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The common sandpiper (Actitis hypoleucos) and the little ringed plover (Charadrius dubius) at the Tyrolean Lech

Distribution, Occurrence, Habitats and changes

Michael SODJA, 01419007

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Betreuer*in:
Univ. Lektor Mag. Dr. Reinhard Lentner
Institut für Zoologie
Fakultät für Biologie

universität innsbruck

Ich erkläre hiermit an Eides statt, dass ich die vorliegende Masterarbeit selbständig angefertigt habe. Die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sind als solche kenntlich gemacht.

Die Arbeit wurde bisher weder in gleicher noch in ähnlicher Form einer anderen Prüfungsbehörde vorgelegt und auch noch nicht veröffentlicht.

Innsbruck, April 2025 _____

Einleitung

Der Tiroler Lech ist einer der wenigen Flüsse in Mitteleuropa, welcher noch in einer weitgehend natürlichen Art und Weise besteht. Die daraus resultierende Dynamik des Flusslaufs und seiner Begleitlebensräume sind in Mitteleuropa zur Seltenheit geworden und im Nordalpenraum gilt der Tiroler Lech als die letzte große Wildflusslandschaft. Aufgrund des sich stetig ändernden Flusslaufs in den natürlichen Bereichen und der dynamischen Geschiebeführung erhalten sich am Tiroler Lech ebenfalls die natürlichen Begleitlebensräume, welche für Alpenflüsse ursprünglich typisch waren. Folglich finden sich auch die natürlichen und typischen Lebensgemeinschaften und Arten an diesem Wildfluss wieder.

Der naturnahe Zustand des Flusssystems „Tiroler Lech" ist allerdings alles andere als selbstverständlich und erfordert immer wieder Maßnahmen, die der anthropogenen Zerstörung dieses Juwels durch z. B. Begradigen und Aufstauen des Flusskörpers, entgegenwirken. Seit den 2000er Jahren wurden daher 2 LIFE-Projekte am Tiroler Lech durchgeführt. Das erste dieser von der Europäischen Union geförderten Projekte wurde zwischen 2001 und 2007 umgesetzt. In diesem Projekt gelang ein erster erfolgreicher Schritt zur Redynamisierung des Lechs. Im Nachfolgeprojekt wurden weitere Maßnahmen gesetzt (u.a. Entfernung von Flussverbauungen, Anlegen von Nebenarmen, Kürzung von Buhnen), um diese Redynamisierung voranzutreiben. Generelle Ziele beider LIFE-Projekte waren den Flusslebensraum zu revitalisieren, bedrohte Arten zu fördern und langfristige Schutzstrategien zu etablieren. Ein besonderes Augenmerk wurde im LIFE Lech II-Projekt dabei auf die dynamisch geprägten Kiesbankflächen und die Pionierstandorte gelegt.

Im Rahmen dieser Projekte waren auch die beiden spezialisierten Vogelarten Flussuferläufer (*Actitis hypoleucos*) und Flussregenpfeifer (*Charadrius dubius*) im Fokus. Ihre Bestände gelten als sensible Indikatoren für die Qualität von Flussauenlebensräumen. Diese Arbeit behandelt die Bestände dieser beiden Charakterarten am Tiroler Lech, welche ebenfalls für Österreich von besonderer Bedeutung sind. Für den Flussuferläufer sind die Vorkommen am Lech neben denen an der Isel in Osttirol eine der bedeutendsten in Tirol und Österreich. Der Flussregenpfeifer hat am Tiroler Lech neben den Vorkommen an den Donauauen die bedeutendsten Brutrevier in ganz Österreich. Die wichtigsten natürlichen Vorkommen des Flussregenpfeifers befinden sich ebenfalls am Tiroler Lech. An den sonst relativ stark begradigten und veränderten Flussläufen in Tirol und auch Österreich finden sich höchstens sporadisch größere Populationen dieser Vögel (mit einigen Ausnahmen, wie die Donauauen).

Um diese österreichweit wichtigen Bestände des Flussuferläufers und des Flussregenpfeifers kontrollieren zu können finden seit über 45 Jahren regelmäßig Bestandsuntersuchungen statt. Die erste Arbeit in dieser Reihe wurde von Landmann in den 70er Jahren durchgeführt. Darauffolgend fanden ebenfalls Studien zu den Bestandsdichten beider Vögel in den späten 80ern durch Landmann und Böhm statt. Mitte der 90er Jahre folgte darauf eine Untersuchung des Flussuferläufers durch Frühauf und Dvorak ehe 2012 wiederum beide Arten untersucht wurden. Die Arbeiten 2012 erfolgten anhand zweier Masterarbeiten von Eberhard und Lassacher unter der Leitung von Lentner welcher auch für die hier vorliegende Arbeit als Supervisor fungierte. Die hier vorliegende, 2022 durchgeführte Arbeit versteht sich daher als ein Beitrag zur längerfristigen Bestandsüberwachung im Sinne eines ökologischen Monitorings, wobei auch andere Aspekte zusätzlich zu den Bestandsdichten in die Untersuchung integriert wurden, wie auch schon bei Eberhard und Lassacher.

Die Ergebnisse dieser Untersuchungen sind insbesondere im Zusammenhang mit dem bestehenden Schutzgebiet „Tiroler Lech", sowie dem gleichnamigen FFH-Gebiet und Vogelschutzgebiet (im Rahmen der Natura 2000 Verordnung) und den in den Managementplänen festgehaltenen und initiierten Maßnahmen zur Erhaltung der wichtigen Flusshabitate relevant. Besonders die letzten beiden

Arbeiten geben einen Einblick in die kurzfristige Wirksamkeit von Maßnahmen, welche im Rahmen der beiden LIFE-Projekte am Lech durchgeführt werden. Ob diese Maßnahmen langfristige Wirkungen zeigen, muss im Rahmen weiterer Untersuchungen diskutiert werden.

Somit bieten diese Arbeiten gemeinsam mit den bestehenden Schutzgebieten eine fundierte Datengrundlage für aktiven Natur- und Artenschutz am Tiroler Lech. Hier spielt vor allem der 2022 gegründete Verein „Lechforschung 2050+“ eine entscheidende Rolle. Dieser Verein verfolgt vor allem die Ziele der Forschungsbasierten Lehre der Ökosysteme am Tiroler Lech mit den Punkten Langzeitforschung, Grundlagenerarbeitung, Erhaltung der Wildflusslandschaft, genereller Wissensausbau und auch Ausweitung der Forschungsaktivitäten. Damit wird auch in Zukunft der Lech und seine begleitenden Lebensräume als Forschungsobjekte genutzt, um die Erhaltung dieser letzten Wildflusslandschaft im nördlichen Alpenraum gewährleisten zu können und die damit verbundenen Arten und Lebensgemeinschaften zu schützen.

Das Untersuchen dieser Bestände von zwei hoch interessanten Vogelarten, welche ebenfalls als Charakterarten sensibler und natürlicher Flusslebensräume gelten, war eine persönliche Motivation für mich diese Arbeit durchzuführen. Im Zusammenhang mit den vorangegangenen Arbeiten, den bestehenden Schutzgebieten und dem damals gerade in der Durchführung befindlichen LIFE Lech II-Projektes vertieften die Interessen an dieser Arbeit und zeigten mir vor allem die Wichtigkeit der Untersuchung beider Vogelarten für den Natur- und Artenschutz auf. Ebenfalls war das Zusammenarbeiten mit Reinhard Lentner und seinen Kollegen im Raufußhühner-Monitoring ein persönlicher Anstoß eine Feldforschung mit praktischem Nutzen als Masterarbeit durchführen zu wollen.

Um die Ergebnisse dieser Untersuchung möglichst vielen interessierten Menschen und vor allem auch den Kollegen und Kolleginnen im Bereich des Naturschutzes bereit zu stellen, wurde in dieser Masterarbeit bewusst die Publikationsform gewählt. Durch dieses Mittel erhoffe ich mir, dass eine breitere Masse Zugriff auf die erlangten Daten und Ergebnisse erhält mit dem Ziel möglichst viele Erkenntnisse zur Verfügung zu stellen, um den Natur- und Artenschutz zu fördern und den Entscheidungsträgern eine weitere fundierte, verständliche Grundlage für weitere Maßnahmen und Diskussionen zu bieten. Dies ist vor allem im Rahmen der neuen Renaturierungsrichtlinie von immenser Bedeutung und Aktualität.

Abstract

This thesis deals with the populations of the common sandpiper (*Actitis hypoleucos*) and the little ringed plover (*Charadrius dubius*) and their development, disturbances, their breeding biology, and their presence on the Tyrolean Lech. The Tyrolean Lech is one of the last near-natural river ecosystems in Austria. As indicator species for such dynamic river systems, data on these two waders are particularly suitable as a foundation for a scientifically discussion on nature conservation issues.

The first and last sightings of these birds were from mid-April and the end of September (little ringed plover) and mid-October (common sandpiper). This presence/abscence data and the delimitation of the breeding period from mid-May to the end of July (from first full clutch to last hatching of the season) for both birds can serve as a basis for further nature conservation projects. In particular, the location of the territories and the hatching period of the chicks should be emphasised here. The results show that the early summer from May to late July is the most sensitive time of the year. They also reflect the migrating behaviour of these waders towards winter territories, which leads to the lack of sightings from late October to the beginning of April.

This paper also discusses the influence of disturbance on the common sandpiper and little ringed plover populations. It distinguishes between natural and anthropogenic influences. This study found no significant effects on the birds due to the previously defined disturbance categories. Nevertheless, avoidance of gravel banks with a high visitor frequency is evident.

This study also analysed habitat selection preferences. It was found that the Tyrolean Lech populations appear to colonise the same habitats as the populations in the rest of Europe. For the common sandpiper, these are dynamic river sections with gravel banks and a certain amount of low vegetation like grasses or small bushes where this bird can hide its nests. On the other hand, the little ringed plover avoids all forms of vegetation as much as possible and prefers finer-grained gravel banks in somewhat broader river sections.

As the LIFE Lech II project was carried out on the Lech between 2017 and 2022, the results of the territory records were checked for the effectiveness of the measures implemented. For this, the research papers by Landmann from 1978, Landmann and Böhm (1993), Frühauf and Dvorak (1996), Eberhard (2013) and Lassacher (2014) were used as references (Table 1). The studies from Eberhard (2013) and Lassacher (2014) were performed after the first LIFE project at the Lech from 2001 to 2007, where also nature revitalisation measurements were implemented. In comparison with these works the data suggest that the population of the common sandpiper is slightly increasing, whereas the little ringed plover population seems to be stable, at least at the Tyrolean Lech.

However, a clear correlation between the measures and a positive effect on the population size could not be established, but this could also be because of the short time span between the measures and the research. In this case the effectiveness is to establish in future studies. In any case, no adverse effects were found.

Zusammenfassung

Diese Arbeit befasst sich mit den Beständen des Flussuferläufers (*Actitis hypoleucos*) und des Flussregenpfeifers (*Charadrius dubius*) und deren Entwicklungen, sowie Störungen, der Brutbiologie und der Anwesenheit am Tiroler Lech. Der Lech in Tirol ist eines der letzten naturnahen Flussökosysteme in Österreich. Als Indikatorarten für solche dynamischen Flusssysteme sind Daten über diese beiden Watvögel besonders geeignet, um Themen des Naturschutzes wissenschaftlich fundiert diskutieren zu können.

Die ersten und letzten Sichtungen im Kalenderjahr gelangen Mitte April und Ende November (Flussregenpfeifer) beziehungsweise Mitte Oktober (Flussuferläufer). Diese Präsenz/Absenz Daten sowie die Eingrenzung der Brutperiode auf Mitte Mai bis Ende Juli (von der ersten Eiablage bis zum letzten Schlüpfen der Saison) dieser beiden Vögel können als Grundlage für weitere Projekte im Rahmen des Naturschutzes dienen. Insbesondere die Lage der Reviere sowie der Schlupfzeitraum der Küken sind hier hervorzuheben. Die Resultate zeigen, dass der Frühsommer von Mai bis Ende Juli die sensibelste Zeit im Laufe des Jahres ist. Die Ergebnisse sind ebenfalls ein Hinweis auf das Zugverhalten der Vögel in Richtung Winterquartiere, was zu dem Fehlen von Sichtungen zwischen Ende Oktober und Anfang April führt.

Ebenso werden in dieser Arbeit der Einfluss von Störungen auf die Populationen des Flussuferläufers und des Flussregenpfeifers erörtert. Hierbei wird zwischen natürlichen und anthropogenen Einflüssen unterschieden. In dieser Studie zeigen sich keine signifikanten Auswirkungen auf die Vögel durch die vorher festgelegten Störungskategorien. Nichtsdestotrotz zeigt sich eine Vermeidung von Kiesbänken mit einer hohen Besucherfrequenz.

Die Präferenzen in der Habitatwahl sind in dieser Studie ebenfalls untersucht worden. Es zeigt sich, dass die Populationen des Tiroler Lechs scheinbar gleiche Habitate besiedeln wie die Populationen im restlichen Europa. Für den Flussuferläufer sind das dynamische Flussabschnitte mit Kiesbänken und einem gewissen Anteil an Vegetation, in denen dieser Vogel seine Nester verstecken kann. Der Flussregenpfeifer hingegen meidet Vegetation so gut es geht und bevorzugt feinkörnigere Kiesbänke in etwas breiteren Flussabschnitten.

Da zwischen 2017 und 2022 am Lech das LIFE Lech II Projekt durchgeführt wurde, wurden die Ergebnisse der Reviernachweise ebenfalls auf die Effektivität der umgesetzten Maßnahmen überprüft. Als Referenz wurden die Forschungsarbeiten von Landmann aus dem Jahre 1978, Landmann und Böhm (1993), Frühauf und Dvorak (1996), Eberhard (2013 und Lassacher (2014) verwendet (Table 1). Die beiden Arbeiten von Eberhard (2013) und Lassacher (2014) fanden nach dem ersten LIFE Projekt am Lech statt, in dem ebenfalls Revitalisierungsmaßnahmen umgesetzt wurden. Im Vergleich mit den genannten Arbeiten zeigen die neuen Daten, dass sich der Bestand des Flussuferläufers im Steigen befindet und der des Flussregenpfeifers stabil zu sein scheint; zumindest am Tiroler Lech.

Allerdings konnte allerdings kein klarer Zusammenhang zwischen den Maßnahmen und einem davon ausgehenden positiven Effekt auf die Populationsgröße festgestellt werden, jedoch könnte dies auch an der kurzen Zeitspanne zwischen den durchgeführten Maßnahmen und den hier berücksichtigten Kartierungen liegen. Die Wirksamkeit der Maßnahmen ist deshalb erst durch in der Zukunft durchgeführte Studien zu bewerten. Negative Auswirkungen wurden in jedem Fall keine festgestellt.

Content

Introduction

Dalla Torre and Anzinger first published general information about the occurrence of bird species in Tyrol in the late 19th century (Dalla Torre and Anzinger 1896/97). Although this work listed the Avifauna of the western part of Austria very well, for the next eight decades, only a few data (e.g. Walde and Neugebauer 1936) about the little ringed plover (*Charadrius dubius*) and the common sandpiper (*Actitis hypoleucos*) is available (Landmann 1978). Therefore, not much is known about population dynamics in this period. In addition, data on breeding season and migration is scarce for this period. It was not until the late 1980s that Landmann described the occurrence and migration dynamics of shorebirds in two papers (Landmann 1978, Landmann 1979). In these two publications, Landmann investigated rivers in Tyrol; consequently, the Lech valley was part of his research. From this time onwards, researchers regularly collected data about the common sandpiper (CS) and the little ringed plover (LRP) at the river Lech (see Table 1). Most publications sampled the whole region of Tyrol, whereas this research concentrates solely on the Lech Valley. To ensure the comparability between this work and the previous studies from Landmann, Eberhard (2013) and Lassacher (2014) (Table 1), the sampling area is adopted from these publications. Therefore, the same 51.4 km of the river Lech and 4 km of the two affluent streams Hornbach and Vils have been objects to this research (see Figure 1).

Table 1 *Previous works for the Common sandpiper and the little ringed plover include the Lech valley. Although more data is available, these publications were most suitable for comparison.*

Common Sandpiper	**Little ringed Plover**
1977 (Landmann 1978)	
1989/90 (Landmann and Böhm 1993)	
1994 (Frühauf and Dvorak 1996)	-
2012 (Eberhard 2013)	2012 (Lassacher 2014)

Although the two shorebirds were subject to various publications described above, very little is known about when the birds appeared and disappeared in this area or the reproduction period. Although Lentner and Sieder gathered breeding times of tyrolean birds from existing literature (Lentner and Sieder 2019), specific data for the Lech region would result in a more precise picture of the two investigated species. During this study, data on population dynamics, development and possible changes in habitats was collected. These parameters were last surveyed in the works of Lassacher (2014) and Eberhard (2013). Afterwards a second LIFE Lech project – "Dynamic River System Lech" was realized between 2017 and 2022 (https://www.life-lech.at/das-projekt/projektbeschreibung/). Therefore, another research study about the little ringed plover and the common sandpiper was necessary to evaluate the impact the actions from the LIFE project have had on the birds, such as possible changes in population dynamics or habitat preferences.

The study presented here shows the overall distribution of the two species, where territories are located and how populations of the common sandpiper and the little ringed plover at the Lech have changed over time. This will be compared with previous research (see Table 1). Additionally, habitat preferences were looked after to understand if the renaturation of parts of the Lech (LIFE Projekt – "Dynamic River System Lech") has led to shifts in habitat preference of the two shorebirds in this region. Additionally, data were collected regarding the first and last sighting of these species at the Lech (attendance), copula, nesting and first sighting of hatchlings (breeding biology), disturbances and the occurrence of syntopic species.

This study aims to deepen our knowledge about the two shorebirds, their preferences, and characteristics at the Lech. This information is helpful in nature preservation and evaluating future actions in this area, which are described in the management plan for the natural reserve Tiroler Lech (REVITAL/Ragger 2022).

The river Lech in Tyrol

As one of the last rivers in Tyrol and Austria, described as nearly natural, the Lech plays a vital role as a refuge for various species and their habitats. The partially vast and untamed river alternates with moderately to strongly impacted river segments (Müller and Scharm 2001). Although this stream is considered near-natural, historical data shows that, as a result of anthropogenic interventions, even the widest part of this river is only half the size it was in the past, which has changed the natural flow and river morphologies gradually (Preis et al. 2008). Nevertheless, some parts have kept their typical characteristics, where river dynamics can form the stream naturally (Müller and Scharm 2001). This leads to the previously mentioned formation of side arms, various islands in different states, alternating vegetation coverage, and various types of shores. This dynamic change allows multiple habitats to develop and, therefore, many species to inhabit numerous ecosystems (Müller and Bürger 1990).

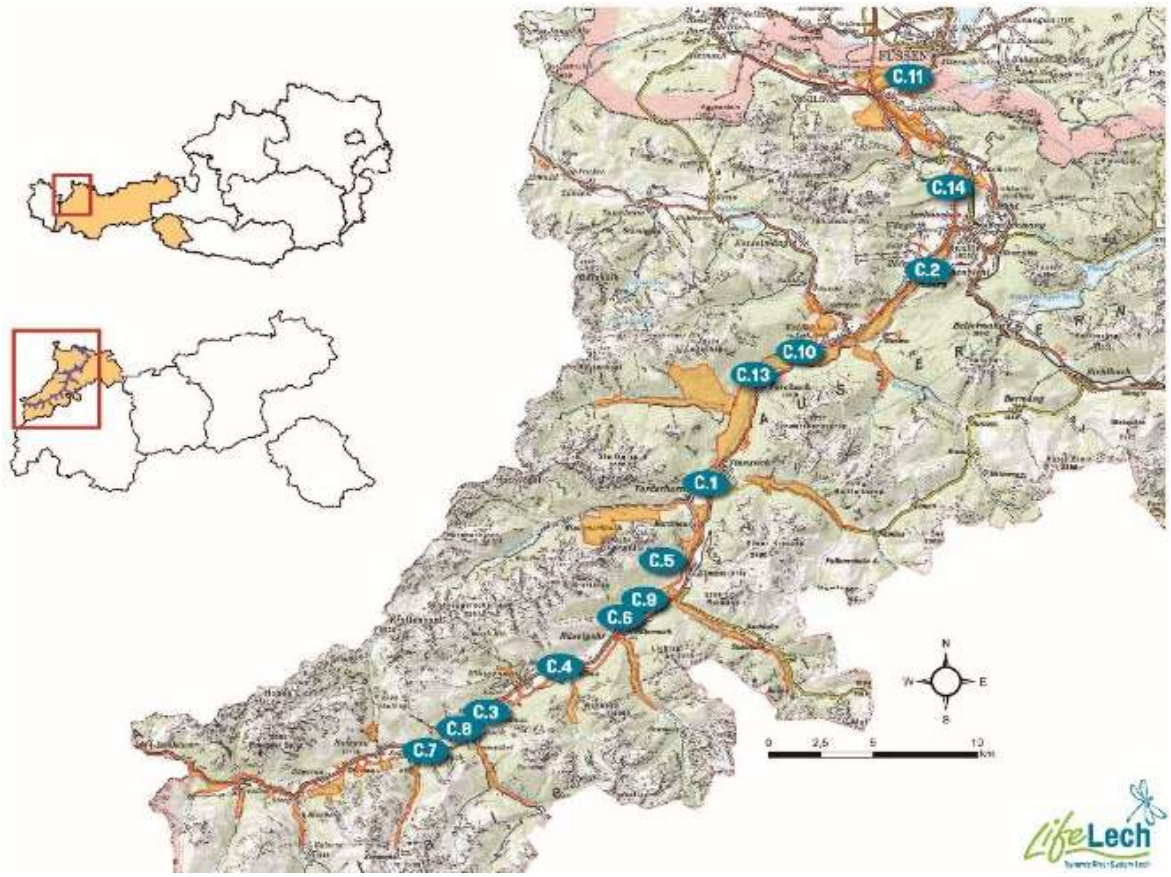


Figure 1 *The 13 measures along the river Lech implemented during the LIFE Project - "Tiroler Lech II". These actions took place between 2017 and 2022 (https://www.life-lech.at/fileadmin/Bilder/content_800x600/LIFE_Lech_Final_Report_20220930_web.pdf).*

To ensure this valuable ecosystem survives, it was declared as the Natura2000 area "Tiroler Lech" (site code: AT3309000, https://www.tirol.gv.at/fileadmin/themen/umwelt/naturschutz/downloads/natura_2000/Standarddatenboegen/Site_AT3309000.pdf) and in 2004 also as a nature reserve (Decree of the federal state government of Tyrol from 12.10.2004 (LGBl. Nr. 84/2004)). Additionally, two LIFE projects were conducted over the last 20 years (https://www.life-lech.at/). The first was between 2001 – 2006, with the target to increase the stream's dynamic and regain parts of the river

by reducing some previously obstructed areas (Preis et al. 2008). The second project was performed from 2017 to 2022 (LIFE Lech II). The aims of this project were again to regain some of the river dynamic, which allows various habitats to form, such as shores with low vegetation or no vegetation at all (Lassacher and Füreder 2017, Salchner 2020). Overall, 13 measures were implemented, resulting in 13,73 km additional dynamic riverbanks and 22,82 ha additional near-natural river areas. Furthermore, an area of 62 ha has the potential for a near-natural river area (https://www.life-lech.at/fileadmin/Bilder/content_800x600/ LIFE_Lech_Final_Report_20220930_web.pdf). Mainly, the resulting gravel or sandbanks are of great interest for this study because they are the primary habitat for the two birds investigated: the common sandpiper and the little ringed plover (Parrinder 1984; Lentner et al. 2022).

Common Sandpiper (Actitis hypoleucos)

Common sandpipers live along rivers, smaller streams and sometimes lakes. The ideal habitat is a shallow shore with mid-sized gravel and some vegetation to hide their nests (Hammer et al. 2013, Lentner et al. 2022). Although *Actitis hypoleucos* needs some vegetation to cover nesting sites, reforestation of shores is dangerous to their habitat, decreasing its preferred foraging areas (Hammer et al. 2013). Dynamic river flow is, therefore, crucial to provide open shores with low vegetation. Due to these special needs concerning their habitat, Arlettaz et al. have chosen the common sandpiper to evaluate a river bed restoration at the Rhone (Arlettaz et al. 2011).

The reproduction period for the common sandpiper starts almost immediately after spring migration in mid-April (Lentner and Sieder 2019). Nests are usually built in low vegetation close to the water body. The usual clutch size is four eggs per nest, and nearly all eggs produce hatchlings (only 1 out of 10 eggs does not hatch). However, if the birds have to make a secondary nest due to losing the first one, the number of eggs laid can decrease to mainly three eggs per nest. With the secondary nests counted, the breeding season can last until mid-July, when the last hatchlings occur (Glutz et al. 1977, Holland et al. 1982, Bauer et al. 2012).

In April, migration to its breeding habitats starts for Actitis hypoleucos (Baccetti et al. 1992, Landmann 1979). Common sandpipers travel middle to long distances to their winter habitats which are usually located in tropical Africa south of the Sahara (Glutz et al. 1977, Bauer et al. 2012). The migration southward begins almost immediately at the end of the breeding season. Adult individuals leave the breeding sites in central Europe at the end of July, whereas the earliest migration from juveniles was seen in August (Adamík and Pietruszková 2008). In the arctic regions of southeastern Sweden, the birds show earlier migration, starting in June (Iwajomo and Hedenström 2011). In Tyrol, migration begins at the end of July. This passing event can last until the end of September, with only some individuals lasting until October; in extreme events, even until November or December (Landmann 1979).

Although the IUCN Red List of Endangered Species ranks the common sandpiper (globally and Europe-wide) as a species of least concern (LC) (https://www.iucnredlist.org/species/22693264/86678952), its numbers are decreasing, and in Austria, this bird is listed as endangered (EN) (Dvorak et al. 2017). In Tyrol, the common sandpiper is a very rare breeding bird listed as endangered from 1990-2000 (Landmann and Lentner 2001), with the most significant distribution at the Lech (Lentner et al. 2022). This enhances the importance of the renaturation projects to increase the habitat quality in general. Studies on how these projects affect the populations of the common sandpiper are needed to evaluate the outcome of these projects.

Little ringed Plover (Charadrius dubius)

An ideal habitat for the little ringed plover would be a shallow riverbank with some small gravel and/or sand or mud and no vegetation at all (Lentner et al. 2022, Parrinder 1984). Areas with these characteristics are found predominantly on natural dynamic river systems, where occasional flooding

keeps the shore free from plants or trees. For a short time, anthropogenic biotopes can also be used, e.g., building sites (Lentner et al. 2022).

The start of the reproduction period for little ringed plovers is usually in April (Lentner and Sieder 2019). This season can last until June (Bauer et al. 2012) if primary nesting sites are lost due to floods. Nesting sites are only slightly covered with some plant material. Otherwise, the camouflaged eggs would lose their disguise (Lassacher 2014). Usually, the female lays four eggs. Especially in secondary nesting sites, the number of eggs can decrease to 3. Laid eggs hatch after 3 to 4 weeks of breeding, with a success of around 60% (Bauer et al. 2012, Glutz et al. 1977).

The little ringed plover is also a long distance traveller who migrates from central Europe to their wintering habitats in Africa in the Sahel Zone and the equator is rarely crossed (Bauer et al. 2012). Migration from winter territories probably starts in March for the Tyrolean population. The earliest date a bird was observed was on the 2nd of March in 1978 (by Loner in Landmann 1979). Although this is suggested as an extremely early date, other authors also state that the arrival time is around March (Bauer et al. 2012). After the breeding season is over, the first peak of migrating birds leaves in mid-July. A second peak reaches its height around September. The relatively early migration in July suggests that most adult birds leave at this time, whereas juveniles remain longer in their birth habitat (Landmann 1979). The little ringed plover is also considered to have a high fidelity to their breeding sites (Bauer et al. 2012).

Like the common sandpiper, the little ringed plover in Europe is also mentioned as LC (least concern) on the list of the IUCN (IUCN 2024). This list shows the overall population size of Europe and thus must not be representable for smaller subpopulations. In Austria, this bird has the status VU (vulnerable) (Dvorak et al. 2017), with the concentration of populations at the Danube River and the Lech. For Tyrol, the little ringed plover was seen as rare or extremely rare by earlier authors of the 20th century, like Thun, Prenn and others (Landmann 1978). Landmann and Lentner listed the little ringed plover for the period 1990-2000 even as critically endangered in Tyrol (Landmann and Lentner 2001). More recent studies also regard this wader as a scarce breeding bird in North Tyrol with a local distribution at the river Lech (Lentner et al. 2022). Regular controls and studies are the first step to maintaining stable populations of *Charadrius dubius*.

Materials and Methods

Study sites

This field research took place in the Lech valley, at the northwestern border of Tyrol in the district of Reutte. Subject to this study was the river Lech from the village Bach, at river kilometre (rk) 219,4, down to Weißhaus at the border of Austria and Germany (rk 168), as well as the affluent streams Hornbach (rk 4 – 0) and Vils (rk 5,9 – 1,9) (see Figure 2). The Hornbach was looked at for 4 km upstream from where it merges into the Lech and the Vils from the same named village Vils also 4 km upstream. The part of the Lech described above as the main research area has a 51.4 km length, totalling a 59.4 km track covered. For its size, the Lech was again divided into three sections.

