IUCN RED LIST

THE STATUS AND DISTRIBUTION OF FRESHWATER BIODIVERSITY IN THE EASTERN MEDITERRANEAN

Kevin G. Smith, Violeta Barrios, William R.T. Darwall, and Catherine Numa (Editors)

EASTERN MEDITERRANEAN

The IUCN Red List of Threatened Species™

SSC Species Survival Commission

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For improved readability the names of countries have been shortened as below:
The Republic of Armenia as Armenia, the Republic of Azerbaijan as Azerbaijan, the Republic of Iraq as Iraq, the Islamic Republic of Iran as Iran, the State of Israel as Israel, Hashemite Kingdom of Jordan is referred to as Jordan, the Lebanese Republic as Lebanon, the State of Palestine as Palestine, the Syrian Arab Republic as Syria, and the Republic of Turkey as Turkey.

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Cover photo: Azraq Wetland in Jordan dried up in 1992 and the endemic fish *Aphanius sirhani* had to be rescued and bred in captivity. Now the wetlands are partially restored, though they rely upon pumped water, and *Aphanius sirhani* has been successfully re-introduced. © Kevin Smith

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If you have any questions regarding the data and outputs presented in this report, please contact the IUCN Freshwater Biodiversity Unit (Freshwater.Biodiversity @iucn.org).

Contents

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All of IUCN's Red List assessment projects rely on the willingness of scientists who are often, but not always, members of the IUCN Species Survival Commission, to pool and contribute their collective knowledge to make the most reliable estimates of a species' conservation status. Without their enthusiastic commitment to species conservation, this kind of assessment project would not be possible. Those scientists are the authors of the various chapters in this report, the contributors to the IUCN Red List species assessments that have been completed through this project and earlier projects, and the experts who provided their time and expertise to review species assessments.

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Executive summary and key messages

In 2003, the former United Nations Secretary General Boutros Boutros Ghali stated that '*water will be more important than oil this century*'[1]. He was referring to the increasing strain being put on water resources in the Middle East and how this may lead to human conflict in the region. While this fear has not yet been realized, it is widely understood to be a real and increasing risk, not just to the Eastern Mediterranean region but to other parts of the world which are also facing major water shortages now and in the future. One aspect of this water crisis that is often overlooked is the impact upon biodiversity that also needs water to survive. This is not setting up a dichotomy between human and biodiversity needs as is often assumed. The availability and quality of water for human use is a service provided by functioning 'healthy' ecosystems and hence biodiversity[2]. Healthy freshwater ecosystems ('natural infrastructure') that support biodiversity not only provide, store, and purify water, but they also provide many other valuable ecosystem services that people rely upon (e.g. food, flood protection, recreation etc.). However, as in many parts of the world, biodiversity needs are rarely incorporated into the decision-making processes governing water resources in the Eastern Mediterranean region which are largely focused upon the provision of water for human needs (primarily for irrigation) and for energy production. The Convention on Biological Diversity (CBD) has stated that it is becoming increasingly critical that policies and management are better informed about how the hydrological cycle functions, and the role of ecosystems and biodiversity in sustaining it[2].

This IUCN report and accompanying dataset on the status and distribution of freshwater biodiversity in the Eastern Mediterranean, and the associated report and data on the Freshwater Key Biodiversity Areas in the wider Mediterranean Basin[3] represent major advances in provision of information to help incorporate biodiversity needs into water development planning processes within an Integrated River Basin Management framework, and also, we hope in raising the profile of freshwater biodiversity. This work represents the most comprehensive assessment yet of freshwater biodiversity at the species level for this part of the world. In addition to informing development decision making, the information presented here is fundamental to meeting national obligations for protection and sustainable use of biodiversity under the Convention on Biological Diversity; the Ramsar Convention; and the Millennium Development Goals (MDGs). Information on species status is particularly important for Targets 11 and 12 of the CBD that state: '*By 2020, at least 17 per cent of terrestrial and inland water areas, … especially areas of particular importance for biodiversity and ecosystem services, are conserved…*' and '*…by 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained*', respectively. The data provided and analysis presented here also provide an important contribution to help States implement the UN Watercourse Convention (UNWC), which came into force in August 2014, and aims to protect and maintain watercourses in their natural state.

