions.

The required actions on the private plots can be preformed by the owners themselves with the guidance of the nature protection specialists. In casevolunteering actions are organized, all activities on the private land must be authorized by the owners and uses of the land parcels in question. Municipality decisions can help with required activities in cases parcels that are not used, and owners contacts can not be obrained.

Instruments such as consent forms, short term collaboration agreements and private land stewardship agreements can ensure effective management and even in the long term and independent of the original parcel owners.