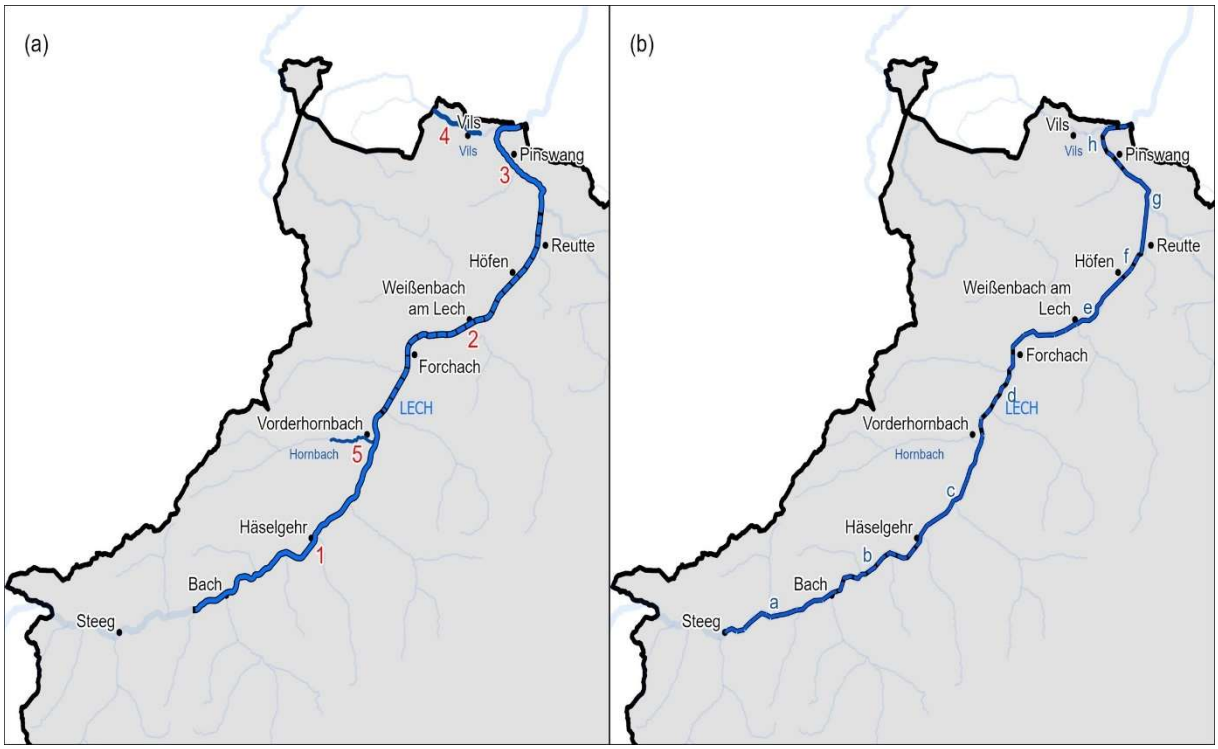


Figure 2 (a) *The research areas are divided into five sections. The Lech´s sections are parted with zig-zag lines. 1-3 are the upper, middle and lower reaches of the Lech. 4 is the Vils, and 5 is the Hornbach. The parts of the Vils and the Lech which were not part of this study are shown as dotted lines.* ***(b)*** *The black dots and the abbreviations a-h along the Lech show the subdivisions according to previous research used for analysing the populations: a…Steeg-Bach, b…Bach-Häselgehr, c…Häselgehr-Vorderhornbach, d…Vorderhornbach-Forchach, e…Forchach-Höfen, f…Höfen-Reutte, g…Reutte-Oberpinswang, h…Oberpinswang-Border (Landmann 1978, Landmann and Böhm 1993, Frühauf and Dvorak 1996, Eberhard 2013, Lassacher 2014).*

The three parts of the Lech have a variety of different morphologies and ecological niches to offer. The first section starts at the community Bach and ends at Stanzach (rk 219,4 – 197,0). Beginning with a narrow riverbed (25-30 m), this section shows some broadening downstream when the riverbed can reach up to 130 m (tirisMaps). In these wider parts, meadows are the main habitats. Wood-free meadows with gravelly surfaces are the most common. However, meadows with different vegetation, such as grey alder (*Alnus incana*), crimson willow (*Salix purpurea*), ash (*Fraxinus excelsior*) or pine (*Pinus sylvestris*) can be found along the river (https://data-tiris.opendata.arcgis.com/datasets/biotopkartierung-flaechen).

Table 2 *The researched sections of the three rivers. The three parts of the river Lech were named after the closest villages to the starting and ending point.*

Section	Section Name	rK (river kilometre)	Length
1	Bach – Stanzach	219,4 – 197,0	22,4 km
2	Stanzach – Pflach	197,0 – 177,2	19,8 km
3	Pflach – Weißhaus	177,2 – 168,0	19,2 km
4	Vils	5,9 – 1,9	4 km
5	Hornbach	4,0 – 0	4 km

Figure 3 *Starting Point at the left side shows gravelly banks (wood-free meadows) and afterwards the narrow riverbed. On the right a typical broadening with a small island is shown (here at Martinau) (tirisMaps).*

The second section starts at Stanzach and ends near Reutte in Pflach. The riverbed opens up a few hundred meters downstream from the starting point, showing a braid pattern that runs for around 1.5 km. This pattern results from historic dams implemented on both sides of the Lech in the past. Afterwards, the riverbed remains broad with up to 400 m width until Höfen (tirisMaps), when the stream gets regulated and straightened. From this point onwards, the Lech is more regulated. However, a few broadenings exist with wood-free meadows at Lechaschau and at the endpoint of this section in Pflach. The characterising habitat of this part is again the wood-free meadow (https://data-tiris.opendata.arcgis.com/datasets/biotopkartierung-flaechen), with vast sections of gravel banks and some sandy shores.

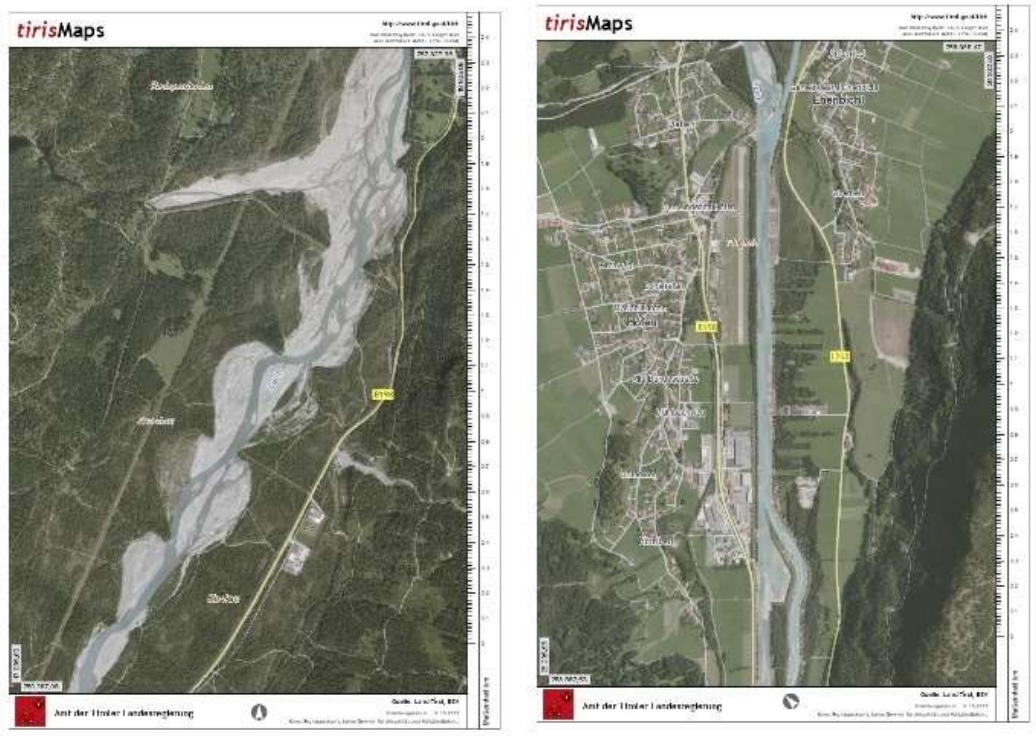


Figure 4 *On the left the braid pattern can be seen with the wide Hornbach-Delta afterwards. Here wood-free meadows are the main habitat at the river. The right orthophoto shows the regulation of the Lech at Höfen (tirisMaps).*

Section 3 at the Lech is between Pflach near Reutte and the German border. After Pflach, only a few gravelly shores occur, and a little over 1 km downstream, the influence of the hydroelectric power plant Kniepass is visible with a dammed waterbody reaching up to the flanking forests and no riverbanks. This power plant has existed since 1951 (WIS-statement), and it forms the Lech massively in this short section. Following the dam of the Kniepass power plant, the river shows an alternating pattern between relatively broad areas with wood-free meadows and narrower sections where spruces (*Picea abies*) are directly adjacent to the water body (https://data-tiris.opendata.arcgis.com/datasets/biotopkartierung-flaechen). At the very end of the Tyrolean Lech, another small dam has led to a wide riverbed (275 m; tirisMaps) with low runoff and high water coverage of the river bed. Here, a variety of meadows occur, which are either wood-free or covered with grey alder, crimson willow or lavender willow (*Salix eleagnos*) (https://data-tiris.opendata.arcgis.com/datasets/biotopkartierung-flaechen).

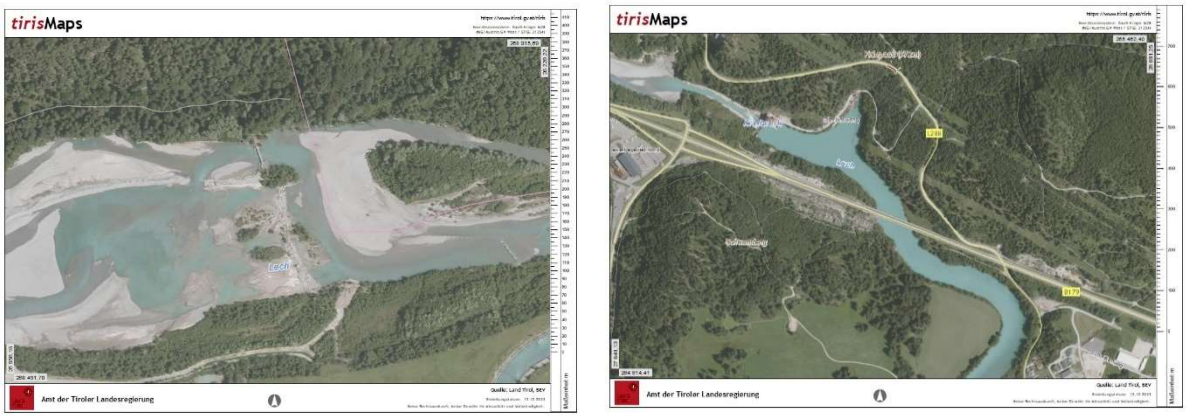


Figure 5 *The left orthophoto shows the high water coverage near the austrian-german border. On the right the Kniepass power plant is shown which heavily influences the river characteristics upstream (tirisMaps).*

The study site at the Vils is characterised by meadows with high coverage of lavender willow or sometimes ashes. Wood-free meadows, on the other hand, rarely exist at this tributary. The riverbed is narrow (mostly 10 to 25 m), with only one substantial broadening in the study area (46 m) (https://data-tiris.opendata.arcgis.com/datasets/biotopkartierung-flaechen).

Figure 6 *Shown here is the only substantial broadening in this study area. Upstream and downstream the Vils is narrow with lavender willow and ash trees on both sides of the water (tirisMaps).*

The Hornbach is a small creek that flows into the Lech. From its estuary upstream, some small wood-free meadows with gravel banks occur. After around 1 km, the creek flows through a canyon where spruces mix with fir trees (Abies alba) alongside the stream. 2.5 km upstream of the estuary of the Hornbach, the streambed widens up, and again, wood-free meadows dominate the landscape. Mixed

with this habitat type, meadows with lavender willow exist in smaller amounts (https://data-tiris.opendata.arcgis.com/datasets/biotopkartierung-flaechen).

Figure 7 *The orthophoto shows the transition from the wide creek bed with gravel banks to the narrow canyon where spruces and fir trees dominate the creek-side habitat types (tirisMaps).*

Precipitation and other climatic parameters

The data for weather parameters such as precipitation or temperature (data from Höfen) and drainage (data from Steeg) or flood events (data from the whole Tyrolean Lech) were obtained from the annual reports of the hydrogeografic service (Land Tirol 2024) and are presented in Table 3. The precipitation over the four months of the reproduction period for both birds was lower in 2012 than in 2022. However, both numbers fluctuated around the long-term mean from 1981 to 2010. The temperature steadily increases every month but in April from 2012 to 2022. However, the temperature in April 2022 was still higher than the mean temperature between 1981 and 2010. The drainage of the Lech shows slightly increased values for 2012 than the mean drainage for 1981 to 2010. In 2022, a contrary picture was shown when water drainage decreased to nearly half of the values in 2012.

Flood events were looked after for the period between 2002 and 2022. The results are presented in Figure 19 (Table on the right side) and show that between 2002 and 2012 and between 2012 and 2022 5 high tides were listed for both ten-year periods (October 2012 is listed for the second period because the high tide falls out of the reproduction period in 2012). However, the floods before 2012 were much more intense than in the ten years before 2022. Especially in August 2005 and 2002, severe floods were recorded with a 50-100-year flood event and a 30-year flood event, respectively. The high tides between 2012 and 2022 showed only one-year flood events and one 1 to 5-year flood event in August 2022.

Table 3 *The arithmetic mean of drainage, temperature and precipitation for the years 2022, 2012 and from 1981-2010 are shown in this table. Drainage data is from Steeg, whereas temperature and precipitation were measured in Höfen (https://www.tirol.gv.at/umwelt/wasserwirtschaft/wasserkreislauf/hydrologische-uebersichten/).*

	runoff m³/s			***temperature***			***precipitation***		
	2022	**2012**	**'81-2010**	**2022**	**2012**	**'81-2010**	**2022**	**2012**	**'81-2010**
April	6,5	13,6	13,2	6,2	7,1	5,9	89,5	78,5	97
May	26,7	39,0	33,0	13,1	12,1	10,8	136,4	112,0	128,0
June	18,8	42,1	31,2	16,9	16,0	13,6	240,9	182,2	165,0
July	9,0	21,7	23,0	17,9	16,3	15,6	127,4	156,6	186,0
per month	*18,2*	*34,3*	*29,1*	*16,0*	*14,8*	*13,3*	*168,2*	*150,3*	*159,7*

Presence - Absence

Attendance data was used to understand when these birds first appeared at the Tyrolean Lech and for how long they remained in the research area. For this, five reference areas along the Lech were

selected for investigation (Figure 8). These river segments were located from north to south near Weißhaus (rk 168,5 – 169,8), at the birdwatching tower in Pflach (rk 177 – 178), at Weißenbach (rk 186,7 - 188), between Häselgehr and Elmen (rk 203,7 – 204,8) and near Bach (rk 215,7 – 216,6). The areas investigated were chosen because of the high and steady abundance in the latest researches from Eberhard (2013) and Lassacher (2014) respectively. The studies from Landmann (1978) and Frühauf and Dvorak (1996) were also taken in account. Starting in October 2021, the areas were investigated three times until November 2021, with two weeks between each inspection. In 2022, observation began in March (first observation day was conducted by Felix Lassacher, all others by the author), and the inspections ended in November 2022.

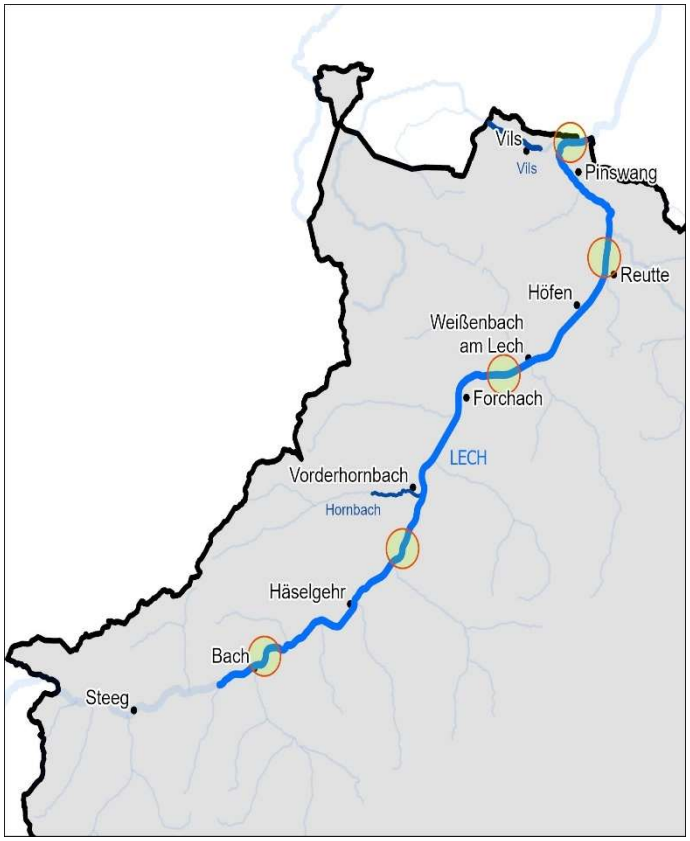


Figure 8 *The five reference areas for the attendance of the two species. From Top to Bottom: near Weißhaus; Pflach near Reutte; Weißenbach; between Häselgehr and Elmen; Bach.*

The start of this method in autumn was before the birds migrate to their winter habitats and ended when no species were detected in two field days after another. Similar, in spring the first field days were before both species could be expected at the Lech and they ended when the first birds of interest were found. The expected time of winter migration and arrival at the Lech were taken from Landmann (1978) and reassured in Glutz et al. (2005) and Bauer et al. (2012) respectively. This data was then used to determine the time frame in which the more intensive method, the territorial mapping, should be performed.

Table 4 *The research cycles for the Presence/Absence analysis (I-III) and for the territorial mapping (1-7) are listed in this table as well as the periods in which they took place. The results of the Presence/Absence analysis are shown in Table 6 and the sightings of birds during territorial mapping are listed in App. Tab. 1*

Research cycle	Period	Method
I	9. Oct – 6. Nov 2021	Presens/Absence
II	3. Apr – 17. Apr 2022	Presens/Absence
1	17. Apr. – 19. Apr 2022	Territorial mapping
2	9. May – 11. May 2022	Territorial mapping
3	31. May – 2. Jun 2022	Territorial mapping
4	14. Jun – 16. Jun 2022	Territorial mapping
5	28. Jun – 1. Jul 2022	Territorial mapping
6	11. Jul – 15. Jul 2022	Territorial mapping
7	25. Jul – 27. Jul 2022	Territorial mapping
III	28. Sep – 07. Nov 2022	Presens/Absence

Territorial mapping

In this research territorial mapping was used for gathering the necessary data. As the study area is limited to one river and two streams as well as their neighbouring habitats, the entire area was mapped in a line along the water bodies with no additional lines in wider areas of the streams. It is the same method used in the studies of Lassacher (2014) and Eberhard (2013), who conducted the latest research in this region about the common sandpiper and the little ringed plover (Lassacher 2014, Eberhard 2013). The inspection of the areas started at dawn in the morning (normally from 06:30 in the morning until 17:30 in the afternoon). The whole area was covered on three to four consecutive days (see Table 4 The research cycles for the Presence/Absence analysis (I-III) and for the territorial mapping (1-7) are listed in this table as well as the periods in which they took place. The results of the Presence/Absence analysis are shown in Table 6 and the sightings of birds during territorial mapping are listed in App. Tab. 1). To maintain a relatively low disturbance from the researchers, a break between each round of inspection were implemented. As suggested by Südbeck et al. 2005, the break lasted two weeks (one time, three weeks). The period where data was collected was from April 17th to July 27th, 2022. In this period, seven rounds of territorial mapping were performed (see Table 4), whereas in the field studies from Lassacher and Eberhard in 2012 (Eberhard 2013, Lassacher 2014), only three rounds were performed due to the larger research area.

For data collection, each bird detected was observed with the binocular for a few minutes (up to 10 minutes if the bird did not flee) to evaluate the behaviour necessary for further analysis (warning behaviour, feeding behaviour, hatchlings as an indication of a territory etc.). The behaviour was then noted along with the habitat (in a 15 m radius, parameters shown in App. Tab. 2 and 3), weather conditions, number and age of birds (division in pulli, juveniles-fully fledged, and adults), disturbances, syntopic species, and the time and date of the sighting. All animals that could potentially harm the birds or their offspring were noted for disturbances, such as raptors, foxes, etc. In addition, anthropogenic influences were looked after (fire settings, walkers with or without dogs, etc.). To define the age of the birds, the three terms pullus or pulli are for non-fledged chicks with down plumage, juveniles for fledged chicks with juvenal plumage, and adult for adult birds with adult plumage. This data was collected for each data point within the radius of 30 m and 100 m (Flade 1994) for the little ringed plover and the common sandpiper, respectively, which represents the flight initiation distance –FID, also known as escape or flush distance (Bonenfant and Kramer 1996, Blumstein et al. 2003). Additionally, independent data points were taken when those species occurred without a nearby detection of the two waders. As syntopic species, all other animals found within the 15 m radius (same radius as for the habitat preferences) were noted.

The coordinates were protocolled using a Garmin GPSMap 66s and noted on the same protocol sheet. Each detected bird was given an ongoing number with the researcher's initials at the beginning.

Additional data, such as riverbed width (tirisMaps), temperature, precipitation (geosphere Austria), and river drainage (Hydrogeografischer Dienst Land Tirol, months May to July), were collected afterwards.

Table 5 *Criteria for forming paper territories, adapted from Südbeck et al. (2005) after Lassacher (2014), Eberhard (2013) and Lentner and Lehne (2024)*

No Territory	Observations of one individual in one or more rounds with no territorial behaviour.
Possible Territory	Observation of an individual with territorial behaviour in one of the rounds 2 – 6 (see Table 4).
Territory	Observation of an individual with territorial behaviour in at least two independent rounds of research (rounds 2 – 6, see Table 4). Or Observation of nesting sites Or Observation of pulli/juveniles.

Analysis

To project the locations of the birds detected, the program QGIS Desktop version 3.32.1 was used. The points on the map then got their designation with abbreviations for their territorial behaviour, number and age (e.g. MSxxx1A+γ for one warning (A) adult (1) with a juvenile (γ)) of the birds seen in the field. This was done to form paper territories to locate all the possible territories in this area. The paper territories were formed with the behavioural data from the research rounds 2 to 6. From the remaining five rounds, the data was divided according to the species, and the paper territories were formed with the criteria described in Table 5 (adapted from Südbeck et al. 2005 and Lentner and Lehne 2024). This method was also used in the studies of Lassacher and Eberhard (Lassacher 2014, Eberhard 2013) with minor adaptations in this research due to the additional research rounds (3 for Lassacher and Eberhard and five rounds for this research).

These territories were then compared with the location of the territories in the previous studies. Therefore, the subdivisions were taken from these researches (see Figure 2 (b)) (Landmann 1978, Landmann and Böhm 1993, Frühauf and Dvorak 1996, Eberhard 2013, Lassacher 2014). Factors like disturbances noted in the protocol or historical disturbances (e.g. high waters) were considered in case of shifts in areas inhabited by the birds. Also, the changes in the environment due to the renaturation project LIFE Lech II were watched closely when analysing this data set.

Only rounds 2 to 6 during the main breeding season were included in the analysis for the determination of territories. The habitat surroundings noted in the field were analysed using the median and the arithmetic mean. The standard error is used to describe the fluctuation in this data. The parameters used to describe the habitat of the birds were the distance from the water, distance from bushes or trees, river width (all in meters), the proportion of mud or sand, small gravel (<5cm), big gravel (>5cm), low vegetation (<30cm), bushes and trees, dead wood and water in an area with 30 m diameter. In addition to the distance of the next bush or tree, the vegetation itself was noted to determine whether these two different morphological types have different effects on the birds. Also characterised in the field was the slope of the shore (from steep to level) and the detection area (whether the bird was on an island, a peninsula or the riverbank). Additionally, environmental characteristics like precipitation,

temperature, river discharge and the width of the whole riverbank (river width is the part only covered with water, and here the riverbanks are included). Therefore, a total of 13 parameters were protocolled in the field, along with an additional four parameters through web searches (for analysis of habitat preference) (see App. Figure 2).

The exact time of the first appearance at the Lech was estimated between the first sighting of an individual and the last date where no bird has been detected. For calculating the migration to wintering areas, the last sighting of the species and the earliest time of no bird sightings were taken. The breeding season was defined with the same definition; however, here, the first and the last sightings of a juvenile were taken. For the start of the breeding season, the average breeding time of the birds and the estimated age of the juvenile birds observed were also considered. Intense research rounds covering the whole Lech were only performed during the main breeding period between April and July (see App. Tab. 1). The other data was collected by checking the five reference areas in a two-week schedule (Figure 8; Table 4).

Statistical analysis was performed with RStudio version 2023.09.0+463. The Mann-Whitney-U test was used to determine the differences in the two birds' habitat preferences and whether a statistical significant difference in the proportions of different habitat parameters (e.g. vegetation like bushes, trees or grass, fine gravel, coarse gravel and so on) is given or not.

Results

The following chapters contain the results of the research done in the fields. Each parameter was assigned to its respective scientific question and presented above.

Presence - Absence

The Presence/Absence analysis took place in five distinct locations over the Tyrolean Lech as described in the method chapter to this question. These parts of the river were selected due to the steady appearance of either one or both of the waders according to the researches from Lassacher(2014) and Eberhard (2013) as well as those of Frühauf and Dvorak (1996), Landmann and Böhm (1993) and Landmann (1978).

The research of the Presence/Absence analysis started in October 2021, where a common sandpiper was detected but no little ringed plover. In the following two field days no further birds of interest were spotted, which means no sighting of the little ringed plover was protocolled for the year 2021 (Table 6).

During the first control of the reference areas in 2022 again no birds were detected. The first sightings of the two species occurred on April 17th (see Table 6 and App. Tab. 1) This was also the first day of the territorial mapping method, where the whole research area was controlled (Table 4).

During territorial mapping both birds were regularly detected, which is described in the chapters later on. After the breeding period (see chapter Reproduction) the reference areas were once again researched for the presence or absence of both waders starting in late September 2022.

In the first round the common sandpiper as well as the little ringed plover were detected in at least one of the reference areas. Roughly two weeks later, on the 11th of October only one species was found, the common sandpiper. In the following two field days checking for presence of both species none of them was detected in neither of the reference areas (see Table 6).

This means the earliest sighting in the year for both birds in this research is the 17th of April. The latest sighting for the little ringed plover is the 28th of September in 2022, whilst in 2021 no little ringed plover could be observed with this method. For the common sandpiper presence data is available for

both years with the latest observations on the 9th of October in 2021 and the 11th of October in 2022 respectively (Table 6).

Table 6 *Attendance of the two birds in the Lech valley. Before October 9th 2021, no research was done; therefore, no data is available. Between April 17th and September 28th 2022, several research rounds were conducted in which the birds were present. Note that the little ringed plover was not detected in October in either year, while the common sandpiper was present. The asterisk shows the date when Felix Lassacher controlled the reference areas.*

Date	***CS***	***LRP***
09.10.2021	**yes**	no
23.10.2021	no	no
06.11.2021	no	no
*03.04.2022**	no	no
17.04.2022	**yes**	**yes**
Territorial mapping		
28.09.2022	**yes**	**yes**
11.10.2022	**yes**	no
25.10.2022	no	no
07.11.2022	no	no

As shown in Figure 9, the birds have a similar pattern of appearance during the research period. At the end of April, some birds are present in the study area. In the course of May, the common sandpiper shows a small first peak at the very beginning, with fewer detected birds at the end of May, whereas the little ringed plover detection points are stable throughout April and May. In mid-June, an increase in detected birds is noticeable. The common sandpiper's detections rise until the period between the end of June and the beginning of July, only to fall to the same level as in mid-June afterwards. Detections of the little ringed plover are more stable in the same period but on a higher level than in April and May. At the end of July, both bird's attendance again decreased. Overall, common sandpipers were detected more often throughout this research. Both birds were detected equally from mid-April to the end of April.

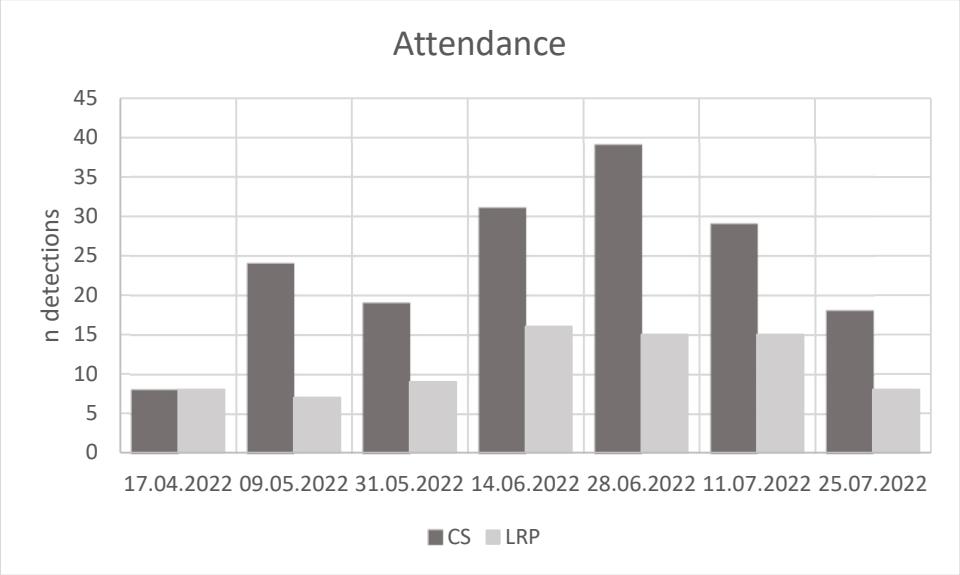


Figure 9 *The abundance of detected birds over the research period is shown in this figure. For the common sandpiper a clear peak of detection points can be seen at the time from end of June to the beginning of July, whereas for the little ringed plover the number of detected birds is stable on a relatively higher level between mid June and mid/end of July*

Spatial Occurrence

Over the intensive research period from April 17th to July 27th, 2022, 78 sightings of the little ringed plover and 169 of the common sandpiper were protocolled (see App. Tab. 1). As seen in Figure 10, the distribution of these two birds varies greatly. The common sandpiper can be found nearly throughout the whole research area of the Lech, with a coverage of 3,29 detection points per km (dp/km). The little ringed plover was less present over the whole area of the Lech with 1,52 dp/km. However, for the little ringed plover no sighting was protocolled in research section 1, meaning no detections for little ringed plovers were made for a little over 22 km of the researched river length (see Figure 2 (a) and Table 2). With this factor included, the number of detections per km increases to 2,79, which is closer to the common sandpiper occurrence ratio. For the two affluent streams, the Hornbach and the Vils, no detections were made for both bird species.

Most detections of the common sandpiper could be made in subdivision d from Vorderhornbach to Forchach with 42. Before and after this part, the subdivisions also have over 30 detection points, just like from Oberpinswang to Weißhaus at the border. As far as density is concerned, this part has the highest ratio of dp/km, at 6,61. The lowest density can be found in the parts Steeg to Bach and Höfen to Reutte with 0,36 dp/km and only one detection point in each section. Most detections of the little ringed plover were found in subdivision e from Forchach to Höfen, with 35 points. This area's density is also the highest, with 3,5 dp/km. The lowest density occurs in the first three parts between Steeg and Vorderhornbach. However, the rest of the subdivisions have a density of more than one detection point per kilometre.

Territories

The territories were formed using paper territories with the criteria mentioned in the methods section. These criteria led to the result that the common sandpiper has 29 to 48 territories in this area, with a density of 0,56-0,93 territories per kilometre (t/km). The little ringed plover inhabited fewer areas, with 15 to 23 territories at the river Lech and a density of 0,29-0,45 t/km.

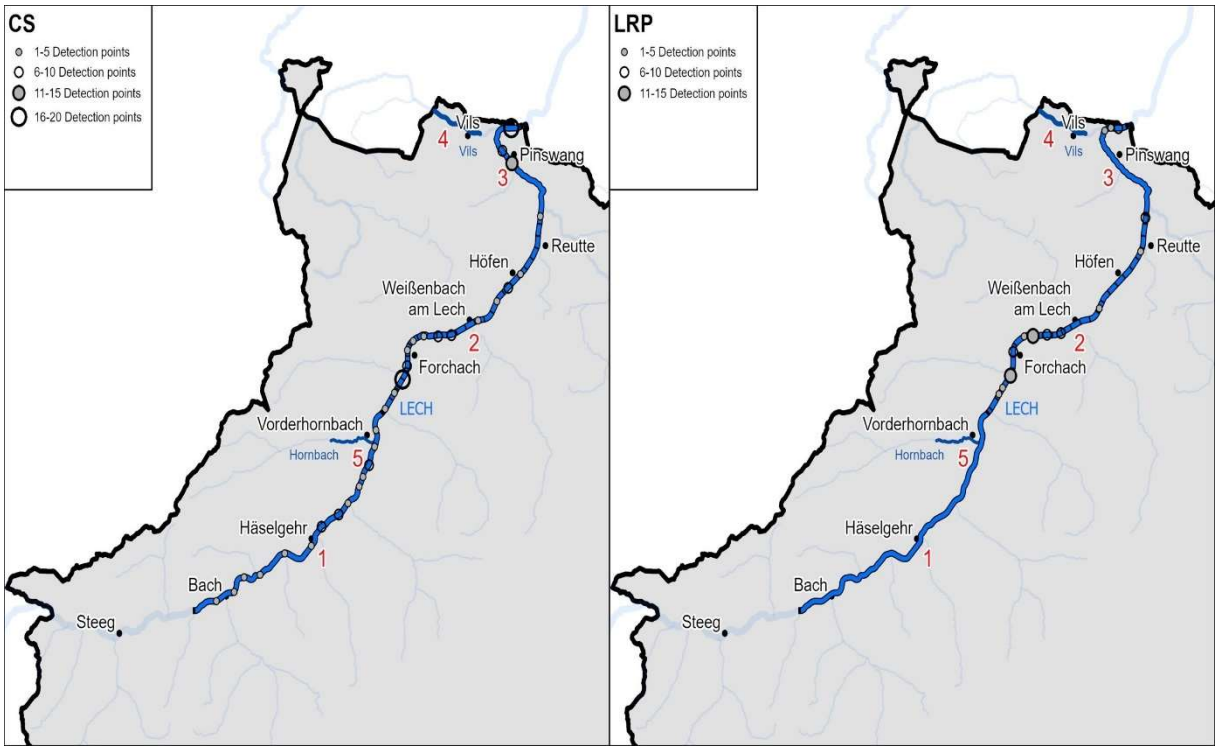


Figure 10 *The distribution of observations of the common sandpiper (left) and the little ringed plover (right). The research area are the deep blue parts of the streams Lech, Vils and Hornbach. No detections were made at the Vils and the Hornbach and the little ringed plover was only found from Vorderhornbach downstream.*

The common sandpiper is relatively even distributed from Bach to Martinau (before Vorderhornbach). This part is followed by an uninhabited stretch of the Lech between Vorderhornbach and Stockach (before Forchach). After this section, highly populated areas (most territories around Forchach at the Schwarzwasserbach-Delta and downstream) alternate with parts where hardly any evidence of the common sandpiper was found (e.g. between Weißenbach and Unterpinswang, with two at Höfen and one at Pflach (Reutte)). Territories are again more frequent, from Unterpinswang to the Border (Figure 11). Over the whole research area, the common sandpiper inhabits around 50 km (from rK 168,4 to rK 217,6) of the Tyrolean Lech.

When using the subdivisions according to Eberhard (2013) and Lassacher (2014) (see Table 8 and Table 9), the parts from Häselgehr to Vorderhornbach and from Vorderhornbach to Forchach have the largest number of territories of the common sandpiper with 6-8 and 6-11 respectively. In the latter, the highest maximal density of territories could also be observed (0,82-1,51 t/km). However, the highest minimal density was noted for the part of Oberpinswang to the border with 1,25-1,43 t/km.

The little ringed plover has a smaller range than the common sandpiper and inhabits roughly 27 km of the Tyrolean Lech (from rK 168,3 to rK 195,6). From Stockach upstream, no territory was detected; however, between Stockach and Weißenbach, territories from the little ringed plover have a high abundance, especially after the suspension bridge between Forchach and Weißenbach. As for the common sandpiper, the region between Weißenbach and Höfen is not well inhabited by the little ringed plover, although more territories can be found around Weißenbach. At Pflach near Reutte, one territory was also detected. However, the following territories downstream are at the border at the very end of the research area (Figure 11).

The little ringed plover has the highest density between Forchach and Höfen (0,9-1 t/km) and a total of 9-10 territories in this section. This number of territories is the highest for the whole research area, with the next highest number occurring between Vorderhornbach and Forchach (3-6). Density-wise, this section has the second highest density as well (0,41-0,82).

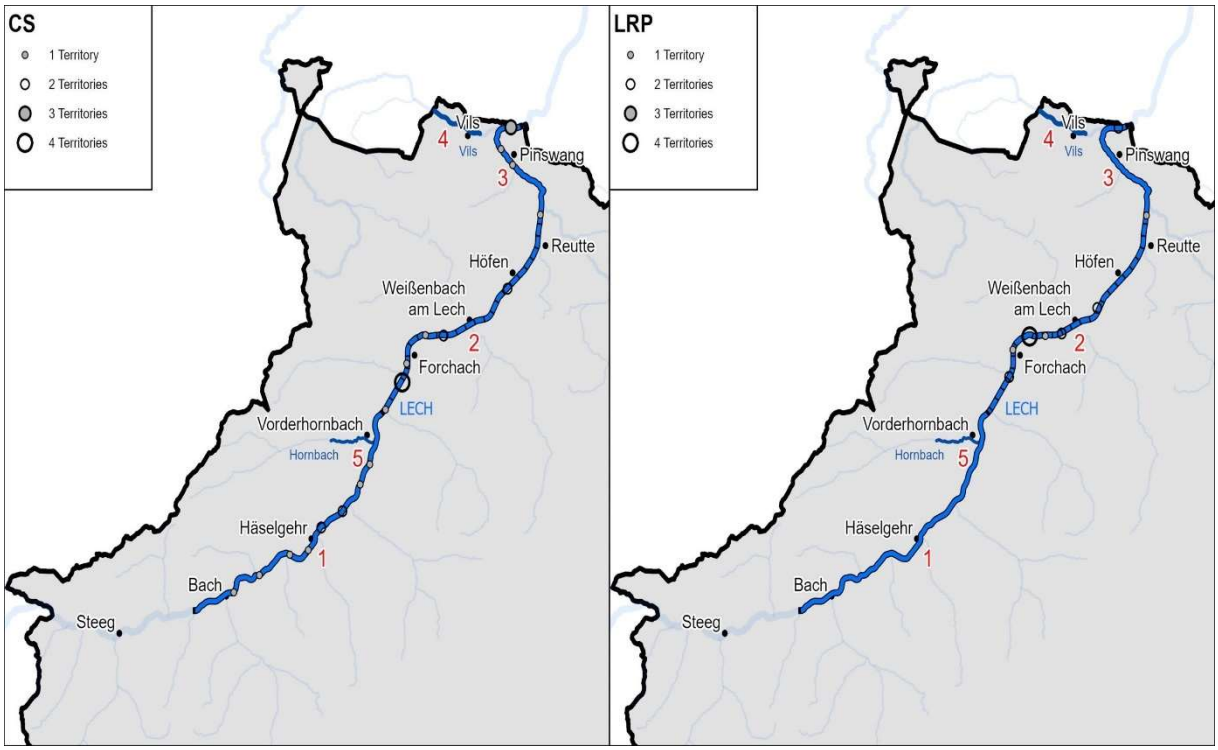


Figure 11 *Territories of the common sandpiper are shown on the right side of the figure. The left side shows the territories of the little ringed plover. Note the wide gaps where no little ringed plover territory was observed between Höfen and Reutte and between Reutte and Weißhaus, respectively.*

Also, the differentiation into subdivisions adapted from Eberhard (2013) and Lassacher (2014) (see Table 8 and Table 9) shows how the territories of the two waders developed between 2012 to 2022. As described in the chapter territorial mapping, the researches performed in 2012 (Eberhard 2013 and Lassacher 2014) and 2022 used the same method. Overall, the territory number of the common sandpiper has more than doubled over this period. The subdivisions from Vorderhornbach to Forchach show the highest increase, where the territories have tripled from 2 to 6-11 and from Oberpinswang to the Border, in which the numbers grew from 0-5 to 7-8 territories. Another sustainable increase in territories was detected in the subdivision from Häselgehr to Vorderhornbach (3 to 4-8), whereas the part from Forchach to Höfen remained stable on a high level (5-6 to 5-9). For the little ringed plover, the subdivisions from Vorderhornbach to Forchach and from Forchach to Höfen showed a slight increase.

Reproduction

The reproduction period of these two species was determined by subtracting the age of the juveniles and the incubation period from the first sighting date. The incubation period for the common sandpiper is 21 to 22 days when the last egg of the first clutch of the season is laid, and for the little ringed plover, 22 to 28 days from the second last egg respectively. Both birds can produce secondary clutches if the first one is destroyed or fails because of other environmental influences. Sometimes, box broods can occur in populations of the little ringed plover, where the female lays another set of eggs before the juveniles fledge (Bauer et al. 2012, Glutz et al. 1977).

For the little ringed plover, the first sighting of a juvenile was on the 15th of June in 2022. These two young birds were given an estimated age of 2 weeks, based on a commentary from Reinhard Lentner, who saw the same group of birds one and a half weeks earlier, and the fact that two weeks prior, no hatchlings were seen. This suggests the earliest full clutch has been laid around the 8th – 15th of May, and the hatching is estimated between the 01st and the 04th of June (App. Tab. 14).

In total, nine juveniles and three pulli could be observed in 8 different detection points. The three pulli were detected within the same sighting (30.06.2022) between Forchach and Höfen. In the next round of research, two juveniles could be detected in nearly the same place. This section, with three detections and six individuals, was the part with the biggest number of young birds observed in the area of the Lech. Between Reutte and Oberpinswang, the times when juveniles were observed were the same; however, fewer birds were detected (3/4).

Juveniles of the common sandpiper were more often detected, with 16 sightings of either 1 (9 times), 2 (6 times) or 3 (once) pulli being observed from the 14th of June to July 27th. The most offsprings occurred between Oberpinswang and the border (Subdivision h from Table 8 and Table 9), where a total of 11 young birds could be observed at six detection points. Other sections with observations from young birds were between Bach and Häselgehr (2 detection points/2 pulli), Häselgehr and Vorderhornbach (4/6) and Vorderhornbach and Forchach (4/5).

The first observation of a juvenile was one day prior to the little ringed plover. Given the size of the observed individual, the estimated age was around one week. Calculated with the method described above the first full clutch was laid approximately around the 15th of May and the bird hatched probably around the 6th of June (App. Tab. 14). The last juveniles of both species were found in the seventh inspection round (App. Tab. 1). For the little ringed plover, the last sighting of young birds was on the 25th of July and for the common sandpiper on the 27th of July (App. Tab. 14). Given the approximate age of one to two weeks (estimation) and the incubation period, the latest clutch could have been laid around the 20th - 27th of June (little ringed plover) and the 19th – 28th of June (common sandpiper),

respectively. The latest hatching of the little ringed plover was probably between July the 11th and 18th and for the common sandpiper between July the 13th and 20th.

Habitat preference

With a total of 138 detection points from rounds 2 to 6 (3 protocols were incomplete and therefore not usable for further analysis) where habitat preferences could be determined, the most observed common sandpipers were located at the riverbanks, with 61% of individuals in this area. These birds were primarily discovered on a plane surface (64%) (Table 7). The habitat parameter with the highest proportion is big gravel, with a median value of 25%, followed by small gravel (20% median value). The plant cover is approximately 15% of the whole area, where low vegetation (grasses=5%) is a little less abundant than bushes or trees (10%). The rest of the area is covered with 5% of dead wood and 15% of water (median values). The arithmetic mean of the river width was 29 m with a standard deviation of 19. On average the birds were 2 m away from the water (sd = 4,5) and 13 m distanced from the next bush and/or tree (sd = 15) (Figure 12). In general, the common sandpiper was more likely to be near bushes than fully grown trees (70% near bushes) (Table 7). The arithmetic mean of the habitat parameters can also be seen in App. Tab. 2, however, the great range of the proportions led to great standard deviations, and therefore the values of the median were used to describe the habitat.

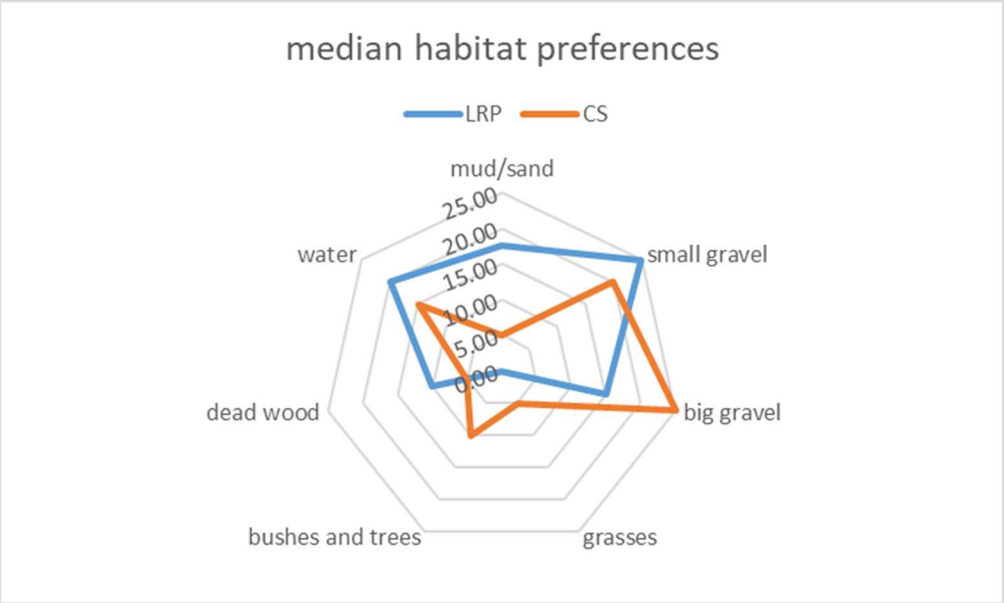


Figure 12 *The percentage of habitat characteristics protocolled at the detection points. For the percentage values the median was taken, therefore the characteristics do not sum up to a hundred percent.*

61 detection points from rounds 2 to 6 (1 protocol incomplete) were used to analyse the data for the little ringed plover. As a result, 46% of these detected birds were observed at the riverbank rather than on an island (38%) or a peninsula (16%). The surface area was at a high percentage plain (87%), and only a few birds were detected on inclined shores (10%), with even fewer on steep shores (3%) (Table 7). The ground characteristics are described using the median value. The highest proportion of coverage was protocolled as small gravel with a percentage of 25%. Following the finer coarsed gravel was the coverage of water (20%) and then mud and sand in the vicinity of 30 m with 17,5% in the median. Big gravel was 15% of the surface area and another 10% were covered with dead wood. For both vegetation types (low vegetation like grasses and small plants and high vegetation like bushes and trees), the median value was zero, meaning that in 50% or more, no vegetation was present within a diameter of 30 meters (Figure 12). The birds were nearly equally distributed in the vicinity of bushes (55%) or trees (45%); however, the average distance was 32 m for bushes and 37 m for trees, which is

substantially higher than the chosen 15 m radius (= 30 m diameter) for the analysis of the habitat parameters (Table 7).

Table 7 *Percentages of the detection points for both the common sandpiper (CS) and the little ringed plover (LRP), as well as the distance from the nearest vegetation in meters. In the last column, the number of protocols used is given.*

shore slope	**steep**	**inclined**	**level**	**N**
CS	3%	33%	64%	**138**
LRP	3%	10%	87%	**60**
detection point	**river bank**	**island**	**peninsula**	**N**
CS	61%	31%	8%	**135**
LRP	46%	38%	16%	**61**
nearest vegetation		**bushes**	**trees**	**N**
CS		70%	30%	**138**
LRP		55%	45%	**60**
CS	distance	10,48	19,29	
LRP		32,24	37,33	

The highest discrepancy in the habitat parameters was for mud and sand, where the median value of coverage differs by 12,5% from 17,5% for the little ringed plover and only 5% for the common sandpiper, respectively. This difference is statistically significant, just like the differences in proportion for the parameters small gravel, low vegetation, bushes/trees and for dead wood (Figure 13). Another parameter which differs quite a lot is big gravel. In comparison, the detection points of the common sandpiper showed a coverage of 25%, which was the highest proportion; the little ringed plover was detected in areas with a coverage of 15%. For the latter, the highest proportion of surface area was covered with small gravel, with a total of 25% (for common sandpipers, 20%) (Figure 12).

Also statistically significant was the minimum distance from the nearest water body and the minimum distance from the next vegetation as well as the riverbed width (Figure 13).

When looking at Table 7, a similar picture is drawn, whether you look at the slope of the shore (decreasing from steep to level) or the detection point (highest percentage at the riverbank and the lowest at the peninsula). Also, the birds tend to have similar percentages for bushes and trees, and which is the closest. However, the distances from these forms of vegetation differ a lot. The common sandpiper has an average distance of 10 m from bushes and 19 m from trees, and the little ringed plover is 32 m and 37 m respectively (Table 7).

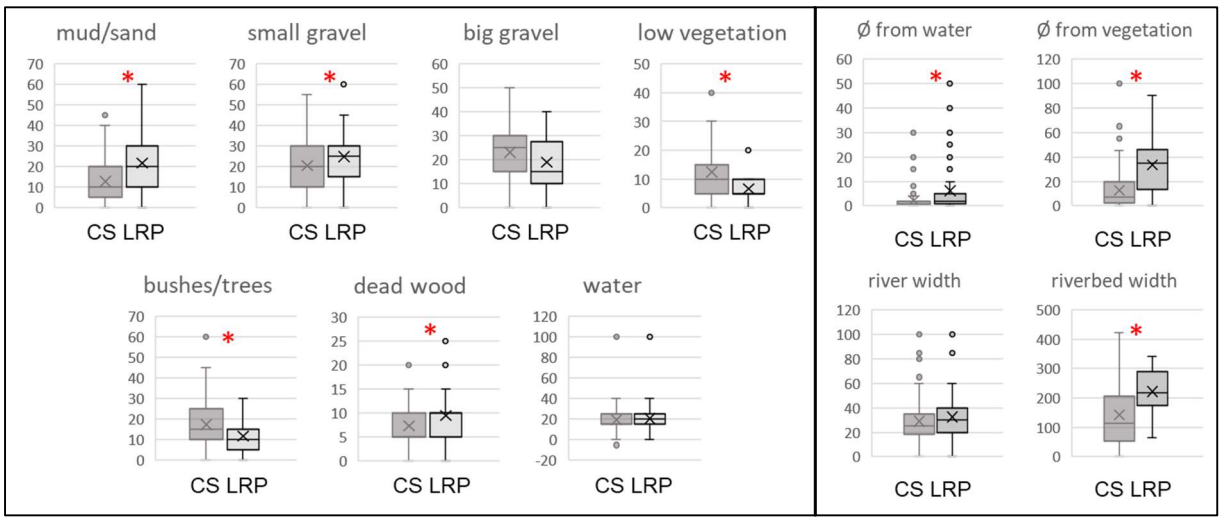


Figure 13 *The differences of habitat parameters within a radius of 30 m of the observation point between the common sandpiper (CS) and the little ringed plover (LRP) are shown in this figure. The left part is measured as percentages, whereas the right part was measured with meters. The asterisks are showing significant differences in the habitat preferences between the two waders. (n= 138 for the common sandpiper and 61 for the little ringed plover)*

Changes and trends over time

In the area investigated in 2022, previous research was conducted in 1977, 1989/90, 1994 and 2012 for the common sandpiper and in 1977, 1989/90 and 2012 for the little ringed plover (Landmann 1978, Landmann and Böhm 1994, Frühauf and Dvorak 1996, Eberhard 2013, Lassacher 2014). Following these investigations, the area was divided into smaller parts of the river to highlight if there were any changes in each of these segments (subdivisions from Table 8 and Table 9).

Territories of the common sandpiper show a high fluctuation over time. The highest numbers occur in the works from 1989/90 (Landmann and Böhm 1993) and 1994 (Frühauf and Dvorak 1996), with 36-48 and 38 territories overall. In the work from Eberhard (2013), territories were nearly as low as in 1977, with 13-20 and 12-16 territories, respectively. The recent study shows again a higher number of territories with 29-48 and comes close to the all-time high from 1994 (Frühauf and Dvorak 1996). Especially, the three sections from Höfen downstream to the Austrian-German border have undergone substantial changes over the last 30 years. From Frühauf and Dvorak (1996) to Eberhard (2013), 16 territories were subtracted to 0-5 in 2012. Such a low performance of the birds in these three sections was not even detected at an all-time low detected by Landmann in 1977 (Landmann 1978). In the present research, the numbers were again higher; however, they are still not on the same level as in 1994, with 8-11 territories found in 2022. An increase in numbers was detected from the sections from Höfen upstream. In all of the parts the Lech was divided into, the count of this year was higher than the numbers of the previous research, except from Forchach to Höfen, where the numbers from 2012 to 2022 differed only slightly (5-6 and 5-9 respectively), and the territory count of 1994 was higher (9 territories). Also, in 1993, the number of territories in this section (9-10) was higher than in the present research, and additionally, the part from Vorderhornbach to Forchach had a higher count than in the work from 2022 (11-14 and 6-11 respectively). However, in Landmann and Böhm (1993) the researchers had a different goal for their study and used a different counting method, where they searched the area twice with additional controls which are not further defined. In conclusion the different counting methods do not allow an analytical comparison between these studies. The maximal number of territories were found between Oberpinswang and the border, which is surprising because the growth shown in the 2012 study was negative with 3-4 (1977), 11 (1994), 0-5 (2012) and 7-8 (2022) territories found respectively (Table 8). In all these years, no territory was found in the affluent streams, the Hornbach and the Vils. As a result of the different mapping methods used in the studies, no statistical test was conducted.

Table 8 *Territories of the Common sandpiper (Actitis hypoleucos) listed in the sections described in the previous papers and compared with the data from these researches. The research from the year 1989/90 only described sightings of individuals and not territories, which leads to a possible overestimation. Therefore, these numbers were not used for further analysis. n.a. …data not available for this subdivision.*

Actitis hypoleucos						
Sections	**Subdivisons**	**1977**	**1989/90**	**1994**	**2012**	**2022**
1	a) Steeg-Bach	n.a.	0	n.a.	0	0-1
1	b) Bach-Häselgehr	n.a.	3	3	3	4-8
1	c) Häselgehr-Vorderhornbach	2	3-4	5	3-4	6-8
1-2	d) Vorderhornbach-Forchach	2-3	11-14	5	2	6-11
2	e) Forchach-Höfen	4-6	9-10	9	5-6	5-9
2	f) Höfen-Reutte	1	3-5	4	0	0-1
3	g) Reutte-Oberpinswang	0	1-2	1	0	1-2
3	h) Oberpinswang-Border	3-4	8-10	11	0-5	7-8
	Total	***12-16***	***36-48***	***38***	***13-20***	***29-48***

Research regarding the little ringed plover shows fewer ups and downs in total territories over the area of the Lech. From 1989/90 (Landmann and Böhm 1993) to the current year, numbers went down by 5, from 18-22 to 13 in 2012 (Lassacher 2014), and then again up to 15-23 in 2022 which resulted in the population being close to its all-time high since recording. However, the numbers from 1989/90 (Landmann and Böhm 1993) must be handled cautiously, as individuals or detection points were counted, not territories. 1977 (Landmann 1978) was the time with the lowest representation of the little ringed plover, with only five territories discovered. In 2012, these numbers nearly tripled, which is the second lowest result over these four studies. Compared to 2012, the number of territories of the little ringed plover has risen slightly, although not as much as the population of the common sandpiper. However, both species show an increase over the last ten years. When looking at the subdivisions one at a time, a slight increase for the year 2022 can be seen from Vorderhornbach to Forchach and from Forchach to Höfen (2 to 3-6 and 7 to 9-10, respectively) when compared with the work from 2012 (Eberhard 2013). However, over the last three rounds of research, the number of territories was nearly consistent in number and distribution, with the highest proportion of territories between Forchach and Höfen. Interestingly, the trend seen in the common sandpiper population, where from Höfen downstream to the border, a heavy decrease from 1994 (Frühauf and Dvorak 1996) to 2012 (Eberhard 2013), and a following increase in the year 2022 was visible, is not present in the numbers of the little ringed plover. Another interesting observation is the clear-cut from Vorderhornbach upstream, where a part with presumably relatively good habitat characteristics passes over to a section where these birds no longer appear. This cut is seen in all of the research done in this area (Table 9).

Table 9 *Territories of the little ringed plover (Charadrius dubius) listed in the sections described in the previous papers and compared with the data from these researches. The research from the year 1989/90 only described sightings of individuals and not territories, which leads to a possible overestimation. Therefore, these numbers were not used for further analysis. n.a. …data not available for this subdivision.*

Charadrius dubius					
Sections	**Subdivisons**	**1977**	**1989/90**	**2012**	**2022**
1	a) Steeg-Bach	n.a.	0	0	0
1	b) Bach-Häselgehr	n.a.	0	0	0
1	c) Häselgehr-Vorderhornbach	0	0	0	0
1-2	d) Vorderhornbach-Forchach	1	6-7	2	3-6
2	e) Forchach-Höfen	1	9-10	7	9-10
2	f) Höfen-Reutte	1	2-3	1	0-2
3	g) Reutte-Oberpinswang	0	0	1	1-2
3	h) Oberpinswang-Border	2	1-2	2	2-3
	Total	***5***	***18-22***	***13***	***15-23***

Changes also occurred in the accessibility of the riverbanks for the birds. This was also described in Lassacher's previous work (2014). Between the research from 2012 and the present study (2022), several areas were lost due to dynamic river development, while other regions were reintroduced in this riverine ecosystem. Losses mainly occurred due to lack of the dynamic processes of the water body, where gains of areas were reintroduced primarily through manufactured measures (LIFE Projekt – "Dynamic River System Lech"; https://www.life-lech.at/fileadmin/Bilder/content_800x600/LIFE_Lech_Final_Report_20220930_web.pdf). The biggest plus of area was between Forchach and Höfen, with approximately 121.100 m² gain of vegetation-free riverbanks (App. Tab. 9). The main reason was the measurement on the suspension bridge between Forchach and Weißenbach, where a large amount of forest was renaturated into riverbanks. The most significant losses were in the sections between Bach and Forchach, with around 30.000 m² of area lost due to ongoing forestation in each section. However, altogether, the area lost between 2010 and 2020 was nearly half of the area gained through manufactured actions during the measurements from the LIFE Lech Project II (124.000 m² to 232.000 m² see App. Tab. 9) (orthophotos from 2010 and 2020: https://maps.tirol.gv.at/synserver?project=tmap_masterandclient=core).

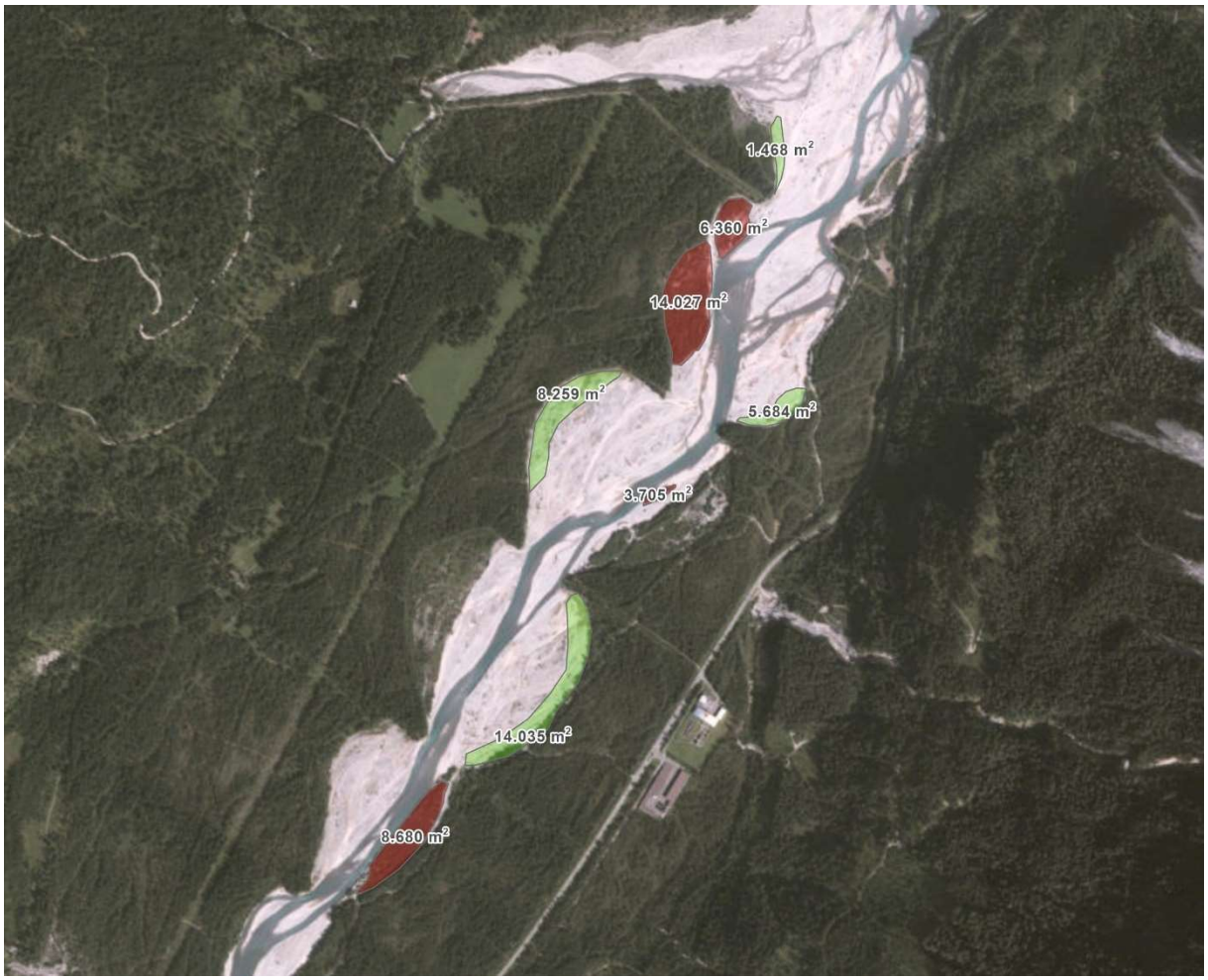


Figure 14 *Gains (in green) and losses (in red) of riverbanks before the Schwarzwasserbach-Delta between Vorderhornbach and Forchach.*

Disturbances

The disturbances (defined in the chapter territorial mapping in the methods section) recorded over the five rounds of investigation were scattered over the whole area (rounds 2 to 6). The highest amounts of disturbances along the river Lech were in the sections Vorderhornbach – Forchach (31), Forchach – Höfen (25) and Oberpinswang- Border (22), as seen in App. Figure 1. In total, 128 disturbances were counted among the Lech. (App. Tab 10)

Additionally, disturbances near or within territories of the common sandpiper and the little ringed plover were investigated. Those were then again divided into territories where no offspring were found and territories with offspring present. The flight initiation distance was set as a border to measure how intense the interference was for the birds (Table 10).

Table 10 *The disturbances within the territories of the little ringed plover and the common sandpiper. Divided are the interferences in whether offspring were abundant (w OS = with offspring) or not (wo OS = without offspring). * with dog.*

Disturbances	**Territories**	Human		fire settings		*L. michahellis*		*M. Milvus*		*B. buteo*		*C. corone*		other raptors	
		wo OS	w OS	wo OS	w OS	wo OS	w OS	wo OS	w OS	wo OS	w OS	wo OS	w OS	wo OS	w OS
LRP	**15**	1*		1		2	1	1				4	2		
CS	**29**	8	1	6	1	3			1		2	8	2	1	

The common sandpiper shows a flight initiation distance of up to 100 m (Flade 1994), and disruptions observed within this distance were counted as possible severe disturbances. Anthropogenic interferences like fire settings or humans (walkers, kayakers, rafters and so on) were detected in both

territories with and without offspring present. However, the numbers were much lower when offspring were abundant in the territories, as shown in Table 10. For “natural” disturbances, only the carrion crow (*Corvus corone*) was spotted in territories with and without offspring, with 8 (without offspring) and 2 (with offspring) observations. The yellow-legged gull (*Larus michahellis*) was detected three times in territories without offspring. Raptors like the red kite (*Milvus milvus*) or the common buzzard (*Buteo buteo*) were present in territories with offspring with 1 and 2 observations, respectively, and an unidentified raptor was once observed in a territory without juveniles or hatchlings.

The flight initiation distance of the little ringed plover is around 30 m (Flade 1994) and thus far less than that of the common sandpiper. Consequently, fewer observations of interferences were made. Humans (with dogs) and fire settings were only once observed in a territory without offspring. Natural disturbances were found both in territories with and without offspring. For territories without offspring, the yellow-legged gull (twice), the red kite (once) and the carrion crow (4 times) were observed. In territories with hatchlings or juveniles present, the yellow-legged gull (once) and the carrion crow (twice) were found.

Also interesting is the frequency of warning behaviour shown by the birds when detected. In total, 13 little ringed plovers showed warning behaviour. However, disturbances like the ones mentioned above were noted only twice in the protocol (once with and once without offspring). The common sandpiper showed warning behaviour more often (38 times), but only 12 predetermined disturbances were detected.

Syntopic species

Syntopic species are defined as species living in close proximity to one another without interfering (Spektrum 2025). In this research, species were counted as syntopic when they shared the same habitat as the little ringed plover or the common sandpiper in the field and were within a radius of approximately 15m.

Although other birds were present sometimes, the majority of detection points for both the common sandpiper and the little ringed plover were without other species in close vicinity. With 41 of 168 (common sandpiper) and 25 of 78 (little ringed plover) detection points in 24% and 32% of the time, respectively, other species could be observed in the given area (Table 11).

The most common bird species, which could be described as syntopic for the common sandpiper, was the white wagtail (*Motacilla alba*). This bird was encountered 14 per cent of the time. The mallard (*Anas platyrhynchos*) was met in around 5 per cent of the observations. Other species fall short of 5 per cent, just as the grey wagtail (*Motacilla cinerea*), the tufted duck (*Aythya fuligula*), the grey heron (*Ardea cinerea*), the great cormorant (*Phalacrocorax carbo*), the white-throated dipper (*Cinclus cinclus*), the Eurasian coot (*Fuliga atra*) and the green sandpiper (*Tringa ochropus*; Coordinates: 47.316082, 10.502380; Date: 09.05.2022). So, a total of 9 other bird species were found syntopic with the common sandpiper in the area of interest (Table 11).

Analysing syntopic species for the little ringed plover, the white wagtail was again the most frequent species to be observed, with 18 per cent. With 6 per cent, the mallard was the second most frequent bird species encountered. The grey wagtail, tufted duck, grey heron and the white-throated dipper can also be regularly seen close to the little ringed plover with 4% of the time. The last species with a percentage of 3% was the great cormorant. In total, seven syntopic species were counted (Table 11).

Table 11 *This table shows all species encountered as syntopic species, the frequency of abundance, and the percentage. CS = Common sandpiper; LRP = Little ringed plover.*

	n	**Total**		*M. alba*		*A. plathyrhynchos*		*M. cinerea*		*A. fuligula*		n species
CS	168	**41**	**24%**	24	14%	9	5%	5	3%	5	3%	**9**
LRP	78	**25**	**32%**	14	18%	5	6%	3	4%	3	4%	**7**
	n	*A. cinerea*		*C. cinclus*		*P. carbo*		*T. ochropus*		*F. atra*		n species
CS	168	3	2%	3	2%	3	2%	1	1%	1	1%	**9**
LRP	78	3	4%	3	4%	2	3%	0	0%	0	0%	**7**

Discussion

Presence - Absence

In this study only the presence and the absence were recorded. However, for the discussion, studies concerning migration in general (Glutz et al. 1977, Landmann 1979, Wüst 1979, Baccetti et al. 1992, Schödl 2003 and Schmidt et al. 2015) are used to compare the results found in this study.

The common sandpiper appears at the Lech in mid-April (first sighting on April 17th) and stays until mid-October, with the last sighting on the 09th (2021) and 11th (2022) October. At the Inn, solitary birds of the common sandpiper were detected at the beginning of March (Landmann 1979); however, the migration reaches its height in mid-April to the start of May, which is also described for Bavaria and central Europe (Wüst 1979, Glutz et al. 1977, Baccetti et al. 1992, Landmann 1979). Central European individuals start migrating to their winter habitats at the beginning of July (Glutz et al. 1977). Wüst and Landmann describe two migration peaks for Bavaria and Tyrol in late July and late August (Wüst 1979, Landmann 1979). Still, some individuals are present until the end of October, when the last birds migrate to their winter territories (Glutz et al. 1977, Wüst 1979, Landmann 1979). This data suggests that no significant changes in the attendance of the common sandpiper at the Lech have been detected over the years. These findings also overlap with the results from two relatively close rivers in southern Germany, the Ammer and the upper Isar, where the first sightings of the common sandpiper were documented for the 6th to 12th April (1996-2002) and for the 9th to 25th April (1996, 1999-2002) (Schödl 2003). In general, these sets of data are difficult to compare because sometimes migrating birds (Landmann 1979) and occasionally stationary birds are detected (Schödl 2003). Additionally, the differentiation between resting birds on their migrating route and still present birds in their breeding region is hard. These problems lead to the relatively large timespan in arrival and dispersal of this species (M. Schödl, pers. comm. April 2024).

The little ringed plover was present in the research area for a slightly smaller period with the first sighting on April 17th and the last sighting on September 28th. The appearance of the breeding habitats overlaps with the migration data of central European populations reaching breeding habitats in mid-April (Glutz et al. 1975). With an extreme date (citation Landmann 1979) at the start of March in Tyrol and a general arrival at the breeding sites in Bavaria in mid-April and rarely in March (Wüst 1979), the first date of sighting in this research on April 17th can be claimed as usual for European standards. Migration to the winter habitats usually starts in June/July, with some birds staying until the third pentad in October (Glutz et al. 1975). In Bavaria, little ringed plovers were detected until the end of October (Wüst 1979), which correlates with a sighting on the 25th of October at the Inn (Landmann

1979). This research suggests that the little ringed plover populations from the Lech disappear up to 1 month earlier than other populations from Tyrol and half a month earlier than central European populations. More detailed research focussed on dispersal is necessary to understand if *Charadrius dubius* is generally disappearing earlier from the Lech or if the results from the recent study are exceptions.

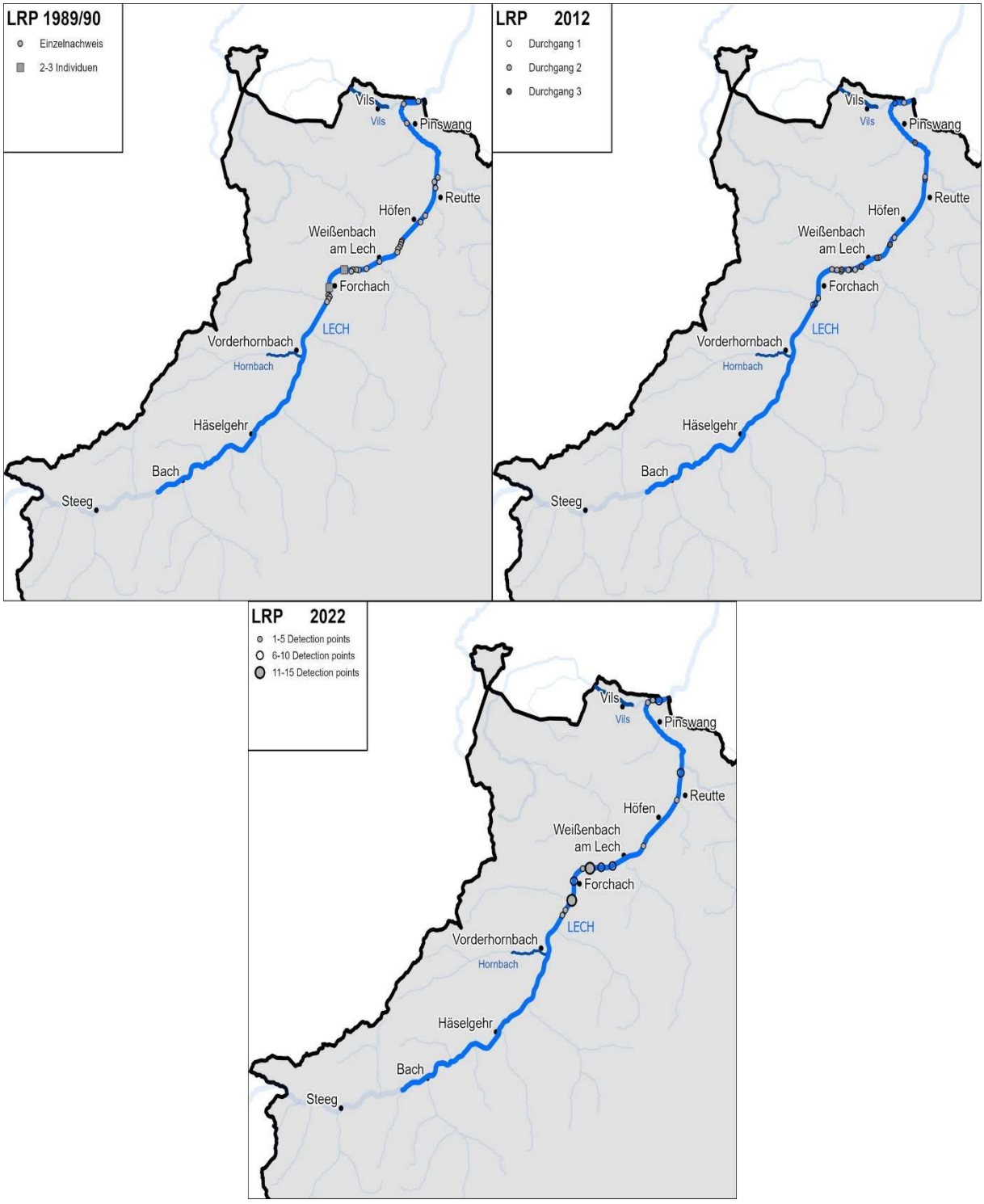


Figure 15 *The detection points of the little ringed plover over the years 1989/90 (Landmann and Böhm 1993), 2012 (Lassacher 2014) and 2022 are shown in these maps. Over the years the distribution along the river shows no major changes.*

Spatial Occurrence

With a ratio of 0,22 detection points per km (dp/km) (round 1-7) and 0,24 dp/km (rounds 2-6), the encounter frequency for the little ringed plover has decreased insignificantly compared to the 2012 research from Lassacher (2014) with 0,25 dp/km respectively. However, in the previous study, only three rounds were made because the whole area of north Tyrol was sampled. In this study, seven rounds were performed because the research was focused on the Lech as the main area (with the Hornbach and the Vils, but there were no detection points).

For the past three studies (Landmann and Böhm 1993, Lassacher 2014 and the recent research), the detection points of the birds were located in nearly all the same areas. The little ringed plover was most likely to be found near Forchach downstream of the suspension bridge (around rk 191) and near the border to Germany at Weißhaus (around rk 169) (Figure 15). Interestingly, the parts where no encounter was protocolled also seem to be stable over the past decade. A very similar distribution can be seen in the research of Landmann and Böhm (1993), where the highest density of encounters is also around Forchach and from Forchach to Weißenbach, respectively. From 1977, no graphic image or list of detection points is available. However, the territories described in this study (Landmann 1978) were found in the same areas where the highest density of detection points was protocolled during later studies. It is also worth mentioning that in the area around Pflach, the encounters with little ringed plovers were stable over the years (Landmann 1978, Landmann and Böhm 1993, Lassacher 2014), although this small area is clearly cut off from the other main areas of dissemination. Due to these findings, the occurrence of little ringed plovers seems stable in the areas where encounters can be made, and no visible changes in the distribution of detection points appear. This shows the tradition of nesting sites. This traditon is less documented for Bavaria, where the missing river dynamics allows vegetation to grow on the gravelly shores and sandbanks which leads ultimately to a loss of nesting sites for the little ringed plover (M. Schödl, pers. comm. April 2024).

For 1989/90 (Landmann and Böhm 1993), a figure shows the distribution of common sandpiper individuals or 2 to 3 individuals as dots. When compared with the distribution of encounters in this research period, the distribution of detections for these two years is similar. Only the distribution in 2022 seems to be more evenly from Bach to Höfen; however, from Reutte to the border of Germany, the research from Landmann and Böhm (1993) presents a more evenly distributed picture. Overall, no significant shifts seem to have occurred over time (Figure 16).

The previous works (Landmann 1978, Landmann and Böhm 1993, Frühauf and Dvorak 1996, Eberhard 2013) stated no encounter frequencies for the Tyrolean Lech. However, for 2012 246 encounters were protocolled for the whole area of north Tyrol (Eberhard 2013). Given the length of the studied rivers with 291 km and the number of research rounds (3; Eberhard 2013, Lassacher 2014), an encounter frequency of 0,28 detections per km can be calculated. This number is considerably smaller than the frequency presented in this work with 0,47 for the rounds 1 to 7 and 0,55 for the rounds 2 to 6. This frequency is also achieved in Bavaria in good common sandpiper habitats (M. Schödl, pers. comm. April 2024). Still, no apparent connection between the numbers from Eberhard (2013) and this research can be made because the calculated frequency of the year 2012 also depends on all the other rivers and streams studied. Therefore, no clear statement of the development in encounter frequency for the Tyrolean Lech is possible.

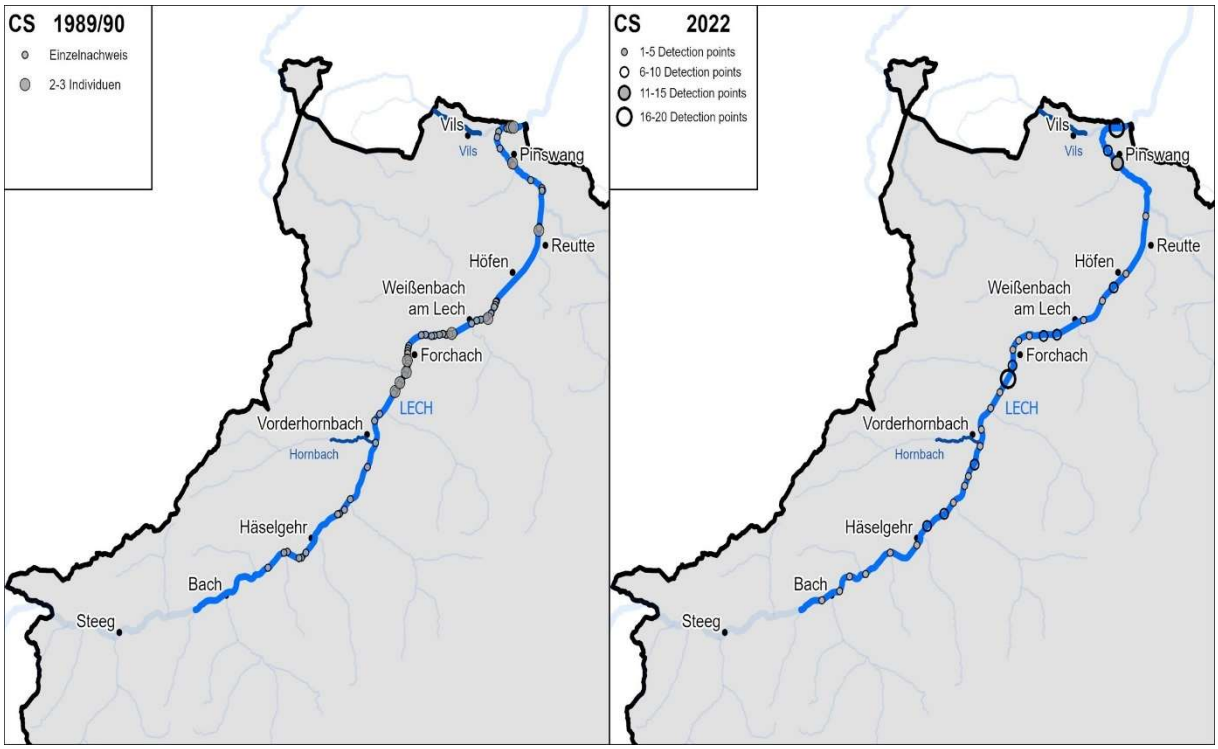


Figure 16 *At the maps you can see the distribution of encounters for the common sandpiper. On the left, the research from Landmann and Böhm (1993) is shown with data from 1989/90. On the right the most recent research with data from 2022 is presented.*

Territories

The little ringed plover occupied territories most likely between Forchach and Weißenbach downstream of the suspension bridge (around rk 191) and at Weißhaus near the border to Germany (around rk 169). This matches the density of detection points for this species. The stream shows a riverbed with mostly gravelly or sandy banks in all these areas. Shunned were the areas where the stream was less natural, with a higher water flow and more vegetation on the riverbanks (TIRIS 2024) as well as the whole area upstream of Stanzach. This could be because of the altitude and the narrower riverbed in the parts of the Lech upstream of Stanzach. Little ringed plovers occur in Tyrol, preferably at altitudes from 400 to 1.000 m, with one exception at 1.500 m (Lentner et al. 2022). After Glutz et al. (1977) breeding sites are rarely over 600 m in the alps. In this study the highest territory is at 1.000 m which is also higher than the highest territories after Bauer et al. (2012) with 800-900 m in the alps. The preference for gravelly or sandy banks is also described in other studies (e.g. Lentner et al. 2022, Lassacher 2014, Conway et al. 2019).

Compared with earlier studies, a huge increase in little ringed plover territories is visible between the research from 1977 (Landmann 1978) and 2012 (Lassacher 2014) (see Table 9). The research by Landmann and Böhm from 1993 is not considered in this comparison due to the different counting methods (they counted individuals). The distribution of the territories is similar to the distribution of detection points, and here, no clear shift is visible in the past years. The only noticeable difference is the lack of a territory near Oberpinswang between Reutte and the border, which was present in 2012 (Lassacher 2014) but not in 2022 (this research). Overall, no changes in the territories' distribution over the Lech seem to have occurred over the last decade with only one exception. The general trend of territories is discussed in the section "changes and trends over time" later.

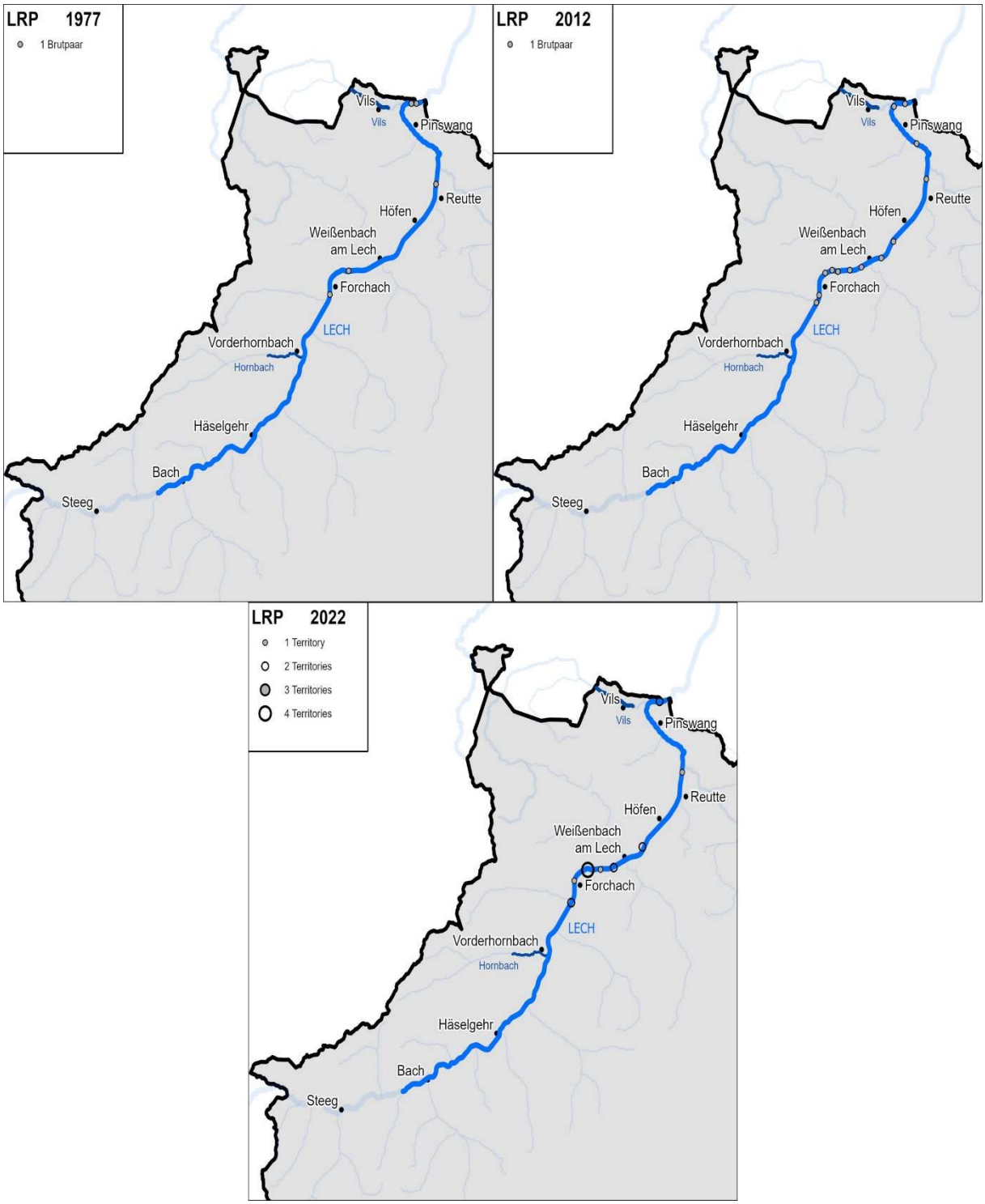


Figure 17 *This figure shows the distribution of territories of the little ringed plover over the Lech for the years 1977 (Landmann 1978), 2012 (Lassacher 2014) and 2022 (from left to right). Note how the last two researches resulted in a similar outcome.*

The density of territories of the little ringed plovers in the researched area is 0,29-0,45 territories per river kilometre (t/km). Given the fact that upstream of Stanzach, no detection points and territories were found, this part of the river Lech was subtracted from the whole length of the research, resulting in a density of 0,37-0,69 t/km for this study. Other European populations also have a density of less than 1 t/km, with probably Polen as an exception. Studies in Germany counted 0,45, 0,64 and 0,78 territories per kilometre, meaning that the density at the Lech is provided at the lower scope compared to the German populations (Glutz et al. 1975). In optimal habitats the densities can even reach 1 to 2 territories per km (Bauer et al. 2012). The reason could be that between Höfen and Reutte, only a few

suitable habitats are present. Also the hydropower plant after Pflach, the Kniepass dam, leads to a lower river dynamic and subsequently to an overgrow of the riverbanks. The results from the subdivisions also suggest that these sections of the Lech are the least inhabited, and the subdivisions from Vorderhornbach to Forchach and from Forchach to Höfen show densities which are in the scope of other populations (0,41-0,82) or even higher (0,9-1,0) respectively. However, these comparisons are difficult to analyse due to the age of the study from Glutz et al. (1975) and the variable length of the river sections observed. Also, other factors like rivalry can play an important role if a habitat is suitable or not. Overall, every European river has its worse and better-suited parts, which makes it all the more important to protect the suitable areas and improve the rest of the river.

The total number of territories of the common sandpipers are distributed over the whole research area of the tyrolean Lech. Still, some concentrations where more territories were clustered have been found in this study. These clusters were found a little upstream of Forchach, and near the border to Germany and at Unterpinswang, respectively. In these areas, riverbanks with mostly gravel banks (sometimes also sandy banks) and a small coverage of vegetation were present (TIRIS 2024). The other sections where no territories were found were most likely narrow and straightened (between Höfen and Reutte), or the river was dammed, and no shore habitats were present (upstream of the Kniepass power plant). Of course, also other reasons for the absence of the common sandpiper occurred. This point is discussed in the section on habitat preference.

The figures show a similar image when looking at the distribution of the territories over the Lech over time (Figure 18 and Table 8). Although in 1977 (Landmann 1978), the territory count was generally lower and the Lech was not inhabited upstream of Vorderhornbach, the distribution from Weißhaus at the border to Germany to Vorderhornbach shows a similar pattern compared to the later studies from 1994 (Frühauf and Dvorak 1996), 2012 (Eberhard 2013) and 2022 (recent study). This leads to the assumption that the birds discovered the upstream parts of the Lech in the early nineties (Frühauf and Dvorak 1996), and since then, stable populations have formed. Another observation from the comparison of the figures is that the common sandpiper inhabited the Vils in the earlier years (1967 from Landmann 1978). However, the same author described the Vils as uninhabitable for this species in 1977 as the once suitable habitats were overgrown with vegetation (Landmann 1978). Following this description, no common sandpiper territory was found at the Vils in the later studies (Frühauf and Dvorak 1996, Eberhard 2013 and in the recent study).

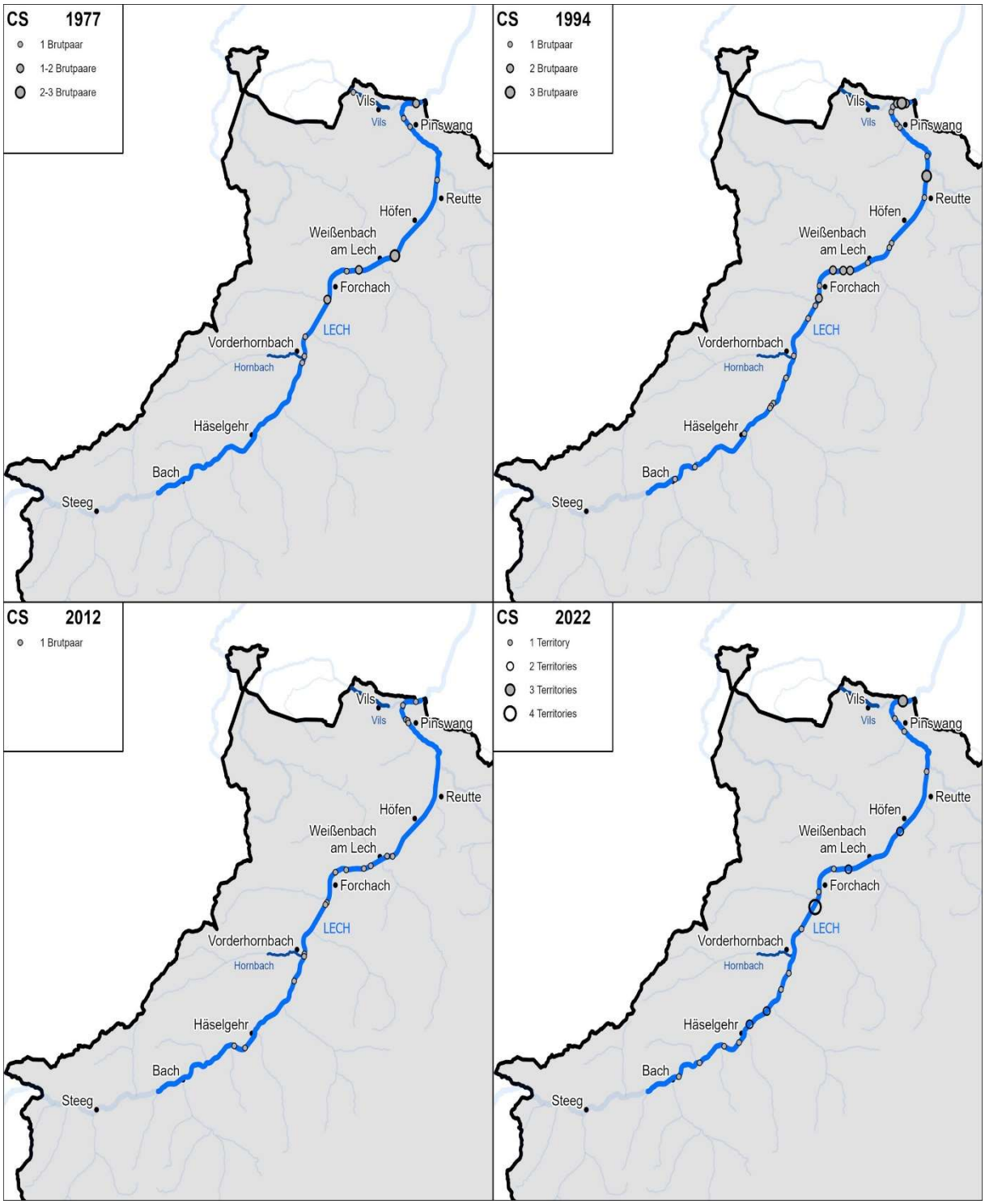


Figure 18 *The distribution of territories for the common sandpiper over time is presented by this image. Interestingly, the distribution from 1977 (Landmann 1978) (top left) is similar to the distribution from 2012 (Eberhard 2013) (bottom left), while 1994 (Frühauf and Dvorak 1996) (top right) and 2022 (bottom right) also show some similarity.*

Density-wise, the common sandpiper has 0,56-0,93 territories per kilometre at the Lech. In the study from Lentner et al. (2022) the highest density for Tyrol was at the Isel with 0,59 followed by the Lech, however, no number was given. In Bavaria, the highest density was one breeding pair per kilometre at the Jachen (Wüst 1979). However, nowadays, no breeding pairs are present at the Jachen (M. Schödl, pers. comm. April 2024), and in other regions, the density also decreases with no exact number stated (Wüst 1979). The highest densities after Glutz et al. (1977) in Bavaria are for natural river sections at the border of the Alps with 0,7-1,0 t/km. For straightened parts, around 0,3 t/km were presented. The

most territories per kilometre were found in Graubünden, with 2-2,7 t/km at a length of 7,5 km (Glutz et al. 1977) consistent with the number given by Bauer et al. (2012) with 2-3 territories per km. This exceeds, by far, the results found in this study. Still, in the more natural flowing subdivisions at the research densities of 0,82-1,51 t/km (between Vorderhornbach and Forchach) are reached, with the other subdivisions only slightly under 1 t/km. This correlates with the findings for the other Bavarian populations as well as the densities at straightened sections, where 0-0,36 t/km (Höfen-Reutte) and 0,18-0,36 t/km (Reutte-Oberpinswang) were found.

In general, both species intensely use the riverbanks between Stanzach and Weißenbach. This is also documented in Chiari (2010) who describes this part as ecologically highly valuable. The heterogeneity of the densities in the subdivisions are therefore a consequence of the suitability of the different river parts. This fluctuation of density can also be observed in Switzerland (Commentary Claudia Müller April 2024).

Reproduction

Although no nest was found in this research, hatchlings for both species were observed during this study. From these observations and the estimated age of the young birds the date on which the full clutch size showed, and the event of hatching was calculated.

The breeding period for the common sandpiper was estimated to be at least from mid-May to the end of June when the last eggs were laid after our calculations. This time span lies within the time in which this species copulates in central Europe after Glutz et al. (1977), and the timing is also very similar to populations in the upper Engadin (Commentary Claudia Müller April 2024). However, the begin of the reproduction period is stated to start in mid to late April. This was also the result of studies at the Vistula in Poland (Elas et al. 2023) and at the Ammer and the upper Isar in southern Germany (Schödl 2003). The results from the Ammer and the upper Isar are calculated from the first hatchings (the 11th and the 18th of May, respectively). The results in this study could describe a generally later start of the reproduction period for the breeding habitats at the Lech. This later start can also be seen at the Rißbach and the upper Isar (M. Schödl, pers. comm. April 2024). Still, before certain reasons can be discussed, such as differences in altitude, precipitation or temperature, more precise research regarding the breeding biology of the common sandpiper at the tyrolean Lech should be performed.

The first nest building for the little ringed plover is described in Tyrol for mid-April (Lentner and Sieder 2019 after Glutz et al. 2001). Generally, the breeding season lasts from April to June (Bauer et al. 2012). In this study, the first egg-laying event was calculated for the second week of May, and the last egg-laying was calculated for the last week of June. The later start of the breeding season observed in this research is striking. Still, the intensity of studying the breeding behaviour of this bird needs to be higher to make a strong statement than it was in this field study. Further research could emphasise this point.

Assumptions regarding the clutch size for either of the two birds have to be handled with caution, because no nests were found during this study. Only one observation of the common sandpiper with 3 juveniles was noted in this research. For the little ringed plover 3 juveniles were spotted twice. Therefore, the minimum clutch size for both birds after observations from this study is 3 eggs. Various authors and their studies (Glutz et al. 1977, Bauer et al. 2012, Müller 1975, Holland et al. 1982) state that for both birds 4 eggs is the usual clutch size for the first nest. A secondary nest can be built if the first one is lost due to floods or predation. For the secondary nest the usual clutch size would be 3 eggs (Glutz et al. 1977, Bauer et al. 2012, Müller 1975, Holland et al. 1982).

Habitat preference

Looking at the median percentage of habitat preferences for the little ringed plover, areas with small gravel (<5 cm) had proportional the highest coverage at the points of encounter. Mud or sand and big

gravel (>5 cm) were also one of the dominant habitat characteristics along with the water body. Adding up these parameters, nearly 80 percent (median 77,5) of the habitat showed no particular vertical structures like low vegetation (<30 cm), bushes/trees or dead wood. Biotopes with these characteristics are classified for biotope mapping as wood-free meadows after the work of Bortenschlager and colleagues (Bortenschlager et al. 2022) and all territories are within this biotope (TIRIS 2024).

Different studies confirm the preference of little ringed plovers to habitats covered mainly by gravel and/or sand (Lentner et al. 2022, Conway et al. 2019, Günther 2015) with little to no vegetation at all (Lentner et al. 2022). This literature also states that anthropogenic manipulated (e. g. gravel pits) areas along lakes and rivers are regularly used as habitats by the little ringed plover (Lentner et al.2022). A statement like this could not be proven or disproven in this study, considering the fact that such areas are rare in the survey area and too far away from the researched streams.

Given the relatively close vicinity to the water body (median 2 m) and the greater minimum distance to bushes or trees (median 35 m) the avoidance of vegetation is an observation of this study. Also the preference of broad river beds was shown by this research with a median of 219 m width. This point was also emphasized in the last work at the Lech (Lassacher 2014) where the median distance was around 238 m. In another work at the Lech, the distance of little ringed plovers to the next area abundantly covered with vegetation lies between 70 – 270 m (Frühauf and Dvorak 1996). A study from Tyrol in 2016 also declared the increase of encounters until a width to 150 m and a steady encounter rate afterwards for this bird (Lumasegger and Gattermayr 2016).

As described in the results for the common sandpiper gravel bigger than 5 cm covered the most area at the detection points. Together with smaller gravel (< 5 cm) and mud/sand these characteristics covered 50 percent of the area (median). However, unlike the little ringed plover, the habitats of the common sandpiper were regularly covered with low vegetation (<30 cm) or bushes/trees. This result fits perfectly in the description of habitat preferences in the Tiroler Brutvogelatlas (Lentner et al. 2022) where gravelly banks with low vegetation are mentioned as an ideal habitat for these birds. In another work from Hungary gravelly banks are also positively connected with the abundance of the birds and vegetation seems to have a negative effect in that research (Hammer et al. 2013). However, in these findings no differentiation was made how much the vegetation covers the whole area. It may be that large coverage of vegetation affects the bird's attendance negatively, while little coverage is needed by the birds for the building of their nests (Glutz et al. 1977, Holland et al. 1982, Bauer et al. 2012). All in all, the findings in this research concerning vegetation cover are similar to the last research done at the Lech in 2012 with 5 % (2022) and 3 % (2012) of grass coverage and 10 % and 12,5 % coverage from bushes or trees respectively (Eberhard 2013).

The minimum distance from the common sandpiper to the water body with 1 m and to bushes or trees with 7 m (both median) was significantly smaller than the minimum distance the little ringed plover held from these characteristics (Fig. 19). The median of the riverbed width was around 114 m which was also significantly less than the median of riverbed width for the little ringed plover. In the previous research at the Lech most encounters happened at sections with 0-50 m width (Eberhard 2013). In 2022 most detections were counted at river sections which were 51-100 m broad (35 encounters) and encounters with a width of 0-50 m were the second most likely (30 encounters). The median of the riverbed width is much higher in this research than in the work of Eberhard (2013). This discrepancy may be the outcome of the different rivers studied. In this study, only the Lech was monitored, where Eberhard (2013) monitored various rivers over North Tyrol. The fact that the Lech is said to be one of the last nearly natural riverine ecosytems in tyrol (Salchner 2020) leads to the suggestion that the other streams are more anthropogenically manipulated and therefore narrower.

This would explain the different medians of the riverbed width in these two studies. Still, Frühauf and Dvorak (1996) mentioned a median width of 150 m for the common sandpiper at rivers all over Austria.

When comparing the habitat parameters documented in this research (with the Mann-Whitney-U Test), significant differences were found in this study. The higher proportion of mud/sand ($p<0,01$) and small gravel ($p<0,01$), for instance, differ significantly between the two species, where the little ringed plover shows higher coverages of these two parameters. The same can be said about the parameter dead wood ($p<0,01$). For low vegetation ($p<0,01$) and for bushes and trees ($p<0,01$), there were also significant differences between these two species, where a clear avoidance of vegetation from the little ringed plover seems obvious (Figure 13). Other studies also mentioned the preference of "empty" gravelly areas by the little ringed plover (Schödl 2006). These results are comparable with the ones from Lassacher (2014), who also found significant differences in the parameters mud/sand ($p=0,0001$), dead wood ($p=0,007$) and bushes and trees ($p=0,007$). On the other hand, the parameters small gravel and low vegetation were not significantly different in the work from Lassacher (2014).

The distance from water and from the next vegetation was also a parameter with significant differences between the two species with a p-value of <0,01 for both parameters. The fact that common sandpipers were observed significantly closer to the water body suggests that this species can inhabit narrower river sections. The riverbed width also showed a significant result with <0,01 as the p-value. However, river width (which means the water-filled part of the stream) was not significantly different between the two species. The greater distance to the next structures and the link to broader riverbeds found in this study suggests that little ringed plovers are associated with areas where rivers are broad enough and dynamic enough to hinder the growth of too much vegetation, whereas common sandpipers are also frequent in narrower river sections. This difference in habitat selection is also mentioned in other studies where little ringed plovers are associated with river sections downstream of alpine regions and wide river beds (Glutz et al. 1975, Bauer et al. 2012). Nevertheless, some Swiss populations can live at altitudes of approximately 2.000 m (Knaus et al. 2018). For the common sandpiper, the maximum altitude where reproduction was proved was also in Switzerland at an altitude of around 2.000 m (Knaus et al. 2018). In general, common sandpipers inhabit higher altitudes than the little ringed plover (Lentner et al. 2022), which could be explained by their feature to also inhabit narrower river sections with steeper shores shown in this study.

The significant differences of the parameters shown in this study were almost the same as in the work of Lassacher (2014). Only the values of p changed, but the significance was stable in ten out of eleven parameters, suggesting that these two birds showed the same differences in habitat preference on the Lech as well as over whole North Tyrol.

Overall, the habitat preferences for the two birds described in this study were comparable with earlier studies where the habitat of the common sandpiper is described as a gravelly shore at a relatively dynamic river system with a little bit of low vegetation and bushes for their nesting sites (Glutz et al. 1977, Lentner et al. 2022). The little ringed plover tolerates even less vegetation and prefers open gravelly banks, which is also described in prior studies (Glutz et al. 1975, Parrinder 1984, Schödl 2006, Lentner et al. 2022). For the Lech population, no shift in habitat usage was observed compared with the studies from 2012 (Eberhard 2013, Lassacher 2014). For the differences in habitat parameters between the two waders, statistical analysis shows more significant differences in this research than in the one from Lassacher (2014) (see Figure 13). This could help to define the habitats of the common sandpiper and the little ringed plover more clearly.

Changes and trends over time

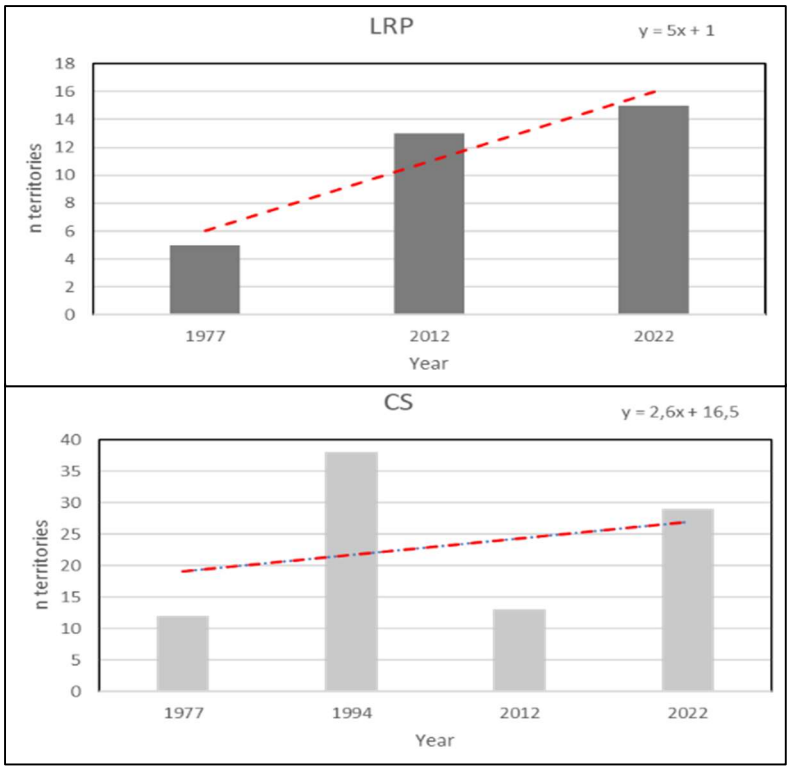
The subject of the comparison between the studies done at the Lech (see Table 1) was, if possible, the territories described in each year. Regarding the comparison of the wader's appearances at the Lech,

the research from Landmann and Böhm (1993) falls out of the grid due to the data represented. It shows the detection point from either one or two/three individuals. A comparison is, therefore, difficult to make as all the other studies worked with territories rather than detection points. The assumption is that in the work from Landmann and Böhm (1993), the number is a little overestimated (Lassacher 2014), and the actual number of territories is presented in Table 8 and Table 9.

Population dynamics of the two birds can be looked after in various scales. For the whole of Europe, both birds have the status LC (least concern) with a decreasing trend (BirdLife 2021). In Austria, the situation is a little different, with the status of the little ringed plover as VU (vulnerable). The common sandpiper populations are rated even worse, as EN (endangered) (Dvorak et al. 2017). The findings for 2005 and 2016 were the same, and therefore, at least the population sizes seem to be stable for the moment but at a very low state.

In Tyrol, the last red list of birds was authored in 2001 where, contrary to the situation for all of Austria, the common sandpiper was given the status of VU, whereas the little ringed plover was rated as "threatened to vanish" (Landmann and Lentner 2001). The latest work about the aviatic fauna's population for Tyrol was published in 2023, where the trends of these two birds were described (only with symbols) as stable over the last 50 years (Landmann 2023). The next red list of birds for Tyrol is currently in progress by Lentner and co-authors.

In this research, the population of both birds seem to have, at least on the small scale at the river Lech, a slightly positive trend for their population size, although some fluctuations are visible. These results deviate from the European scale, where population sizes are decreasing for both species (IUCN 2024). Population sizes from little ringed plovers are said to fluctuate frequently (Glutz et al. 1977), often due to anthropogenic disturbances (Bauer et al. 2012), while no such description can be found for populations of common sandpipers. However, the results from the last 45 years at the Lech show a picture which is quite the opposite (Figure 19). However, in this study only 3 or 4 works, respectively, over a span of fifty years are comparable. To see, if the populations fluctuate shorter periods of time would be necessary.



Flood events		
year	month	yearly probability
2002	March	5
2002	August	30
2005	August	50-100
2006	May	5
2010	August	1
2012	October	1
2013	September	1
2017	July	1
2020	February	1
2022	August	1-5

Figure 19 *The number of territories over a 45 year span for both, the little ringed plover (LRP) on the top left and the common sandpiper (CS) on the bottom left. The dotted line is the linear trend-line for the populations. Results are from 1977 (Landmann 1978), 1994 (Frühauf and Dvorak 1996), 2012 (Lassacher 2014 – little ringed plover; Eberhard 2013 – common sandpiper) and 2022. The table on the right side shows the high tides between 2002 and 2022. The yearly probability describes how many times floods of this intensity happen over the years (e.g. "5" means that a flood of this intensity happens every 5 years). The data are from hydrological summaries from the years 2002 to 2022 available under https://www.tirol.gv.at/umwelt/wasserwirtschaft/wasserkreislauf/hydrologische-uebersichten/.*

The numbers of territories for the common sandpiper vary greatly over the last studies, with an all-time high in 1994 (Frühauf and Dvorak 1996) and the second highest count in 2022 done by the author. Although between these two counts (1994-2022), a decrease of 24% occurred, the time span from 2012 (Eberhard 2013) to 2022 showed an increase of 113% in territories for this bird. For the little ringed plover, the trend seems to be more linear, with a steady increase in territories and a plus of 15% from 2012 (Eberhard 2013) to this research. This variation in territories can also be observed in Bavaria and Switzerland, where the little ringed plover also seems to have a slightly more stable population (Commentary Michael Schödl April 2024). However, as mentioned above, more frequent researches would be necessary to better determine fluctuations of the populations over time.

The reason for the different trend lines (Figure 19) in these species' populations is hard to argue, minding the fact that both are suitable indicator species for dynamic river systems (Baumann 2003). One study found that adult birds have a lower chance of surviving when April temperatures are low, and the following population counts showed lesser territories (Holland and Yalden 1991). This explanation cannot be used in this case when looking at the temperatures for April 2012 and 2022 (Table 3). The table clearly shows that the runoff was twice as high in 2012 than in 2022(for three quarters of the breeding period). Temperature and precipitation, on the other hand, were, in general, lower for the year 2012. Therefore, nests of the common sandpiper could have been lost in 2012 due to flood events, which led to less territorial behaviour observed and a lower count. Why these higher drainages occurred is not visible from the data, as no flood event was registered for the first half of the year in 2012 (Land Tirol 2024).

However, flood events could have had an impact on the population of the common sandpiper in 2012 (Eberhard 2013). When looking at the table in Figure 19, more intense floods happened in the timespan between 2002 and 2012 than between 2012 and 2022, with one flood in 2005, which occurs only every 50 to 100 years. The decrease in territories between 1994 and 2012 could be the aftermath of the extreme flood event of the year 2005 and also of the year 2002 (30-year flood, Figure 19, Land Tirol 2024). The fact that only the common sandpiper seems to be affected by the flood can be explained by the different habitats used. As described in the section, habitat preferences above, the common sandpiper inhabits narrower river sections at the Lech than the little ringed plover. These sections are more heavily affected by extreme flood events because the water flows faster in these narrower parts than in areas with a wider riverbed. Although nests of the common sandpiper are a bit elevated (C. Müller, pers. Comm. April 2024) big flood events could have been a factor for the decrease in population in 2012 (Eberhard (2013).

However, Holland and Yalden (1991) state that populations are predominantly affected by dispersal from other populations and survival of the adults rather than breeding success. This means that the decrease in 2012 could have been a result of habitat loss or other events in populations nearby, and the high drainage had no impact on population size at all. Nevertheless, the increase in the last ten years is probably related to the renaturations that took place with the LIFE Lech II Project, which led to a total gain of 107.695 m² of the riverbed, and therefore, additional suitable habitats were available. Such a scenario was also observed in Arlettaz et al. (2011), where the population increased by 83% after the riverbed was restored. Baumann (2003) also mentions the possible positive effects of enlarging riverbeds but also states that the disturbances of these newly created riverbanks through humans play a large role in whether the two birds can form territory or not (Baumann 2003, Chiari 2010).

Populations of the little ringed plover showed a nearly linear increase over the last 45 years based on the three studies from 1977 (Landmann 1978), 2012 (Lassacher 2014) and 2022 with an all-time-high in 2022 with 15 territories. The “natural” fluctuations described in Glutz et al. (1977) cannot be observed in the results from this paper, although long-term monitoring would be necessary to get more precise results. Like the common sandpiper, the little ringed plover is sensitive to flood events (Glutz et al. 1977, Bauer et al. 2012). However, the concentration of territories where the riverbed is wide could lead to a lesser impact of floods over the years. This could be the reason why the numbers of common sandpipers were this low in 2012, and little ringed plover territories seem to be stable over the last ten years. The absence of territories at Höfen or Pflach in 2012 for the common sandpiper would support this theory.

Another reason for the increase in the population could be the measurements of the LIFE Lech II – Project, as well as the renaturations from the LIFE Lech I-Project (2001-2008). River restorations and broadening of the riverbed seem to boost the populations of these two birds (Baumann 2003, Arlettaz et al. 2011). The results of this research show that in some subdivisions with river restorations, an increase in territories can be observed for both species. However, in other subdivisions, no change in territory numbers was observed, although measurements were taken. For instance, from Forchach to Höfen, common sandpiper territories did not change over the years as well as territory numbers of the little ringed plover between Reutte and Oberpinswang and from Oberpinswang to the border.

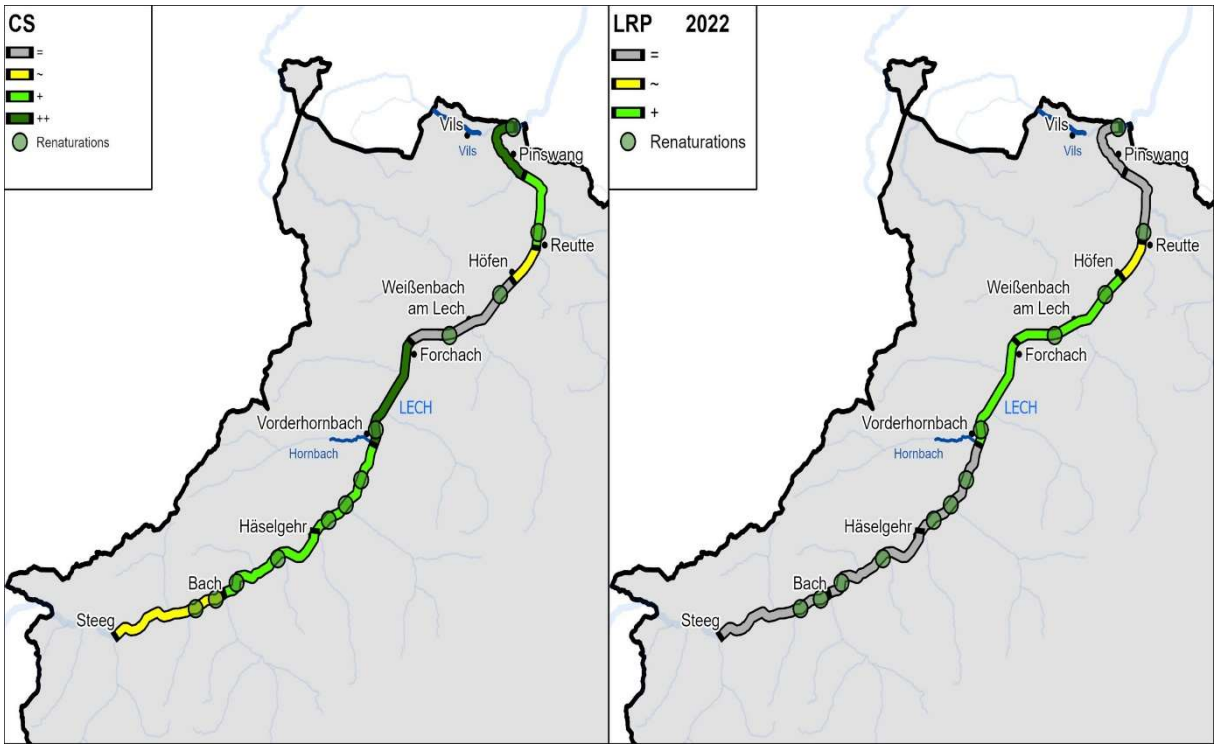


Figure 20 *The changes of territories in the subdivisions between the last research done in 2012 and this study. The results for the little ringed plover (Lassacher 2014) are shown on the left, and for the common sandpiper (Eberhard 2013) they are shown on the right side. The circles mark the renaturations finalised during the „LIFE Lech II – Dynamic River system Lech" – Project. =… no changes detected; ~… little changes in numbers; +… an increase in territories is visible; ++… the numbers show twice or more territories than in 2012.*

River restoration could play a role in the increase of territories in parts of the Lech but it is no guarantee for success as the measurement conducted at the Vils during the LIFE Lech I project shows (https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE00-NAT-A-007053/wild-river-landscape-of-the-tyrolean-lech). As stated in Eberhard (2013) and Lassacher (2014) no little ringed plover and no common sandpiper were detected at the Vils although the measurement was finalised. Also in this study, no birds were detected at the Vils in all of the research rounds. This highlights the fact that more factors attribute to the establishing of a territory. The ongoing forestation progress could also affect the numbers negatively and may be the reason why in some subdivisions no changes were observed although restorations took place. This forestation seems to have a greater impact on the little ringed plover when looking at the App. Tab. 9 and comparing it to App. Tab. 5 as suggested by Lassacher (2014). The subdivisions with the most gain of riverbanks were the ones where an increase in numbers of territories was observed (Figure 20). For the common sandpiper no clear pattern is visible. The numbers of this bird have increased in nearly all subdivisions. The forestation in its early stages could also improve habitat suitability for the common sandpiper by increasing the area of large gravel banks with only little vegetation at the riverbanks, which are used as nesting sites by this bird (Lentner et al. 2022).

Other than forestation, recreational activity on the riverbanks also affects the populations of both birds negatively (Baumann 2003, Chiari 2010). Interestingly, protection of already inhabited riverbanks does not necessarily lead to an increase in populations of the common sandpiper (Schödl 2006) or the little ringed plover (Schödl 2007). These findings and the positive impact of the additional wood-free riverbanks discussed in this paper, leads to the assumption that other factors have to be considered in order to maintain stable populations of these birds such as maintaining and creating more habitats through restoration (Schödl 2006).

Disturbances

As mentioned in the results the disturbances are divided into natural predation and anthropogenic disturbances.

The species which count as disturbance were predetermined and were counted when encountered nearby the two waders. From the results no clear pattern which species has the most impact on the two birds studied was observable (App. Tab. 10).

In southwest Sweden, hooded crows (*Corvus corone cornix*) are mentioned as possible predators on waders' nests (Wallander et al. 2006). The common crows encountered in my study showed in contrast no observable interactions with the common sandpiper or the little ringed plover and vice versa. Not even warning calls were protocolled when common crows were present. In this study, no predation event from crows nor warning behaviour was observed when common crows were within the flight initiation distance of the two waders studied.

The same picture was drawn when the yellow-legged gull was adjacent. No warning behaviour could be observed, and the birds behaved as always. Raptors like the red kite or the common buzzard also seem to have no visible effect on the behaviour of the two waders. The fact that no predation event or any warning behaviour towards the predetermined disturbances was observed could mean that the two waders experienced no pressure from predation at the Lech. However, more realistically would be that predation events happen most likely at night or at dawn. This was the result of another study that detected nocturnal and/or mammalian predation as the most frequent one in waders' nests (MacDonald and Bolton 2008). Therefore, it is not surprising that no predation was observed in this study, and further research is necessary. In the Engadin the common sandpiper warns most likely when humans or their dogs are present during the time when pulli are present and lesser during the breeding period (C. Müller, pers. comm. April 2024). Due to the limited observations of common sandpipers with pulli (only once), the results could be misleading.

A reason why the little ringed plover and the common sandpiper seemed so calm when bigger, potentially hazardous birds were present could be the deterrence effect they have on other predators. This sort of relation was observed between oystercatchers (*Haematopus ostralegus*) and Kentish plovers (*Charadrius alexandrines*) in northern Italy, where, although oystercatchers are known to feed on the plovers eggs, the smaller birds nests are often in close vicinity to the nests of oystercatchers (Valle and Scarton 1999). Nevertheless, this situation is not quite comparable due to the species concerned. The same interactions have yet to be observed for the little ringed plover and the common sandpiper with other species.

Anthropogenic disturbances seem to have a different impact on the waders. Avoiding the frequent people visiting sites was observable (personal observation). The great accessibility of potential habitats for the waders leads to the simultaneous usage of the Lech (especially between Stanzach and Weißenbach) as a breeding habitat for birds and as a recovery site for humans (Chiari 2010). This observation may be transferable to other areas of the Lech (Pflach and at the border) as there is also some pressure present from visitors.

The usage of the riverbanks with motocross vehicles was described once in this research and is probably the most disturbing and potentially harmful activity observed at the Lech (Chiari 2010).

Although in this study no destruction of nests was protocolled, the strolling over the riverbanks or the usage of these riverbanks for sunbathing and other activities led to numerous losses of broods for both of the waders and can have a great impact on the nest survival rate (Schuck et al. 2020).

All in all, natural predation by the predetermined bird species mentioned above appear to have not that much impact on the waders at this riverside. Reactions to human presence (e.g. also to the author himself) and in some cases their dogs seem to be more disturbing for both of the bird species. Only the great potential of the Lech as a breeding site with multiple nesting and feeding areas (Chiari 2010) seems to be the reason that the population of these birds is not more negatively affected by anthropogenic disturbances.

However, the method used in this research may not be very effective for understanding the different disturbances that the birds experience due to the small amount of time the researcher is present in the area. Therefore, explicit statements are hard to make, and other methods might be more suitable for this kind of study. Also, in further studies, natural predation and anthropogenic disturbance should be looked at separately to obtain more precise results, because predation is a part of the natural relationship between predators and their prey.

Syntopic species

The species found in the same area of the little ringed plover and the common sandpiper are listed in the result section in Table 11. The most frequent bird in the vicinity of both species was the white wagtail, followed by the mallard, the grey wagtail and six other species (shown in the results). In northern Italy, research has been done on the selection of nesting sites by eight syntopic species of gulls and terns. Six of these species built their nesting sites despite the other birds being around, meaning that the presence of the other species did not influence the habitat selection (Fasola and Canova 1992). Whether the species mentioned in the results count as syntopic species is yet to be discussed because not all species nest in the same area. The presence of some birds is probably related to feeding events rather than using the habitat as a nesting site. However, some species, like the white and the grey wagtail, could breed in the same habitat as the two waders and can, therefore, be considered syntopic (Lentner et al. 2022).

At the border to Germany, tufted ducks are regularly seen on a small island (own observation; App. Tab. 14), and in this area, the species could be considered syntopic. This habitat suits the duck due to its relatively low flow (Lentner et al. 2022). Nevertheless, the relatively low presence of birds encountered together with the two waders does not suggest any interspecific association as is described for gulls and terns in northern Italy (Fasola and Canova 1992).

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Figures

Figure 15 The detection points of the little ringed plover over the years 1989/90 (Landmann and Böhm 1993), 2012 (Lassacher 2014) and 2022 are shown in these maps. Over the years the distribution along the river shows no major changes.
Figure 16 At the maps you can see the distribution of encounters for the common sandpiper. On the left, the research from Landmann and Böhm (1993) is shown with data from 1989/90. On the right the most recent research with data from 2022 is presented.
Figure 17 This figure shows the distribution of territories of the little ringed plover over the Lech for the years 1977 (Landmann 1978), 2012 (Lassacher 2014) and 2022 (from left to right). Note how the last two researches resulted in a similar outcome.
Figure 18 The distribution of territories for the common sandpiper over time is presented by this image. Interestingly, the distribution from 1977 (Landmann 1978) (top left) is similar to the distribution from 2012 (Eberhard 2013) (bottom left), while 1994 (Frühauf and Dvorak 1996) (top right) and 2022 (bottom right) also show some similarity.
Figure 19 The number of territories over a 45 year span for both, the little ringed plover (LRP) on the top left and the common sandpiper (CS) on the bottom left. The dotted line is the linear trend-line for the populations. Results are from 1977 (Landmann 1978), 1994 (Frühauf and Dvorak 1996), 2012 (Lassacher 2014 – little ringed plover; Eberhard 2013 – common sandpiper) and 2022. The table on the right side shows the high tides between 2002 and 2022. The yearly probability describes how many times floods of this intensity happen over the years (e.g. "5" means that a flood of this intensity happens every 5 years). The data are from hydrological summaries from the years 2002 to 2022 available under https://www.tirol.gv.at/umwelt/wasserwirtschaft/wasserkreislauf/hydrologische-uebersichten/.
Figure 20 The changes of territories in the subdivisions between the last research done in 2012 and this study. The results for the little ringed plover (Lassacher 2014) are shown on the left, and for the common sandpiper (Eberhard 2013) they are shown on the right side. The circles mark the renaturations finalised during the „LIFE Lech II – Dynamic River system Lech" – Project. =… no changes detected; ~… little changes in numbers; +… an increase in territories is visible; ++… the numbers show twice or more territories than in 2012.

Tables

Table 1 Previous works for the Common sandpiper and the little ringed plover include the Lech valley. Although more data is available, these publications were most suitable for comparison.
Table 2 The researched sections of the three rivers. The three parts of the river Lech were named after the closest villages to the starting and ending point.
Table 3 The arithmetic mean of drainage, temperature and precipitation for the years 2022, 2012 and from 1981-2010 are shown in this table. Drainage data is from Steeg, whereas temperature and precipitation were measured in Höfen (https://www.tirol.gv.at/umwelt/wasserwirtschaft/wasserkreislauf/hydrologische-uebersichten/).
Table 4 The research cycles for the Presence/Absence analysis (I-III) and for the territorial mapping (1-7) are listed in this table as well as the periods in which they took place. The results of the Presence/Absence analysis are shown in Table 6 and the sightings of birds during territorial mapping are listed in App. Tab. 1
Table 5 Criteria for forming paper territories, adapted from Südbeck et al. (2005) after Lassacher (2014), Eberhard (2013) and Lentner and Lehne (2024)
Table 6 Attendance of the two birds in the Lech valley. Before October 9th 2021, no research was done; therefore, no data is available. Between April 17th and September 28th 2022, several research rounds were conducted in which the birds were present. Note that the little ringed plover was not detected in October in either year, while the common sandpiper was present. The asterisk shows the date when Felix Lassacher controlled the reference areas.

Table 7 Percentages of the detection points for both the common sandpiper (CS) and the little ringed plover (LRP), as well as the distance from the nearest vegetation in meters. In the last column, the number of protocols used is given.

Table 8 Territories of the Common sandpiper (Actitis hypoleucos) listed in the sections described in the previous papers and compared with the data from these researches. The research from the year 1989/90 only described sightings of individuals and not territories, which leads to a possible overestimation. Therefore, these numbers were not used for further analysis. n.a. …data not available for this subdivision.

Table 9 Territories of the little ringed plover (Charadrius dubius) listed in the sections described in the previous papers and compared with the data from these researches. The research from the year 1989/90 only described sightings of individuals and not territories, which leads to a possible overestimation. Therefore, these numbers were not used for further analysis. n.a. …data not available for this subdivision.

Table 10 The disturbances within the territories of the little ringed plover and the common sandpiper. Divided are the interferences in whether offspring were abundant (w OS = with offspring) or not (wo OS = without offspring). * with dog.

Table 11 This table shows all species encountered as syntopic species, the frequency of abundance, and the percentage. CS = Common sandpiper; LRP = Little ringed plover.

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Appendix

App. Tab. 1 Complete schedule of the field study.

Round	Section	Date	n LRP	n CS	covered river length (km)	River kilometre
1	1: Bach-Stanzach	17.04.2022	0	4	22,4	219,4-197
	2: Stanzach-Höfen	18.04.2022	5	2	19,8	197-177,2
	3: Höfen-Border	19.04.2022	3	3	9,2	177,2-168,0
	4: Vils	19.04.2022	0	0	4	4,0-0
	5: Hornbach	18.04.2022	0	0	4	5,9-1,9
2	1: Bach-Stanzach	09.05.2022	0	8	22,4	219,4-197
	2: Stanzach-Höfen	10.05.2022	5	11	19,8	197-177,2
	3: Höfen-Border	11.05.2022	2	5	9,2	177,2-168,0
	4: Vils	11.05.2022	0	0	4	4,0-0
	5: Hornbach	10.05.2022	0	0	4	5,9-1,9
3	1: Bach-Stanzach	31.05.2022	0	6	22,4	219,4-197
	2: Stanzach-Höfen	01.06.2022	7	6	19,8	197-177,2
	3: Höfen-Border	02.06.2022	2	7	9,2	177,2-168,0
	4: Vils	02.06.2022	0	0	4	4,0-0
	5: Hornbach	01.06.2022	0	0	4	5,9-1,9
4	1: Bach-Stanzach	14.06.2022	0	5	22,4	219,4-197
	2: Stanzach-Höfen	16.06.2022	13	19	19,8	197-177,2
	3: Höfen-Border	15.06.2022	3	7	9,2	177,2-168,0
	4: Vils	15.06.2022	0	0	4	4,0-0
	5: Hornbach	14.06.2022	0	0	4	5,9-1,9
5	1: Bach-Stanzach	28.06.2022	0	11	22,4	219,4-197
	2: Stanzach-Höfen	29.06.2022	12	20	19,8	197-177,2
	3: Höfen-Border	30.06.2022	3	8	9,2	177,2-168,0
	4: Vils	01.07.2022	0	0	4	4,0-0
	5: Hornbach	01.07.2022	0	0	4	5,9-1,9
6	1: Bach-Stanzach	11.07.2022	0	11	22,4	219,4-197
	2: Stanzach-Höfen	14.07.2022	13	13	19,8	197-177,2
	3: Höfen-Border	15.07.2022	2	5	9,2	177,2-168,0
	4: Vils	15.07.2022	0	0	4	4,0-0
	5: Hornbach	14.07.2022	0	0	4	5,9-1,9
7	1: Bach-Stanzach	25.07.2022	0	5	22,4	219,4-197
	2: Stanzach-Höfen	26.07.2022	8	9	19,8	197-177,2
	3: Höfen-Border	27.07.2022	0	4	9,2	177,2-168,0
	4: Vils	27.07.2022	0	0	4	4,0-0
	5: Hornbach	26.07.2022	0	0	4	5,9-1,9
		Total n	*78*	*169*		

App. Tab. 2 This table shows some arithmetic values of the habitat parameters for the common sandpiper.

CS	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se	
from water	139	2.21	4.46	1.00	1.26	0.74	0.00	30.00	30.00	4.61	22.93	0.38	in meters
from vegetation	139	13.01	15.24	7.00	10.35	8.90	0.00	100.00	100.00	2.25	7.28	1.29	in meters
river width	139	28.77	18.66	25.00	26.52	14.83	0.00	100.00	100.00	1.60	3.47	1.58	in meters
mud/sand	139	9.94	11.20	5.00	8.07	7.41	0.00	45.00	45.00	1.43	1.17	0.95	in %
small gravel	139	20.65	11.78	20.00	19.87	14.83	0.00	55.00	55.00	0.44	-0.45	1.00	in %
big gravel	139	22.34	11.65	25.00	22.43	14.83	0.00	50.00	50.00	-0.10	-0.83	0.99	in %
grasses	139	8.92	9.36	5.00	7.43	7.41	0.00	40.00	40.00	1.29	1.39	0.79	in %
bushes and trees	139	14.75	12.30	10.00	13.54	14.83	0.00	60.00	60.00	0.87	0.43	1.04	in %
dead wood	139	5.09	4.57	5.00	4.67	7.41	0.00	20.00	20.00	0.65	-0.13	0.39	in %
water	139	18.02	9.14	15.00	18.05	7.41	-5.00	40.00	45.00	-0.02	-0.39	0.78	in %

App. Tab. 3 This table shows some arithmetic values of the habitat parameters for the little ringed plover.

LRP	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se

from water	62	6.15	10.08	2.00	3.61	2.22	0.00	50.00	50.00	2.56	6.35	1.28	in meters
from vegetation	62	33.50	23.37	35.00	31.60	29.65	0.00	90.00	90.00	0.54	-0.69	2.97	in meters
river width	60	33.13	19.66	32.50	30.92	18.53	4.00	100.00	96.00	1.30	2.20	2.54	in meters
mud/sand	62	20.00	14.77	17.50	18.90	18.53	0.00	60.00	60.00	0.60	-0.36	1.88	in %
small gravel	62	24.92	10.30	25.00	24.70	7.41	0.00	60.00	60.00	0.35	1.00	1.31	in %
big gravel	62	18.71	10.63	15.00	18.40	7.41	0.00	40.00	40.00	0.34	-0.99	1.35	in %
grasses	62	2.90	4.10	0.00	2.20	0.00	0.00	20.00	20.00	1.58	3.03	0.52	in %
bushes and trees	62	4.35	7.44	0.00	2.80	0.00	0.00	30.00	30.00	1.81	2.70	0.94	in %
dead wood	62	8.47	5.25	10.00	8.30	7.41	0.00	25.00	25.00	0.45	0.54	0.67	in %
water	62	21.05	13.46	20.00	19.60	7.41	0.00	100.00	100.00	3.25	16.60	1.71	in %

App. Tab. 4 River sections (in river kilometres).

Stream	River section (km)	Total length in km
Lech	219,4-168,0	51,4 km
Hornbach	4,0-0	4 km
Vils	5,9-1,9	4 km

App. Tab. 5 Territory development over the last ten years for the common sandpiper (left) and the little ringed plover (right). In the column Trend the symbols stand for: 0... no territories in either researches; ~... territories are fluctuating but no visible trend is obvious; =... numbers of territories are stable; +... number of territories are increasing; ++... numbers of territories are strongly increasing (double or more). The column Renaturation shows how many actions were implemented during the last LIFE Lech project.

Section	Year	n Territories	Development	n Territories	Development	Renaturations
		Common sandpiper		Little ringed plover		
Steeg-Bach	2012	0	~	0	0	2
	2022	0-1		0		
Bach-Häselgehr	2012	3	+	0	0	2
	2022	4-8		0		
Häselgehr-Vorderhornbach	2012	3-4	+	0	0	3
	2022	6-8		0		
Vorderhornbach-Forchach	2012	2	++	2	+	1
	2022	6-11		3-6		
Forchach-Höfen	2012	5-6	=	7	+	2
	2022	5-9		9-10		
Höfen-Reutte	2012	0	~	1	~/=	0
	2022	0-1		0-2		
Reutte-Oberpinswang	2012	0	+	1	=	1
	2022	1-2		1-2		
Oberpinswang-Border	2012	0-5	++	2	=	1
	2022	7-8		2-3		
Total	2012	13-20	++	13	=/+	12
	2022	29-48		15-23		

App. Tab. 8 Detection points of both species divided by the sections. Furthermore, the river kilometres of the sections and the detection points per km and round are listed in this table. CS = common sandpiper; LRP = little ringed plover.

		Detections		river km		ratio dp/(km*round)	
Sections	**Subdivisions**	**CS**	**LRP**	**from**	**to**	**CS**	**LRP**
1	a) Steeg-Bach	1	0	219,4	216,6	0,05	0
1	b) Bach-Häselgehr	16	0	216,6	207,4	0,25	0
1	c) Häselgehr-Vorderhornbach	31	0	207,4	199,3	0,55	0
1-2	d) Vorderhornbach-Forchach	42	21	199,3	192	0,82	0,41
2	e) Forchach-Höfen	36	35	192	182	0,51	0,5
2	f) Höfen-Reutte	1	4	182	179,2	0,05	0,2
3	g) Reutte-Oberpinswang	5	6	179,2	173,6	0,13	0,15
3	h) Oberpinswang-Border	37	12	173,6	168	0,94	0,31
	Total	*169*	*78*	*219,4*	*168*	*0,47*	*0,22*

App. Tab. 9 Territories of both species divided by the subdivisions. Furthermore, the river kilometres of the sections and the territories per km are listed in this table. The results for the LRP with the asterisks are calculated without the first 3 subdivisions because no detection was made upstream of Vorderhornbach. CS = common sandpiper; LRP = little ringed plover.

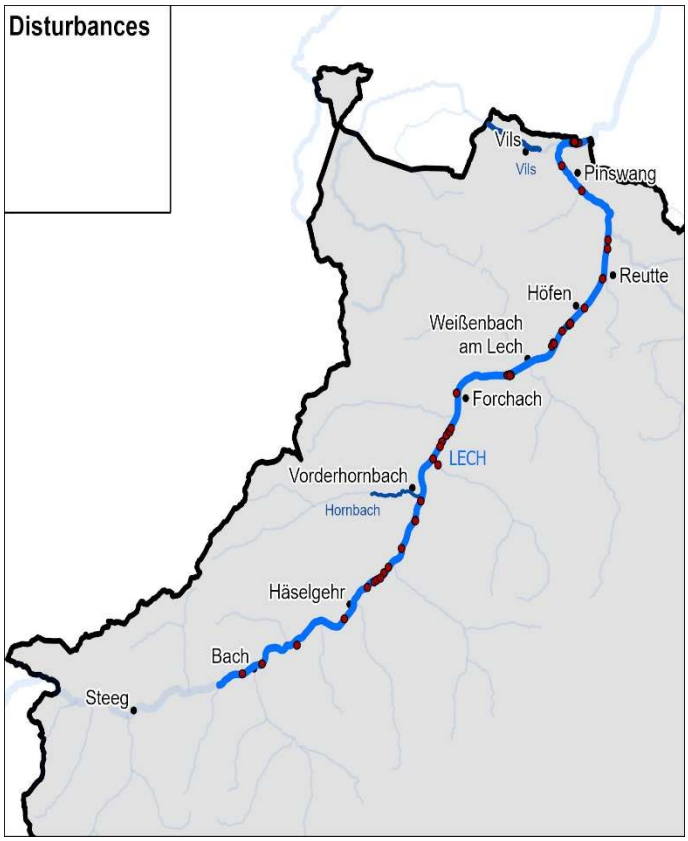
		Territories				river km		ratio t/km			
		CS		LRP		from	to	CS		LRP	
Sections	**Subdivisions**	**min**	**max**	**min**	**max**			**min**	**max**	**min**	**max**
1	a) Steeg-Bach	0	1	0	0	219,4	216,6	0	0,36	0	0
1	b) Bach-Häselgehr	4	8	0	0	216,6	207,4	0,43	0,87	0	0
1	c) Häselgehr-Vorderhornbach	6	8	0	0	207,4	199,3	0,74	0,99	0	0
1-2	d) Vorderhornbach-Forchach	6	11	3	6	199,3	192	0,82	1,51	0,41	0,82
2	e) Forchach-Höfen	5	9	9	10	192	182	0,5	0,9	0,9	1
2	f) Höfen-Reutte	0	1	0	2	182	179,2	0	0,36	0	0,71
3	g) Reutte-Oberpinswang	1	2	1	2	179,2	173,6	0,18	0,36	0,18	0,36
3	h) Oberpinswang-Border	7	8	2	3	173,6	168	1,25	1,43	0,36	0,54
	Total	*29*	*48*	*15*	*23*	*219,4*	*168*	*0,56*	*0,93*	*0,29 (0,37*)*	*0,45 (0,69*)*

App. Tab. 10 The number of events when offsprings were sighted plus the total number of offsprings observed divided into the sections. The slightly greyish background at the numbers for the LRP between Forchach and Höfen indicates that not only juveniles, but also pulli were observed (1 sighting/ 3 pulli). CS= common sandpiper; LRP = little ringed plover.

		Offsprings			
		CS		LRP	
Sections	**Subdivisions**	**Sightings**	**Number**	**Sightings**	**Number**
1	a) Steeg-Bach	0	0	0	0
1	b) Bach-Häselgehr	2	2	0	0
1	c) Häselgehr-Vorderhornbach	4	6	0	0
1-2	d) Vorderhornbach-Forchach	4	5	2	2
2	e) Forchach-Höfen	0	0	3	6
2	f) Höfen-Reutte	0	0	0	0
3	g) Reutte-Oberpinswang	0	0	0	0
3	h) Oberpinswang-Border	6	11	3	4
	Total	*16*	*24*	*8*	*12*

App. Tab. 11 Comparison between the loss and the gain of riverbanks without vegetation. The orthophoto was taken from tirisMaps with the years of 2010 and 2020. Changes in the area were measured in m² (https://maps.tirol.gv.at/synserver?project=tmap_masterandclient=core).

	Comparison river banks 2010-2020		
Sections	**Subdivisons**	**Loss**	**Gain**
1	a) Steeg-Bach	-	11.610,70 m²
1	b) Bach-Häselgehr	33.707,50 m²	4.740,20 m²
1	c) Häselgehr-Vorderhornbach	34.343,70 m²	16.599,50 m²
1-2	d) Vorderhornbach-Forchach	32.757,70 m²	62.148,50 m²
2	e) Forchach-Höfen	14.879,10 m²	121.106,90 m²
2	f) Höfen-Reutte	-	11.895,20 m²
3	g) Reutte-Oberpinswang	2.533,60 m²	3.597,70 m²
3	h) Oberpinswang-Border	5.781,80 m²	-
	Total	*124.003,40* m²	*231.698,70* m²



App. Figure 1 Disturbances along the Lech. Over the research area no cluster of significantly higher concentrations was found.

App. Tab. 12 All disturbances along the river Lech divided into the sections with disturbances per km.

Sections	Anthropogenic Influences						Natural Disturbances							Total	per km
	Human	Human w dog	fire settings	machinery	construction	motocross	*L. michahellis M. Milvus*	*B. buteo*	*C. corone*	*P. carbo*	*M. erminea*	*other raptors*			
Steeg-Bach	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0,71
Bach-Häselgehr	2	1	3	0	0	0	0	0	1	7	0	0	0	14	1,52
Häselgehr-Vorderhornbach	3	1	2	0	0	0	0	1	2	8	0	0	1	18	2,22
Vorderhornbach-Forchach	7	2	9	0	0	0	0	1	0	12	0	0	0	31	4,25
Forchach-Höfen	2	5	3	1	0	1	0	0	0	13	0	0	0	25	2,50
Höfen-Reutte	2	0	2	0	0	0	0	0	0	2	1	0	0	7	2,50
Reutte-Oberpinswang	0	0	1	1	1	0	2	0	0	2	2	0	0	9	1,61
Oberpinswang-Border	3	0	7	0	0	0	7	0	0	0	4	0	1	22	3,93
Total	19	9	27	2	1	1	9	2	3	45	7	1	2	128	2,49

App. Tab. 13 This table shows how often warning behaviour was observed for both species. A division was made for the occurence of offsprings as well as for the distance of the disturbance.

warning behaviour	**Total**	**without offsprings**			**with offsprings**			**total**		
Disturbance		within 30 m	30-100 m	in both	within 30 m	30-100 m	in both	within 30 m	30-100 m	in both
LRP	**13**	1	0	0	1	0	0	2	0	0
CS	**38**	6	2	1	1	2	0	7	4	1

Start: _____Uhr Seite 1/2
Ende: _____Uhr Anzahl Protokolle/Tag:___

Kartierung Flussuferläufer und Flussregenpfeifer 2022 (Version 7. April 22)			
Kartierstrecke:		**Teilstrecke:**	**Datum:**
Begehungsdurchgang:			**Uhrzeit:**
Protokollnummer:			**Bearbeiter:**
Koordinaten GPS:		**Wegpunktkürzel:**	**Fotonummer:**
Flussufer:	o rechts	o links	

Witterung:	**Abflusssituation:**
o wolkenlos	o niedrig
o heiter	o mittel
o bewölkt	o hoch
o Regen	
o windig	

Art:		**Anzahl:**	**Nachweisart:**
o Flussuferläufer		__Adult	__Sichtung
o Flussregenpfeifer		__Jungvogel	__Ruf
o Gänsesäger	o m o w	__Pullus	__Nest (weiter bei 2/2)
		__Ei	__anders:

Nachweispunkt:			**Störungen**	
o Insel	o Halbinsel	o Ufer	**>30 m:**	
Uferneigung:			o **Mensch:**	_____
o flach	o geneigt	o steil	o **Hund**	o **Fuchs**
Einmündungen:	___ (Anzahl)	(in 30m Umkreis)	o **Katze**	o **Marderartige**
Entfernung in m:			o **Rabenkrähe**	o **sonstige:** _____
von Uferlinie:	___		o **Kolkrabe**	
von Gehölz:	___	o Gebüsch		
		o dichter Wald	**30-100 m:**	
Flussbreite:	___		o **Mensch:**	_____
OF Bedeckung in 30m Umkreis:			o **Hund**	o **Fuchs**
__ Schlamm/Sand	__ Schotter < 5 cm	__ Schotter > 5 cm	o **Katze**	o **Marderartige**
__ Krautschicht	__ Büsche/Bäume	__ Totholz	o **Rabenkrähe**	o **sonstige:** _____
__ sonstiges			o **Kolkrabe**	

Verhalten:	**Nahrungssuche:**
o H (zur Brutzeit in geeignetem Habitat)	o im Wasser o Uferbereich o im Kies
o S (singendes Männchen zur Brutzeit)	o Vegetation o sonstige:
o P (Paar zur Brutzeit)	Pickrate: _____
o R (Revierkampf)	
o D (Balzverhalten, Kopula)	
o N (Aufsuchen des Nistplatzes)	**Weitere Arten:**
o A (Angst-/Warnverhalten von Altvögeln)	
o DD (Verleiten)	
o FL (kürzlich ausgeflogenes Junge)	
o ON (brütender Altvogel gesehen)	
o NE (Nest mit Eiern)	

Seite 2/2

Protokoll Nestfund: Stand 16.04.22

o Erstgelege	sonstiges:
o Zweitgelege	
Anzahl Eier: __	davon geschlüpft: __

Neststruktur:

Bau:		Material:			
o flach im Kies	o in Mulde	o Sand	o Kies	o Gras	o Geäst
o erhöht (wenn ja: wo?)_____		o sonstiges: _____		Foto Nr.: _____	

Nachweispunkt:			**Entfernung in m:**	
o Insel	o Halbinsel	o Ufer	**von Uferlinie:**	___
Uferneigung:			**von Gehölz:**	___
o flach	o geneigt	o steil		o Gebüsch
Einmündungen:	___ (Anzahl)	(in 30m Umkreis)		o dichter Wald

Flussbreite: ___

OF Bedeckung in 30m Umkreis:

__ Schlamm/Sand	__ Schotter < 5 cm	__ Schotter > 5 cm
__ Krautschicht	__ Büsche/Bäume	__ Totholz
__ sonstiges		

App. Figure 2 The research protocol used in the field

App. Tab. 64 All detection points and informations relevant for this paper are presented in this table. The column names from left to right are: identification number; research round; protocol number; Coordinates lat; Coordinates long; date; time; researcher; river shore (left or right); weather; drainage; species; n of adults; n of juveniles; n of pulli; place of detection; slope of shore; distance from shore; distance from vegetation; bushes/wood; river width; mud/sand; gravel <5cm; gravel >5cm; vegetation; bushes/trees; dead wood; water; other; disturbances <30m; disturbances 30-100m; behaviour; syntopic species.

Kürzel	Begehungsdurchgang	Protokollnummer	Koordinaten lat	Koordinaten long	Datum	Uhrzeit	Bearbeiter	Flussufer	Witterung	Abflusssituation	Art	Adult	Jungtier	Pullus	Nachweisart	Nachweispunkt	Uferneigung	von Uferlinie	von Gehölz	Gebüsch/Wald	Flussbreite	Schl/Sa	Scho <5cm	Scho >5cm	Kra	Bü/Bäu	Totholz	Wasser	andere	Stör <30m	Stör 30-100m	Verhalten	weitere Arten
MS002	1	9	47.330000	10.525000	17.04.2022	15:24	MS	li	heiter windig	mittel	FUL	2			Sichtung, Ruf	Ufer	flach	0.5	3	Ge	15		10	15		30		45				A	
MS003	1	11	47.338611	10.535000	17.04.2022	16:03	MS	li	heiter windig	mittel	FUL	1			Sichtung	Halbinsel	flach	1	20	Wa	15	5	15	30	5	5		40		Spaziergänger, Rabenkrähe	A		
MS004	1	12	47.350278	10.541944	17.04.2022	16:35	MS	li	heiter windig	mittel	FUL	3			Sichtung, Ruf	Ufer, Flug	flach	0	3	Ge	10	5	10	20	15	10		40				R	WA
MS005	1	4	47.395556	10.566944	18.04.2022	11:40	MS	mi	wolkenlos, windig	mittel	FRP	1			Ruf	Insel	flach	?	10	Ge	20	10	30	10		5	5	40			Spaziergänger	S	
MS006	1	6	47.421389	10.578333	18.04.2022	13:01	MS	li	wolkenlos, windig	mittel	FRP	2			Sichtung, Ruf	Ufer	flach	1	40	Ge	30	15	25	10			5	45			Spaziergänger	Uferbereich, Schlick	
MS007	1	8	47.432778	10.624444	18.04.2022	14:33	MS	li	wolkenlos, windig	mittel	FRP	1			Sichtung	Insel	flach	0.5	30	ge	5	35	25		5			30		Hütten			BaSt, StEn
MS008	1	9	47.433056	10.628056	18.04.2022	14:45	MS	re	wolkenlos, windig	mittel	FRP	1			Sichtung, Ruf	Ufer	flach	1.5	30	Wa	30	25	25	10	5		5	30			Hütte		StEn
MS009	1	10	47.434722	10.632778	18.04.2022	14:55	MS	re	wolkenlos, windig	mittel	FRP	1			Sichtung	Halbinsel	flach	1	40	Wa	25	40	5	5			5	45				H	BaSt
MS010	1	13	47.461389	10.679444	18.04.2022	16:35	MS	re	wolkenlos, windig	mittel	FUL	1			Sichtung	Insel	flach	0.5	5	Ge	18	5	10	25		10		45	5 Fels	Straße	Querverbauung	H	
MS011	1	14	47.462222	10.681111	18.04.2022	16:40	MS	mi	wolkenlos, windig	mittel	FUL	2			Sichtung	Insel	flach	0.5	20	Ge	50	15	10	10			5	60			Querverbauung	P	
MS015	1	2	47.502500	10.711667	19.04.2022	09:45	MS	re	wolkenlos	mittel	FRP	2			Sichtung	Insel	flach	0.5	30	Wa	35	5	35	20			5	35		Bauarbeiten		P	
MS022	1	7	47.541667	10.666389	19.04.2022	12:58	MS	li	bewölkt, windig	mittel	FUL	1			Sichtung	Ufer	flach	0.5	12	Ge	4		35	20		5	5	35				H	StEn

MS025	1	10	*47.556667*	*10.675278*	19.04.2022	14:05	MS	li	bewölkt, windig	mittel	FRP	1		Sichtung, Ruf	Halbinsel	geneigt	0.5	40	Ge	60		45	10			5	35	5 Fels		Querverbauung				
MS026	1	11	*47.555833*	*10.676667*	19.04.2022	14:15	MS	mi	bewölkt, windig	mittel	FUL	2		Sichtung, Ruf	Insel	flach	0.5	15	Ge	50	15	10	5	20			50		Querverbauung	D			
MS027	1	12	*47.555833*	*10.677778*	19.04.2022	14:28	MS	mi	bewölkt, windig	mittel	FUL	2		Sichtung, Ruf	Insel	flach	0.5	5	Ge	10		15	10	20	20		35		Querverbauung	D			
MS028	1	13	*47.556111*	*10.679722*	19.04.2022	14:34	MS	li	bewölkt, windig	mittel	FRP	2		Sichtung	Ufer	flach	2	7	Ge	20	10	35	10	15	5	5	30						
MS031	2	2	*47.266760*	*10.393547*	09.05.2022	08:18	MS	li	bewölkt	hoch	FUL	2		Sichtung	Ufer	flach	1	15	Ge	15	10	10	15	15	10	5	35		Hermelin	Stall	H		
MS034	2	5	*47.297555*	*10.466868*	09.05.2022	10:44	MS	re	wolkenlos	mittelhoch	FUL	1		Sichtung	Ufer	steil	0.5	1	Ge	10	0	10	15	40			35				S		
MS035	2	6	*47.299813*	*10.485252*	09.05.2022	11:16	MS	re	wolkenlos	mittelhoch	FUL	1		Sichtung	Ufer	geneigt	0.5	1.5	Ge	15	5	5	20	20	30		20			Spaziergänger, Hund	S		
MS036	2	8	*47.316082*	*10.502380*	09.05.2022	12:03	MS	li	heiter, windig	mittelhoch	FUL	1		Sichtun	Ufer	steil	0.5	0.5	Wa	10			10	10	40		20	20 Fels			A		
MS037	2	9	*47.316987*	*10.505268*	09.05.2022	12:13	MS	re	heiter, windig	mittelhoch	FUL	1		Sichtung	Ufer	geneigt	0.5	6	Wa	15		10	25	25	10	5	25		Rabenkrähe				BaSt
MS038	2	10	*47.320280*	*10.511257*	09.05.2022	12:50	MS	mi	heiter, windig	mittelhoch	FUL	2		Sichtung, Ruf	Insel	flach	0	10	Ge	20		20	35		5	10	30			Rafting	H, S		
MS040	2	13	*47.353498*	*10.546135*	09.05.2022	14:38	MS	li	bewölkt, windig	mittelhoch	FUL	2		Sichtung	Insel	flach	1	20	Ge	18	30	25	10		5	15	15			Rabenkrähe			GeSt
MS041	2	14	*47.363965*	*10.550473*	09.05.2022	15:09	MS	re	bewölkt,windig	mittelhoch	FUL	1		Sichtung	Halbinsel	flach	1	12	Ge	25	30	30	15		15	10			Rabenkrähe				BaSt, GeSt
MS045	2	1	*47.386513*	*10.559660*	10.05.2022	07:21	MS	mi	wolkenlos	mittelhoch	FUL	2		Sichtung, Ruf	Halbinsel	flach	1	15	Wa	15	20	25	10		5	10	30				P		
MS046a	2	2	*47.399578*	*10.570827*	10.05.2022	08:07	MS	li	wolkenlos	mittelhoch	FUL	2		Sichtung, Ruf	Insel	flach	2	20	Wa	25	30	20	15		5	5	25				P		BaSt
MS046b	2		*47.399578*	*10.570827*	10.05.2022		MS				FRP	2		Sichtung, Ruf	Insel	flach	0.5	20	Wa	25	35	20	15				30				P		BaSt
MS047	2	3	*47.402102*	*10.574700*	10.05.2022	08:23	MS	re	wolkenlos	mittelhoch	FUL	2		Sichtung, Ruf	Insel	flach					10	25	20	10	10	5	30				H		BaSt
MS048	2	5	*47.409513*	*10.579692*	10.05.2022	08:52	MS	re	wolkenlos	mittelhoch	FUL	1		Sichtung, Ruf	Insel	flach	5	15	Ge	20	5	20	30		5	5	35						

MS049	2	6	*47.413552*	*10.580417*	10.05.2022	09:05	MS	Flug	wolkenlos	mittelhoch	FUL	1		Sichtung, Ruf	Flug												100					A			
MS050	2	7	*47.421100*	*10.578283*	10.05.2022	09:26	MS	li	wolkenlos	mittelhoch	FUL	2		Sichtung, Ruf	Ufer	flach	1	20	Ge		5	20	30	5	5	5	30					D			
MS052	2	9	*47.427540*	*10.584482*	10.05.2022	09:49	MS	li	wolkenlos, windig	mittelhoch	FUL	2		Sichtung, Ruf	Insel	flach	1	10	Ge	50	5	20	30		5	10	30					R	BaSt, GäSä		
MS053	2	10	*47.430692*	*10.598223*	10.05.2022	10:11	MS	re	wolkenlos	mittelhoch	FRP	1		Sichtung, Ruf	Ufer	flach	10	35	Wa	20	30	15	15			25	15					H			
MS054a	2	12	*47.431268*	*10.613585*	10.05.2022	10:53	MS	re	wolkenlos	mittelhoch	FRP	1		Sichtung, Ruf	Insel	flach	1	15	Ge	25	20	20	15		5	5	35					H			
MS054b	2		*47.431268*	*10.613585*	10.05.2022		MS				FUL	1		Sichtung	Insel	flach	0.5	10	Ge	25	10	20	20		5	10	35					H			
MS055	2	13	*47.431755*	*10.620283*	10.05.2022	11:06	MS	mi	wolkenlos	mittelhoch	FUL	2		Sichtung	Insel	flach	1	30	Ge		30	20			10		40					P	BaSt		
MS056	2	14	*47.433182*	*10.626810*	10.05.2022	11:20	MS	mi	wolkenlos	mittelhoch	FRP	2		Sichtung	Insel	flach	1.5	35	Wa	40		15	40			10	35				Hütte	P	FUL ?		
MS058	2	16	*47.451565*	*10.665992*	10.05.2022	12:30	MS	li	heiter, windig	mittelhoch	FRP	2		Sichtung, Ruf	Insel	flach	1	40	Wa	20	20	20	10			10	40				Rabenkrähe	D	BaSt		
MS059	2	17	*47.457960*	*10.673650*	10.05.2022	12:49	MS	li	heiter, windig	mittelhoch	FUL	1		Sichtung, Ruf	Flug	geneigt											100				Verbauung				
MS060	2	18	*47.470925*	*10.693427*	10.05.2022	13:22	MS	re	heiter, windig	mittelhoch	FUL	2		Sichtung, Ruf	Ufer	flach	2	2	Ge	35	20	10	30	20	10	5	5		Brücke, Spaziergänger		Kraftwerk	P, A	BaSt		
MS061	2	20	*47.508173*	*10.711673*	10.05.2022	15:14	MS	li	heiter, windig	mittelhoch	FRP	1		Sichtung, Ruf	Insel	flach	1	30	Wa	45	5	30	20			10	35					H			
MS066	2	3	*47.534500*	*10.679828*	11.05.2022	08:34	MS	re	wolkenlos, windig	hoch	FUL	2		Sichtung, Ruf	Insel	geneigt	1.5	16	Wa	60		10	20	10			40	20 Fels				P			
MS067	2	4	*47.538815*	*10.672522*	11.05.2022	08:54	MS	li	wolkenlos	hoch	FUL	2		Sichtung, Ruf	Ufer	flach	0.5	2	Wa	40		20	35	10	20	5	10					S, R			
MS068	2	5	*47.543558*	*10.665108*	11.05.2022	09:12	MS	li	wolkenlos, windig	hoch	FUL	1		Sichtung, Ruf	Ufer	geneigt	0.5	1.5	Ge	35		25	25	5	25		20		Haus	Möwe		H			
MS071	2	8	*47.556225*	*10.676044*	11.05.2022	10:45	MS	mi	wolkenlos, windig	hoch	FUL	2		Sichtung, Ruf	Insel	geneigt	0.5	1	Ge	80	30	5	10	10	30		15		Querverbauung, Kormoran	P		Uferbereich, im Sand			
MS072	2	9	*47.556225*	*10.677589*	11.05.2022	11:03	MS	re	wolkenlos, windig	hoch	FUL	2		Sichtung, Ruf	Insel	geneigt	1	10	Ge	25	10	20	25	15	10		20		Querverbauung	Kormoran		P	StEn		

MS073	2	10	*47.556308*	*10.679687*	11.05.2022	11:15	MS	li	wolkenlos, windig	hoch	FRP	2		Sichtung, Ruf	Ufer	flach	1.5	8	Ge	30	20	25	10	5	20		40			Querverbauung	P	StEn
MS080	3	1	*47.283417*	*10.433767*	31.05.2022	08:23	MS	re	bewölkt	mittelhoch	FUL	2		Sichtung	Ufer	flach	1	10	Wa	15		10	40	15	5	5	25				H	WaAm
MS081	3	2	*47.295382*	*10.456037*	31.05.2022	09:12	MS	li	heiter	mittelhoch	FUL	2		Sichtung, Ruf	Halbinsel	flach	30	6	Ge	18	10	20	35	5	5		25				H, D	StEn
MS083	3	4	*47.301880*	*10.488427*	31.05.2022	10:10	MS	re	heiter	mittelhoch	FUL	2		Sichtung, Ruf	Ufer	flach	1.5	5	Wa	22	10	15	35		10		30				H	
MS084	3	5	*47.305802*	*10.492743*	31.05.2022	10:23	MS	mi	heiter	mittelhoch	FUL	1		Sichtung, Ruf	Flug	geneigt	8	9	Ge	18	10	25	25		10		30				A	WaAm, BaSt
MS085	3	6	*47.321245*	*10.513817*	31.05.2022	11:21	MS	re	heiter	mittelhoch	FUL	1		Sichtung	Ufer	flach	0.5	6	Ge	23		30	25	5	15	10	15	Rabenkrähe			A	BaSt
MS086	3	7	*47.353850*	*10.546547*	31.05.2022	12:51	MS	re	heiter	mittelhoch	FUL	1		Sichtung, Ruf	Insel	flach	5	5	Ge	18	5	20	30	5	15	15	10	Rabenkrähe	Greifvogel		S, A	
MS090	3	1	*47.386508*	*10.559582*	01.06.2022	07:46	MS	re	bewölkt	mittel	FUL	2		Sichtung, Ruf	Ufer	flach	1	18	Wa	15	15	25	30	5	5		20		Rabenkrähe		P	
MS092	3	3	*47.401325*	*10.572968*	01.06.2022	08:35	MS	re	heiter	mittel	FUL	1		Sichtung, Ruf	Insel	flach	1	15	Ge	20	5	25	35	5	10	5	15		Weidevieh		A	
MS095	3	5	*47.406743*	*10.578228*	01.06.2022	09:00	MS	re	heiter	mittel	FUL	1		Sichtung, Ruf	Ufer	flach	1	10	Ge	25	5	30	30	5	15	10	5				A	
MS096	3	6	*47.407810*	*10.577952*	01.06.2022	09:07	MS	re	heiter	mittel	FRP	2		Sichtung	Halbinsel	flach	5	40	Ge	35	10	20	40			15	15				H	
MS097	3	7	*47.409556*	*10.579131*	01.06.2022	09:19	MS	re	heiter	mittel	FUL	1		Sichtung	Ufer	flach	2	5	Ge	40	10	20	20	15	15	5	15				H	
MS098	3	8	*47.430205*	*10.599932*	01.06.2022	10:19	MS	re	heiter	mittel	FRP	1		Sichtung, Ruf	Ufer	flach	2	15	Ge	10	15	30	25		10	10	10				H	GeSt
MS100	3	10	*47.432727*	*10.627012*	01.06.2022	11:11	MS	re	heiter	mittel	FRP	2		Sichtung, Ruf	ufer	flach	2	35	Ge	40	35	15	15	10		10	15		Rabenkrähe		P	BaSt
MS101a	3	11	*47.435135*	*10.631917*	01.06.2022	11:21	MS	re	heiter	mittel	FUL	1		Sichtung, Ruf	ufer	flach	5	45	Ge	40	5	30	30			10	25				H	
MS101b	3		*47.435135*	*10.631917*	01.06.2022		MS				FRP	2		Sichtung, Ruf	Ufer	flach	15	50	Ge	40	30	15	15			10	30				P	
MS103	3	13	*47.483267*	*10.707033*	01.06.2022	14:07	MS	li	bewölkt, windig	mittel	FRP	2		Sichtung, Ruf	Ufer	flach	1	35	Ge	35	35	30	15			5	15				H	

MS104	3	14	*47.487027*	*10.708823*	01.06.2022	14:17	MS	li	bewölkt	mittel	FRP	2		Sichtung, Ruf	Ufer	flach	10	10	Wa	50	30	30	10	5	10	5	10		Brücke	P	BaSt
MS106a	3	16	*47.503127*	*10.711892*	01.06.2022	14:53	MS	re	bewölkt, Regen	mittel	FUL	1		Sichtung	Insel	flach	2	9	Wa	50	30	20	15		10	10	15			A	
MS106 b	3		*47.503127*	*10.711892*	01.06.2022		MS				FRP	2		Sichtung	Insel	flach	4	6	Wa	50	50	15	5		15	10	5			P	
MS107	3	17	*47.507050*	*10.711727*	01.06.2022	15:10	MS	re	bewölkt	mittel	FUL	1		Sichtung	Insel	flach	1	40	Ge	35	5	40	30			5	20		Kormoran	A	StEn
MS110	3	1	*47.530907*	*10.687237*	02.06.2022	08:34	MS	re	bewölkt	mittel	FUL	2		Sichtung, Ruf	Ufer	flach	0.5	20	Ge	20	5	40	35		5	5	10			P	StEn
MS111	3	2	*47.533458*	*10.681837*	02.06.2022	08:48	MS	li	bewölkt	mittel	FUL	2		Sichtung, Ruf	Ufer	flach	0.5	20	Ge	20	5	40	40		5		10			P	
MS112	3	3	*47.540942*	*10.670230*	02.06.2022	09:15	MS	re	bewölkt	mittel	FUL	1		Sichtung	Ufer	flach	0	5	Wa	15	5	20	25	10	20	5	15			H	StEn
MS114	3	5	*47.556277*	*10.674348*	02.06.2022	10:12	MS	re	bewölkt	mittel	FUL	2		Sichtung	Flug	flach	1	7	Ge	100	10	35	30	20			5		Kormoran	R	BlHu, ReEn
MS115	3	6	*47.556662*	*10.674960*	02.06.2022	10:18	MS	li	bewölkt	mittel	FRP	1		Sichtung	Ufer	steil	0	45	Ge	100	10	35	25			10	20		Greifvogel	H	
MS116	3	7	*47.556633*	*10.676612*	02.06.2022	10:23	MS	mi	bewölkt	mittel	FUL	2		Sichtung, Ruf	Insel	geneigt	0.5	1	Ge	100	35	5		30	20		10			P	
MS118a	3	9	*47.556323*	*10.679233*	02.06.2022	10:33	MS	li	bewölkt	mittel	FRP	2		Sichtung, Ruf	Ufer	flach	1	10	Ge	25	20	30	30		15		5			P	
MS118 b	3		*47.556323*	*10.679233*	02.06.2022		MS				FUL	1		Sichtung	Ufer	flach	0.5	20	Ge	25	10	35	35		5		15			H	
MS120	4	1	*47.272848*	*10.411357*	14.06.2022	08:33	MS	mi	wolkenlos	mittelhoch	FUL	1	1	Sichtung, Ruf	Insel	geneigt	1	7	Wa	15	5	10	25	20	25	5	10		Rabenkrähe	N, A	BaSt
MS121	4	2	*47.284143*	*10.442625*	14.06.2022	09:37	MS	li	wolkenlos	mittelhoch	FUL	2		Sichtung, Ruf	Ufer	flach	1	4	Ge	20	2	5	30	15	15	3	30		Spaziergänger	H	
MS123	4	4	*47.325222*	*10.519818*	14.06.2022	12:52	MS	li	wolkenlos, windig	mittelhoch	FUL	1		Sichtung, Ruf	Ufer	flach	1	4	Ge	22	15	10	15	5	30		25		Brücke	Rabenkrähe	S	
MS124	4	5	*47.326252*	*10.522040*	14.06.2022	13:01	MS	re	wolkenlos, windig	mittelhoch	FUL	2		Sichtung, Ruf	Ufer	geneigt	0.5	0.5	Ge	20		5	10		60		25			A	
MS125	4	6	*47.353487*	*10.546485*	14.06.2022	14:16	MS	mi	wolkenlos, windig	mittelhoch	FUL	2		Sichtung, Ruf	Insel	geneigt	0.5	0.5	Ge	23	5	5	5	30	30	5	20		Picknicker	A	

MS126	4	1	*47.507198*	*10.711948*	15.06.2022	06:30	MS	re	heiter	mittelhoch	FRP	2	2	Sichtung, Ruf	Insel	geneigt	10	70	Wa	30	5	30	15			15	35			N, A	Ko, GrRe
MS127	4	2	*47.506637*	*10.711282*	15.06.2022	06:38	MS	re	heiter	mittelhoch	FUL	2		Sichtung	Insel	flach	0.5	40	Wa	30	5	25	25			15	30			P	Ko, GrRe
MS130	4	5	*47.535733*	*10.677307*	15.06.2022	08:41	MS	li	heiter	mittelhoch	FUL	1		Sichtung	Ufer	flach	0.5	15	Wa	45	30	10	20	15	5	5	15			H	
MS131	4	6	*47.536485*	*10.676383*	15.06.2022	08:53	MS	li	heiter	mittelhoch	FUL	1		Sichtung, Ruf	Ufer	flach	2	25	Wa	30	10	45	15	5	5	5	15			S	
MS132	4	7	*47.537877*	*10.674012*	15.06.2022	09:02	MS	li	heiter	mittelhoch	FUL	1		Sichtung	Ufer	flach	0.5	10	Wa	35	10	30	10	15	15	5	15			H	
MS134	4	9	*47.542722*	*10.666677*	15.06.2022	09:35	MS	re	heiter	mittelhoch	FUL	2		Sichtung, Ruf	Ufer	flach	20	5	Ge	15	10	25	25	10	20	5	5			A	
MS136	4	11	*47.556883*	*10.675977*	15.06.2022	10:30	MS	mi	heiter	mittelhoch	FRP	2		Sichtung	Halbinsel	steil	2	50	Ge	85	15	35	20	5		5	20			P	Ko, ReEn
MS137	4	12	*47.556957*	*10.676805*	15.06.2022	10:40	MS	li	heiter	mittelhoch	FUL	1		Sichtung, Ruf	Ufer	steil	1	5	Ge	5	15	15	10	15	20		25			A	
MS138	4	13	*47.556847*	*10.676000*	15.06.2022	10:56	MS	mi	heiter	mittelhoch	FUL	1		Sichtung, Ruf	Insel	flach	1	5	Ge	85	45	5		10	15		25				Ko, ReEn
MS139	4	14	*47.556678*	*10.676913*	15.06.2022	11:21	MS	mi	heiter	mittelhoch	FUL	2	2	Sichtung, Ruf	Insel	geneigt	2	0.5	Ge	20	20	10	5	20	30		15		Spaziergänger	A, DD, FL	
MS140	4	15	*47.556397*	*10.679327*	15.06.2022	11:34	MS	li	heiter	mittelhoch	FRP	2		Sichtung	Ufer	flach	1	6	Ge	30	20	15	10	10	20	5	20			P	
MS141	4	1	*47.393105*	*10.565508*	16.06.2022	08:08	MS, RL	re	bewölkt, windig	mittel	FUL	1		Sichtung, Ruf	Ufer	flach	2	15	Wa	25	5	20	30	15	5		25	Spaziergänger	Kühe	D, A	
MS142	4	2	*47.399113*	*10.571088*	16.06.2022	08:32	MS, RL	re	Regen	mittel	FUL	1		Sichtung	Ufer	flach	2	15	Wa	25	5	25	30	5	10	10	15		Kühe	H	
MS143	4	3	*47.400988*	*10.573767*	16.06.2022	08:48	MS, RL	re	bewölkt, windig	mittel	FUL	1		Ruf	Ufer		1	7	Ge	5	5	25	25	10	20	15	0		Kajak	H	BaSt
MS144	4	4	*47.402900*	*10.574897*	16.06.2022	09:07	MS, RL	li	bewölkt, windig	mittel	FUL	2		Sichtung, Ruf	Ufer	flach	1	35	Ge	40	35	10	15	5		10	25	RK			
MS145	4	5	*47.403832*	*10.575807*	16.06.2022	09:19	MS, RL	re	bewölkt	mittel	FRP	1		Sichtung, Ruf	Halbinsel	flach	3	45	Wa	20	5	20	35	5		15	20			S	
MS146	4	6	*47.404168*	*10.575223*	16.06.2022	09:31	MS, RL	li	bewölkt	mittel	FUL	1		Ruf	Ufer	geneigt	1	25	Ge	35	5	20	25	10	10	5	25			A	

MS147	4	7	*47.407083*	*10.577093*	16.06.2022	09:45	MS, RL	re	bewölkt	mittel	FRP	1	Ruf	Ufer	flach	1	35	Ge	30	5	30	25	5	5	10	20					H	
MS148	4	8	*47.407415*	*10.578431*	16.06.2022	10:11	MS, RL	re	bewölkt	mittel	FUL	1	Sichtung, Ruf	Ufer	Flach	1	0	Gebüsch	32	5	15	5	5	45	10	15					A	
MS149	4	9	*47.408290*	*10.579897*	16.06.2022	10:18	MS, RL	re	bewölkt	mittel	FRP	1	Sichtung, Ruf	Halbinsel	flach	25	15	Gebüsch	17	15	15	35	5	5	10	15					A	
MS150	4	10	*47.408837*	*10.578770*	16.06.2022	10:25	MS, RL	mi	bewölkt	mittel	FUL	1	Sichtung	Flug	flach	3	55	Gebüsch	18	15	30	20			10	25						
MS151	4	11	*47.409453*	*10.580007*	16.06.2022	10:30	MS, RL	re	bewölkt	mittel	FRP	1	Sichtung	Ufer	flach	0	10	Wald	20	15	10	35		15	5	20						
MS152	4	12	*47.411827*	*10.578612*	16.06.2022	10:40	MS, RL	li	bewölkt	mittel	FUL	1	Sichtung, Ruf	Ufer	flach	2	40	Wa	35	10	20	30	25			15					H	
MS153	4	13	*47.415900*	*10.579597*	16.06.2022	11:09	MS, RL	li	bewölkt	mittel	FUL	1	Sichtung	Ufer	flach	1	40	Wa	35	5	30	25	25		10	5					H	
MS154	4	14	*47.423712*	*10.579633*	16.06.2022	11:34	MS, RL	li	bewölkt	mittel	FRP	2	Ruf	Insel	flach	2	25	Wa	40	10	30	30			5	25					H, A	
MS156	4	16	*47.424642*	*10.581397*	16.06.2022	11:47	MS, RL	re	bewölkt	mittel	FUL	1	Sichtung	Ufer	flach	20	25	Wa	35	35	20	10	5	5	10	15						
MS157	4	17	*47.428498*	*10.585842*	16.06.2022	12:13	MS, RL	li	bewölkt	mittel	FUL	1	Sichtung	Ufer	geneigt	1	2	Ge	20		30	25	5	35		5					H	
MS158	4	18	*47.430878*	*10.598082*	16.06.2022	12:41	MS, RL	li	bewölkt	mittel	FUL	2	Sichtung, Ruf	Insel	flach	1	40	Ge	45	10	30	20			15	25					H	
MS159	4	19	*47.430853*	*10.597605*	16.06.2022	12:47	MS, RL	re	bewölkt	mittel	FRP	1	Sichtung, Ruf	ufer	flach	4	80	Wa	40	20	25	15			15	25						
MS160	4	20	*47.430233*	*10.598353*	16.06.2022	12:49	MS, RL	re	bewölkt	mittel	FRP	2	Sichtung, Ruf	Ufer	flach	40	25	Wa	35	10	30	25	5	5	10	15					R	
MS162	4	22	*47.430192*	*10.600703*	16.06.2022	13:06	MS, RL	re	bewölkt	mittel	FRP	1	Sichtung, Ruf	Ufer	flach	1	8	Ge	20	35	15	10	10	15	5	10					H	
MS163	4	23	*47.430487*	*10.603060*	16.06.2022	13:15	MS, RL	re	heiter	mittel	FRP	2	Sichtung	F+A140:S 146lug, Ufer		15	Ge	20	5	25	25			10	40			H		Uferbereich, im Kies	
MS164	4	24	*47.431343*	*10.610492*	16.06.2022	13:36	MS, RL	re	bewölkt	mittel	FUL	2	Sichtung	Insel	flach	2	10	Ge	50	10	30	30	10	10	5	5					H	
MS165	4	25	*47.431777*	*10.611283*	16.06.2022	13:45	MS, RL	li	heiter	mittel	FRP	1	Sichtung	Halbinsel	flach	6	7	Ge	60	30	20	15	5	30		0					H	

MS166	4	26	*47.432463*	*10.617318*	16.06.2022	14:15	MS, RL	li	bewölkt		mittel	FRP	1		Ruf											100				
MS167	4	27	*47.431383*	*10.620778*	16.06.2022	14:26	MS, RL	re	bewölkt		mittel	FUL	1		Sichtung	Ufer	flach	1	20	Wa	65	35	5	5	30	5	15	5				A
MS168	4	28	*47.432720*	*10.626758*	16.06.2022	14:47	MS, RL	re	bewölkt		mittel	FUL	1		Sichtung	Ufer	geneigt	1	10	Ge	35	10	30	25	5	5	10	15				H
MS169	4	29	*47.434927*	*10.632052*	16.06.2022	15:04	MS, RL	re	bewölkt		mittel	FRP	2		Sichtung	Ufer	flach	30	70	Ge	45	10	20	35	5		10	20				P
MS170	4	30	*47.451877*	*10.667130*	16.06.2022	16:12	MS, RL	mi	bewölkt		mittel	FRP	2		Sichtung	Insel	flach	5	50	Gebüsch	37	5	35	30		5	15	10				P
MS171	4	31	*47.453800*	*10.669952*	16.06.2022	16:24	MS, RL	re	bewölkt		mittel	FUL	1		Sichtung, Ruf	Flug										100				
MS173	4	33	*47.461453*	*10.679746*	16.06.2022	16:35	MS, RL	re	bewölkt		mittel	FUL	1		Sichtung	Ufer	flach	0.5	10	Ge	18	5	40	15		5	15	20	Straße	Querverbauung		H
MS174	4	34	*47.462583*	*10.680742*	16.06.2022	16:41	MS, RL	mi	bewölkt		mittel	FUL	2		Sichtung	Insel	flach	0.5	6	Ge	50	30	15	10		20	5	20		Querverbauung		H
MS180	5	1	*47.531478*	*10.684973*	28.06.2022	10:04	MS	re	bewölkt		niedrig/mittel	FUL	1		Sichtung, Ruf	Ufer	flach	2	25	Wald	15		45	20	5	5	5	20	Mensch			A
MS181	5	2	*47.537508*	*10.673808*	28.06.2022	10:34	MS	li	bewölkt		niedrig/mittel	FUL	2	2	Sichtung, Ruf	Ufer	geneigt	5	1	Wald	20	5	30	20	10	30	5	0				A
MS182	5	3	*47.541252*	*10.668563*	28.06.2022	10:54	MS	li	bewölkt		niedrig/mittel	FUL	1		Sichtung, Ruf	Ufer	geneigt	2	8	Gebüsch	35		25	30	10	10	5	20				H
MS183	5	4	*47.543008*	*10.666448*	28.06.2022	11:05	MS	re	bewölkt		niedrig/mittel	FUL	2		Sichtung, Ruf	Ufer	flach	15	3	Gebüsch	15	5	50	10	10	15		10				P
MS184	5	5	*47.553698*	*10.663823*	28.06.2022	11:37	MS	re	bewölkt		niedrig/mittel	FRP	1		Sichtung, Ruf	Ufer	flach	1	40	Gebüsch	35	30	30	10			5	25				H, S
MS186	5	7	*47.556627*	*10.675508*	28.06.2022	12:07	MS	mi	bewölkt		mittel	FUL	1		Sichtung	Insel	flach	2	20	Gebüsch	85	20	35			20		25	MiMö			
MS187	5	8	*47.557020*	*10.675842*	28.06.2022	12:10	MS	mi	bewölkt		mittel	FUL	1		Sichtung, Ruf	Insel	geneigt	0.5	1	Gebüsch	85	20	10		5	40		25	MiMö			A
MS188	5	9	*47.556908*	*10.675508*	28.06.2022	12:12	MS	mi	bewölkt		mittel	FRP	1		Sichtung	Insel	flach	1	15	Gebüsch	85	20	45	5		15		15	MiMö			
MS189	5	10	*47.556570*	*10.675592*	28.06.2022	12:18	MS	re	bewölkt		mittel	FRP	1		Sichtung, Ruf	Ufer	flach	1	7	Gebüsch	85		35	10		30		25	MiMö			A

MS190	5	11	*-31.333333*	*-6.666667*	28.06.2022	12:00	MS	li	bewölkt	mittel	FUL	2		Scihtung, Ruf	Ufer	flach	1	5	Gebüsch	35	10	25	5	20	15	5	20				A
MS191	5	1	*47.272582*	*10.410862*	29.06.2022	06:11	MS	mi	bewölkt	niedrig/ mittel	FUL	1	1	Sichtung, Ruf	Insel	geneigt	1	0.5	Wald	20	10	10	15	10	35	5	15				A, FL
MS192	5	2	*47.274443*	*10.412758*	29.06.2022	06:20	MS	li	bewölkt	mittel	FUL	2		Sichtung, Ruf	ufer	flach	1.5	2	Gebüsch	30	5	20	35	10	15		15				P
MS193	5	3	*47.281468*	*10.419850*	29.06.2022	06:45	MS		bewölkt	mittel	FUL	1		Sichtung	Ufer	flach	1	6	Gebüsch	22	10	15	35	10	15		15				H
MS194	5	4	*47.296870*	*10.469217*	29.06.2022	08:43	MS	li	bewölkt	mittel	FUL	1		Ruf	Ufer	flach	2	5	Gebüsch	15		10	45	5	25		15				S
MS195	5	5	*47.312928*	*10.497157*	29.06.2022	09:41	MS	re	bewölkt	mittel	FUL	1		Sichtung	Halbinsel	flach	1	10	Gebüsch	15	5	20	40	5	10		20				H
MS196	5	6	*47.315288*	*10.500257*	29.06.2022	10:06	MS	re	bewölkt	mittel	FUL	1		Ruf	Ufer	flach	0.5	0.5	Gebüsch	45	30	5	15	10	40	5	-5				S
MS197	5	7	*47.322373*	*10.516693*	29.06.2022	10:51	MS	re	bewölkt	mittel	FUL	1	1	Sichtung, Ruf	Ufer	geneigt	1	40	Wald	25	10	10	25	15	20	5	15		RK		N, A, FL
MS198	5	8	*47.328340*	*10.523923*	29.06.2022	11:13	MS	re	heiter	mittel	FUL	2	2	Sichtung, Ruf	Ufer	geneigt	1	0.5	Gebüsch	35	5	15	25	10	35	5	5		MB		N, A, FL
MS199	5	9	*47.331058*	*10.527097*	29.06.2022	11:25	MS	re	heiter	mittel	FUL	2		Sichtung	Insel	flach	3	17	Gebüsch	15		25	40	5	10	5	15				H
MS200	5	10	*47.340932*	*10.536783*	29.06.2022	11:56	MS	mi	heiter	mittel	FUL	1		Sichtung, Ruf	Insel	flach	5	4	Gebüsch	40		5	40	5	25	10	15				S
MS201	5	11	*47.353763*	*10.546597*	29.06.2022	12:38	MS	mi	heiter	mittel	FUL	2		Sichtung, Ruf	Insel	geneigt	2	0.5	Gebüsch	35	5	5	15	15	30	10	20				P, A
MS203	5	1	*47.393603*	*10.565057*	30.06.2022	05:54	MS	li	heiter	mittel	FUL	1		Sichtung	Ufer	flach	0.5	4	Wald		10	15	30	10	15		20				H
MS204	5	2	*47.398792*	*10.569142*	30.06.2022	06:11	MS	li	heiter	mittel	FUL	1		Sichtung, Ruf	Insel	flach	0.5	10	Gebüsch	20	5	30	25	10	10		20				S
MS205	5	3	*47.401632*	*10.574462*	30.06.2022	06:22	MS	re	heiter	mittel	FUL	2	1	Sichtung, Ruf	Halbinsel	flach	3	2	Gebüsch	10	20	20	10	10	15		25				A, FL
MS206	5	4	*47.404820*	*10.575742*	30.06.2022	06:34	MS	mi	heiter	mittel	FRP	1		Sichtung, Ruf	Insel	flach	2	35	Gebüsch	15	15	25	20			20	20				H
MS207	5	5	*47.406670*	*10.578487*	30.06.2022	06:43	MS	re	heiter	mittel	FUL	2		Sichtung, Ruf	Ufer	geneigt	0.5	0.5	Gebüsch	25	5	10	10	20	35		20				A

MS208	5	6	*47.408332*	*10.577832*	30.06.2022	06:49	MS	mi	heiter	mittel	FRP	1		Sichtung, Ruf	Insel	flach	2	70	Gebüsch	40	10	25	35	5		10	15		A, DD
MS209	5	7	*47.408838*	*10.577748*	30.06.2022	06:54	MS	mi	heiter	mittel	FUL	1		Sichtung	Insel	geneigt	2	65	Gebüsch	30	5	30	30			10	25		
MS210	5	8	*47.409175*	*10.580082*	30.06.2022	07:00	MS	re	heiter	mittel	FRP	1		Sichtung, Ruf	Ufer	geneigt	1	15	Wald	20	5	15	35	5	10	10	20		H
MS211	5	9	*47.415830*	*10.579703*	30.06.2022	07:20	MS	li	heiter	mittel	FUL	1		Ruf	Ufer	flach	4	40	Wald	35	5	15	40			10	30		S
MS212	5	10	*47.418032*	*10.578372*	30.06.2022	07:29	MS	mi	heiter	mittel	FRP	1		Ruf	Insel	flach	3	70	Gebüsch	50	10	30	35			10	15		
MS213	5	11	*47.423475*	*10.580053*	30.06.2022	07:43	MS	re	heiter	mittel	FUL	1		Sichtung	Ufer	flach	0.5	35	Gebüsch	40		30	35			20	15		H
MS214	5	12	*47.428132*	*10.585370*	30.06.2022	08:06	MS	li	wolkenlos	mittel	FUL	1		Sichtung	Ufer	geneigt	2	5	Gebüsch	30		30	30	15	20		5		H
MS215	5	13	*47.430238*	*10.589998*	30.06.2022	08:23	MS	mi	wolkenlos	mittel	FRP	1	3	Sichtung, Ruf	Insel	geneigt	4	45	Wald	10	40	20	5		10		25		A
MS216	5	14	*47.431005*	*10.597283*	30.06.2022	08:37	MS	mi	wolkenlos	mittel	FUL	1		Sichtung, Ruf	Insel	geneigt	1	100	Wald	40		35	30			10	25		S
MS217	5	15	*47.431397*	*10.596362*	30.06.2022	08:38	MS	mi	wolkenlos	mittel	FRP	1		Sichtung, Ruf	Insel	flach	1	90	Wald	35	15	30	25			10	20		S
MS218	5	16	*47.430123*	*10.600273*	30.06.2022	08:47	MS	re	wolkenlos	mittel	FRP	1		Sichtung, Ruf	Halbinsel	flach	0.5	5	Gebüsch	10	45	5	10	10	5	5	20		
MS219	5	17	*47.431632*	*10.611305*	30.06.2022	09:07	MS	mi	wolkenlos	mittel	FUL	1		Sichtung	Insel	flach	2	1	Gebüsch	45	40	5		10	30	5	10		H
MS220	5	18	*47.431688*	*10.610890*	30.06.2022	09:12	MS	mi	wolkenlos	mittel	FRP	1		Sichtung	Insel	flach	3	6	Gebüsch	45	55	5	5	10	15	5	5		
MS221	5	19	*47.431743*	*10.620697*	30.06.2022	09:28	MS	re	wolkenlos	mittel	FUL	1		Ruf	Ufer	flach	1	10	Wald	50	20	5	5	40		15	15		H
MS222	5	20	*47.432970*	*10.625885*	30.06.2022	09:43	MS	mi	wolkenlos	mittel	FUL	1		Sichtung	Insel	flach	0.5	35	Gebüsch	30		20	45			10	25		H
MS223	5	21	*47.434975*	*10.633783*	30.06.2022	10:01	MS	re	wolkenlos	mittel	FRP	2		Sichtung, Ruf	Ufer	flach	5	40	Gebüsch	5	30	25	15			10	20		P
MS224	5	22	*47.441452*	*10.648715*	30.06.2022	10:29	MS	re	wolkenlos	mittel	FUL	1		Sichtung, Ruf	Insel	flach	0.5	15	Wald	40		30	40		10	5	15		

MS225	5	23	*47.442108*	*10.655012*	30.06.2022	10:39	MS	re	wolkenlos	mittel	FUL	2		Sichtung, Ruf	Ufer	genei gt	5	0	Gebüsc h	35	30	5	5		45		15					A
MS226	5	24	*47.464942*	*10.683923*	30.06.2022	11:37	MS	li	wolkenlos	mittel	FUL	2		Sichtung, Ruf	Ufer	genei gt	0.5	4	Gebüsc h	35	5	30	20	5	20	10	0	10 Fels				P
MS227	5	25	*47.502977*	*10.707767*	30.06.2022	12:41	MS	li	wolkenlos, windig	niedrig	FRP	1		Sichtung, Ruf	Ufer	genei gt	5	35	Wald	25	5	40	35			5	15					H
MS228	5	26	*47.506673*	*10.712018*	30.06.2022	13:29	MS	re	wolkenlos, windig	niedrig	FRP	1	1	Sichtung, Ruf	Halbinsel	flach	4	7	Gebüsc h	5	40	25	5	10		10	10					A, FL
MS229	5	27	*47.507012*	*10.710937*	30.06.2022	13:32	MS	li	wolkenlos, windig	niedrig	FUL	1		Sichtung, Ruf	Ufer	genei gt	1	20	Wald	30		10	25	30	10	10	15					
MS231	5	1	*47.414140*	*10.578832*	01.07.2022	06:10	MS	li	bewölkt, Regen	niedrig	FUL	1		Sichtung, Ruf	Halbinsel	genei gt	1	45	Wald	5	5	20	25	30		5	15					S
MS232	5	2	*47.406243*	*10.576113*	01.07.2022	06:26	MS	li	bewölkt	niedrig	FUL	1		Sichtung, Ruf	Ufer	genei gt	1	2	Wald	5	5	30	20	5	25		15					H
MS233	5	3	*47.404488*	*10.575072*	01.07.2022	06:34	MS	li	bewölkt	niedrig	FRP	1		Sichtung, Ruf	Ufer	flach	2	30	Gebüsc h	45	45	15	10	5		10	15					
MS234	5	4	*47.404432*	*10.575737*	01.07.2022	06:36	MS	li	bewölkt	niedrig	FUL	2		Sichtung, Ruf	Insel	flach	1	45	Wald	40	5	55	15	5		5	15					
MS235	5	5	*47.462012*	*10.680255*	01.07.2022	07:54	MS	re	bewölkt, Regen	niedrig	FUL	1		Sichtung, Ruf	Halbinsel	flach	1	5	Gebüsc h	35	45	15	5		20	5	10					S
MS236	5	6	*47.463083*	*10.681337*	01.07.2022	07:56	MS	re	bewölkt, Regen	niedrig	FUL	2		Sichtung, Ruf	Ufer	genei gt	1	6	Gebüsc h	40	15	35	10		20	5	15					P
MS237	6	1	*47.272833*	*10.411502*	11.07.2022	06:01	MS	mi	wolkenlos	niedrig	FUL	1		Ruf	Ufer	genei gt	10	0	Wald	20	5	5	20	10	30		30					
MS238	6	2	*47.281912*	*10.422565*	11.07.2022	06:30	MS	re	wolkenlos	niedrig	FUL	1		Ruf	Ufer	genei gt	1	5	Gebüsc h	20		10	35	5	15		35					
MS239	6	3	*47.305783*	*10.492437*	11.07.2022	08:39	MS	mi	wolkenlos	niedrig	FUL	1		Sichtung, Ruf	Ufer	flach	2	5	Gebüsc h	35		5	50	10	15		20					
MS240	6	4	*47.313288*	*10.497487*	11.07.2022	08:56	MS	re	wolkenlos	niedrig	FUL		1	Sichtung	Ufer	genei gt	0.5	8	Gebüsc h	7		20	35		15		30					FL
MS241	6	5	*47.315257*	*10.499453*	11.07.2022	09:01	MS	mi	wolkenlos	niedrig	FUL	1		Sichtung, Ruf	Insel	flach	0.5	7	Gebüsc h	35		15	40		10	5	30					
MS242	6	6	*47.323267*	*10.517962*	11.07.2022	09:34	MS	li	wolkenlos	niedrig	FUL	2		Sichtung, Ruf	Ufer	flach	1	9	Gebüsc h	20		25	35	10	10		20					H

MS243	6	7	*47.329753*	*10.526027*	11.07.2022	09:58	MS	re	wokenlos	niedrig	FUL	2		Sichtung	Ufer, Flug	genei gt	0.5	0.5	Gebüsch	30	20	5	15	15	30	5	10					
MS244	6	8	*47.338457*	*10.535462*	11.07.2022	10:26	MS	li	wolkenlos	niedrig	FUL	1		Sichtung, Ruf	Ufer	flach	0.5	20	Gebüsch	15	5	30	30	5	10	5	15					
MS245	6	9	*47.342280*	*10.538367*	11.07.2022	10:38	MS	re	wolkenlos	niedrig	FUL	1	2	Sichtung, Ruf	Ufer	genei gt	0.5	1	Gebüsch	15	15	10	15	10	25	5	20			A, FL		
MS246	6	10	*47.353173*	*10.546358*	11.07.2022	11:00	MS	li	wolkenlos, windig	niedrig	FUL	1		Sichtung	Flug		1	10	Gebüsch	15		30	40		20	5	5					
MS247	6	11	*47.373898*	*10.551038*	11.07.2022	11:36	MS	re	wolkenlos, windig	niedrig	FUL	2		Sichtung, Ruf	Ufer	genei gt	0.5	3	Gebüsch	25		5	10	30	30	5	20					
MS248	6	1	*47.383388*	*10.564603*	14.07.2022	06:20	MS	li	bewölkt	niedrig	FUL	1		Sichtung, Ruf	Ufer	flach	3	5	Wald	40	5	15	30	10	5	10	25	Mensch, Hund				
MS249	6	2	*47.399312*	*10.570153*	14.07.2022	06:34	MS	li	bewölkt	niedrig	FRP	1		Sichtung, Ruf	Ufer	flach	5	5	Wald		10	35	20	5	5	10	15					
MS250	6	3	*47.401188*	*10.573785*	14.07.2022	06:43	MS	re	bewölkt	niedrig	FUL	2	2	Sichtung, Ruf	Halbinsel	flach	6	2	Gebüsch	7	5	15	35	5	15	5	20			A, FL		
MS251	6	4	*47.402982*	*10.574627*	14.07.2022	06:48	MS	mi	bewölkt	niedrig	FUL		1	Sichtung, Ruf	Insel	genei gt	0.5	30	Gebüsch	25	5	10	40	5		10	30			FL		
MS252	6	5	*47.407018*	*10.578457*	14.07.2022	06:59	MS	re	bewölkt	niedrig	FUL	1		Sichtung, Ruf	Ufer	flach	4	0	Gebüsch	3	5	20	25	5	30	10	5			A		
MS253	6	6	*47.408197*	*10.577703*	14.07.2022	07:04	MS	re	bewölkt	niedrig	FRP	1	1	Sichtung, Ruf	Ufer	flach	1	80	Gebüsch	25	15	25	25	5		10	20			A, FL		
MS254	6	7	*47.411583*	*10.578535*	14.07.2022	07:16	MS	li	bewölkt	niedrig	FUL	1		Ruf	Ufer	flach	4	1	Gebüsch	25		35	30	10	15	5	5					
MS255	6	8	*47.418102*	*10.579547*	14.07.2022	07:32	MS	re	bewölkt	niedrig	FRP	1		Ruf	Halbinsel	genei gt	30	45	Wald	15	30	15	15			10	30					
MS256	6	9	*47.420023*	*10.578303*	14.07.2022	07:36	MS	li	heiter	niedrig	FUL	1		Ruf	Ufer	flach	5	7	Gebüsch	25		30	30	5	10		25					BaSt, GeSt
MS257	6	10	*47.420747*	*10.579033*	14.07.2022	07:41	MS	re	heiter	niedrig	FRP	1		Sichtung, Ruf	Insel	flach	1	45	Wald	40		40	20			15	25					BaSt
MS258	6	11	*47.427400*	*10.585550*	14.07.2022	07:58	MS	re	bewölkt	niedrig	FUL	1		Sichtung	Ufer	genei gt	1	25	Wald	20		45	35			5	15					BaSt (JT)
MS259	6	12	*47.430522*	*10.590937*	14.07.2022	08:09	MS	mi	heiter	niedrig	FRP	1	2	Sichtung, Ruf	Insel	flach	4	60	Wald	25	15	35	15	5		5	25			A, FL		BaSt, WaAm

MS260	6	13	*47.430873*	*10.596893*	14.07.2022	08:19	MS	re	heiter	niedrig	FRP	1		Sichtung, Ruf	Ufer	flach	25	60	Wald	20	30	20	10	5		20	15					
MS261	6	14	*47.430163*	*10.599963*	14.07.2022	08:25	MS	re	heiter	niedrig	FRP	1		Ruf	Ufer	flach	4	35	Wald	4	30	25	15			10	20					BaSt, GeSt
MS262	6	15	*47.431180*	*10.607818*	14.07.2022	08:37	MS	re	bewölkt	niedrig	FUL	2		Sichtung, Ruf	Ufer	geneigt	0	30	Gebüsch	10	5	35	15	5		10	30					BaSt
MS263	6	16	*47.430998*	*10.609582*	14.07.2022	08:40	MS	mi	bewölkt	niedrig	FUL	1		Sichtung	Insel	flach	0	10	Gebüsch	30		45	20		25	5	5					
MS264	6	17	*47.431738*	*10.611288*	14.07.2022	08:46	MS	mi	bewölkt	niedrig	FRP	1		Sichtung	Halbinsel	flach	20	5		30	30	25	5	20		10	10					BaSt
MS265	6	18	*47.431738*	*10.611538*	14.07.2022	08:47	MS	mi	bewölkt	niedrig	FUL	1		Sichtung	Halbinsel	flach	0	1	Gebüsch	30	40	10		15	30	5	0					BaSt
MS266	6	19	*47.431928*	*10.618423*	14.07.2022	09:01	MS	re	heiter	niedrig	FRP	1		Sichtung	Insel	flach	0	65	Wald	35	5	60	10			5	20					BaSt
MS267	6	20	*47.434272*	*10.629283*	14.07.2022	09:18	MS	mi	heiter	niedrig	FRP	2		Sichtung	Insel	flach	1	17	Wald	35		35	30	10	5	5	15			D?		
MS268	6	21	*47.449842*	*10.664805*	14.07.2022	10:31	MS	mi	wolkenlos, windig	niedrig	FRP	2	1	Sichtung	Insel	flach	50	80	Gebüsch	35	20	25	15	5		10	25		Rabenkrähe	A		
MS269	6	22	*47.450590*	*10.665120*	14.07.2022	10:34	MS	mi	wolkenlos, windig	niedrig	FRP	1		Sichtung	Insel	geneigt	0	50	Gebüsch	35	30	25	15			10	20					
MS270	6	23	*47.462063*	*10.679380*	14.07.2022	11:02	MS	re	wolkenlos, windig	niedrig	FUL	2		Sichtung	Halbinsel	flach	0	6	Gebüsch	35	40	15	10		25	5	5					
MS271	6	24	*47.462738*	*10.680960*	14.07.2022	11:10	MS	re	wolkenlos, windig	niedrig	FUL	2		Sichtung, Ruf	Insel	flach	0	10	Gebüsch	35	5	40	15		10	5	25					
MS273	6	26	*47.506408*	*10.712207*	14.07.2022	12:53	MS	re	wolkenlos, windig	niedrig	FRP	1	1	Sichtung, Ruf	Insel	flach	10	20	Wald	5	60	15				15	10			A, FL		
MS274	6	27	*47.506633*	*10.710958*	14.07.2022	13:05	MS	li	wolkenlos, windig	niedrig	FUL	1		Sichtung, Ruf	Ufer	steil	1	10	Wald	25		5	20	40	15	5	15					
MS275	6	1	*47.535090*	*10.678268*	15.07.2022	07:13	MS	li	bewölkt	niedrig	FUL		1	Sichtung, Ruf	Ufer	geneigt	0	3	Gebüsch	20	10	5	10	25	25	10	15			FL		
MS276	6	2	*47.542765*	*10.666938*	15.07.2022	07:38	MS	re	heiter	niedrig	FUL	2		Sichtung	Ufer	flach	30	5	Gebüsch	15	15	35	10	20	10		10					
MS277	6	3	*47.553428*	*10.663730*	15.07.2022	08:04	MS	re	bewölkt	niedrig	FRP	1		Sichtung, Ruf	Ufer	flach	5	40	Wald	35	30	35	10			5	20					

MS278	6	4	*47.556197*	*10.671962*	15.07.2022	08:18	MS	mi	bewölkt	niedrig	FUL	1	1	Sichtung, Ruf	Halbinsel	flach	1	40	Wald	25		45	30			5	20			A	BaSt
MS279	6	5	*47.556270*	*10.673540*	15.07.2022	08:22	MS	re	bewölkt	niedrig	FUL	2	3	Sichtung, Ruf	Ufer	geneigt	0	5	Wald	85	10	15	20		35	5	15				StEn
MS280	6	6	*47.556372*	*10.677337*	15.07.2022	08:41	MS	mi	bewölkt	niedrig	FUL	1		Ruf	Insel	geneigt	1	0	Gebüsch	10	5	5	5	20	45	5	15				
MS281	6	7	*47.555717*	*10.669690*	15.07.2022	08:59	MS	li	bewölkt	niedrig	FRP	1		Ruf	Halbinsel	flach	1	20	Gebüsch	20		40	30	5		5	20				GeSt
MS282	7	1	*47.398002*	*10.569523*	25.07.2022	06:43	MS	re	wolkenlos	niedrig	FUL		1	Sichtung	Ufer	flach	0	40	Wald	25		5	60			10	25			FL	BaSt
MS283	7	2	*47.402623*	*10.575073*	25.07.2022	06:54	MS	re	wolkenlos	niedrig	FUL	1		Sichtung, Ruf	Ufer	flach	3	10	Wald	20		20	40		10		30				
MS284	7	3	*47.406023*	*10.577483*	25.07.2022	07:00	MS	re	wolkenlos	niedrig	FRP	1		Sichtung	Insel	flach	1	40	Gebüsch	10	15	30	15			10	30				WaAm
MS285	7	4	*47.405092*	*10.577393*	25.07.2022	07:05	MS	re	wolkenlos	niedrig	FUL	1		Ruf	Insel	flach	0	5	Gebüsch	10	25	10	20		15	10	20				
MS286	7	5	*47.408708*	*10.577982*	25.07.2022	07:14	MS	re	wolkenlos	niedrig	FRP	1		Sichtung, Ruf	Ufer	flach	30	100	Gebüsch	15	15	20	35			5	25			A	BaSt
MS287	7	6	*47.410225*	*10.578793*	25.07.2022	07:22	MS	mi	wolkenlos	niedrig	FUL	1		Sichtung	Insel	geneigt	0	25	Gebüsch	22		25	35	5	5	10	20				
MS288	7	7	*47.413590*	*10.580697*	25.07.2022	07:34	MS	re	wolkenlos	niedrig	FUL	1		Sichtung	Ufer	steil	0	1	Wald	30			10	10	40		20	20 Fels			
MS289	7	8	*47.421278*	*10.578477*	25.07.2022	07:50	MS	mi	wolkenlos	niedrig	FRP		1	Sichtung	Insel	flach	0	85	Wald	25	5	20	35			10	30				WaAm
MS290	7	9	*47.429567*	*10.590872*	25.07.2022	08:22	MS	re	wolkenlos	niedrig	FUL	1		Sichtung	Ufer	flach	0	25	Wald	23	5	25	30	5	5	15	15				
MS291	7	10	*47.431275*	*10.597268*	25.07.2022	08:32	MS	mi	wolkenlos	niedrig	FRP	1		Sichtung	Insel	flach	1	95	Wald	15	5	40	20			5	30				
MS292	7	11	*47.430862*	*10.598082*	25.07.2022	08:36	MS	re	wolkenlos	niedrig	FRP	1		Sichtung	Ufer	flach	25	80	Gebüsch	10	15	30	30			15	10				
MS293	7	12	*47.430267*	*10.599652*	25.07.2022	08:38	MS	re	wolkenlos	niedrig	FRP	2		Sichtung, Ruf	Ufer	flach	80	15	Gebüsch	10	10	35	20	5		15	15			R, A	BaSt
MS294	7	13	*47.434075*	*10.632267*	25.07.2022	09:28	MS	re	wolkenlos	niedrig	FRP	1		Ruf	Ufer	flach	70	40	Gebüsch	27	5	40	30	5		10	10				

MS295	7	14	*47.451140*	*10.666838*	25.07.2022	10:49	MS	mi	wolkenlos, windig	niedrig	FUL	1		Sichtung	Insel	flach	20	70	Wald	25	10	45	30			5	10			Rabenkräh e		BaSt
MS297	7	16	*47.461615*	*10.679845*	25.07.2022	11:20	MS	re	wolkenlos, windig	mittel	FUL	1		Sichtung	Insel	flach	0.5	7	Gebüsch	40	15	35	25		15	5	5	Straße		Querverb auung	H	
MS298	7	17	*47.462211*	*10.680725*	25.07.2022	11:23	MS	mi	wolkenlos, windig	mittel	FUL	2		Sichtung	Insel	flach	0.5	3	Gebüsch	42	35	10	10		20	5	20			Querverb auung	P	
MS299	7	18	*47.486753*	*10.708822*	25.07.2022	12:47	MS	li	wolkenlos	niedrig	FRP	1		Sichtung, Ruf	Ufer	flach	40	20	Wald		5	60	15			5	15			Rabenkräh e		
MS300	7	1	*47.297768*	*10.460763*	26.07.2022	09:49	MS	re	Regen	hoch	FUL	1		Sichtung	Ufer	flach	1	3	Gebüsch		20	25	5	35	5	10					
MS301	7	2	*47.314340*	*10.498632*	26.07.2022	11:25	MS	re	bewölkt	hoch	FUL	1		Sichtung, Ruf	Ufer	geneigt	0	10	Gebüsch	10	15	20	20	10		25				im Kies	
MS302	7	3	*47.331082*	*10.528342*	26.07.2022	12:25	MS	re	bewölkt	hoch	FUL	2		Sichtung, Ruf	Halbinsel	flach	2	10	Gebüsch	20		20	45	5	10		20				
MS303	7	4	*47.345937*	*10.540717*	26.07.2022	12:56	MS	li	Regen	hoch	FUL	1		Sichtung	Halbinsel	flach	1	12	Wald		5	30	35	5	10	5	10				BaSt 2
MS304	7	5	*47.353007*	*10.546330*	26.07.2022	13:14	MS	li	Regen	hoch	FUL	2		Sichtung, Ruf	Halbinsel	flach	2	25	Gebüsch	30		15	45			10	30				
MS305	7	1	*47.537573*	*10.673262*	27.07.2022	07:43	MS	li	bewölkt	niedrig	FUL	2		Sichtung, Ruf	Ufer	geneigt	1	10	Wald	17	5	45	20		10	5	15			A aber keine Jungtiere		
MS306	7	2	*47.543418*	*10.665168*	27.07.2022	08:15	MS	li	bewölkt	niedrig	FUL	1		Sichtung, Ruf	Ufer	geneigt	0	15	Gebüsch	14		50	30	0	5	5	10					BaSt
MS307	7	3	*47.556178*	*10.673058*	27.07.2022	08:42	MS	mi	bewölkt	niedrig	FUL	1		Ruf	Halbinsel	flach	5	80	Gebüsch	100	5	70	10				15					BaSt
MS308	7	4	*47.556323*	*10.675902*	27.07.2022	08:49	MS	mi	bewölkt	niedrig	FUL	2	2	Sichtung	Insel	flach	0	20	Gebüsch	90	20	55	10		5		10					