The Eastern Mediterranean region supports just over 4.4% of the global human population, yet contains only 1.1% of its renewable water resources[4]. Water withdrawal in the region, primarily for irrigation purposes, is largely unsustainable and has led to a continuing reduction of ground waters at an alarming rate[5]. There is also considerable dam development across the region, primarily in Turkey, and pollution from agricultural and domestic sources. Climate change is leading to an increase in mean annual temperatures, and frequency of extremely hot summer days along with decreasing precipitation[6]. The resulting impacts from these compounding threats has been the reduction and alteration of flows in freshwater systems across the region, and in some cases the total loss of a number of water bodies (e.g. Lake Amik in Turkey, and Azraq Oasis in Jordan) and the seasonal drying out of once permanent rivers (e.g. Qweik River in Turkey and Syria). As a major contribution towards the provision of information on the region's freshwater species, IUCN's Global Species Programme, in collaboration with its partners, conducted an assessment of the status (according to the IUCN Red List of Threatened Species™) and distribution of all described species of freshwater fishes, molluscs, odonates, and plants from across the Eastern Mediterranean. Existing information for species of freshwater dependent amphibians, birds, crustaceans, and mammals was also incorporated to present a more comprehensive overview of the status and distribution of freshwater species across the region. In total, information on 1,236 species has been included in this report. With species information compiled for each river or lake sub-basin, this volume represents a major advance in knowledge for informing development actions at a spatial scale appropriate for conservation management. The full dataset, including all species distribution files, will be made available through the IUCN Red List website (www.iucnredlist.org).

Nineteen per cent of all freshwater species assessed here are globally threatened. However, when only those species that are endemic to the region are considered (species which, if lost from the region, will become globally extinct) this level of threat rises to 58.2%. Six species, all fishes, are considered to have become globally Extinct (EX) and 18 species (seven fishes and 11 molluscs) are assessed as Critically Endangered Possibly Extinct – field surveys are urgently required to confirm whether these species are still extant. Major drivers of threat are identified as water abstraction and dams, pollution from agricultural and urban areas, habitat loss/conversion for agriculture, and over-harvesting. Habitats that contain the greatest proportion of threatened species are freshwater springs and seepages, and karst systems. Springs often act as refuges for species when rivers and lakes dry (either naturally, or due to excessive water extraction) but are themselves susceptible to groundwater extraction. The highest number of threatened species are found within six distinct areas within the region: the coastal Levant and Gulf of İskenderun catchments from the Orontes to the Litani and the Upper Hula basin and Lake Kinneret/Sea of Galilee, the wider Tigris and Euphrates lower plains including the Hawizah marshes up to the Diyala River in Iraq and lower Karoun in Iran, the Khabur River including the Ras al-Ain springs (Euphrates catchment) in northern Syria, the Lakes Region of Turkey (including the upper Büyük Menderes, the Köprü River, and Kırkgöz Springs), the lower Çoruh River and other Black Sea catchments in north-eastern Turkey, and the lower Aras/Kura River in Azerbaijan and southern Armenia. This distribution largely reflects the overall spatial distribution of recorded species richness and the parts of the region where our knowledge is most complete – other centres of richness and threat may also be detected as further information becomes available. The IUCN Red List is one of the most authoritative global standards supporting policy and action to conserve species. We hope this analysis, based in large part on an assessment of species' Red List status, will provide new information and insights that will motivate actions to help safeguard the diversity of life within the Eastern Mediterranean inland waters.

Key messages

- **High regional diversity of freshwater species.** Despite the relatively semi-arid and arid nature of large parts of the region, it supports a diverse set of freshwater species and habitats which provide a wide variety of ecosystem services, including water, food, and income. Of the 1,236 species of freshwater fish, mollusc, odonate (dragonfly and damselfly), freshwater plant, bird, amphibian, crustacean, and mammal, 368 species (29.8%) are endemic to the Eastern Mediterranean region (i.e. they are found nowhere else in the world).
- **Water stress and pollution has led to a high level of threat in freshwater biodiversity.** Freshwater biodiversity and habitats are under a great amount of stress caused by excessive water extraction, pollution, and dams which are all compounded by a drying climate. This has caused the loss of many permanent flowing rivers (which now intermittently run dry) and other wetlands such as marshes and lakes. This situation has led to 19.1% of freshwater biodiversity in the region being assessed as threatened and 58.2% of the region's endemic freshwater species assessed as threatened. Of the groups assessed for this project, freshwater molluscs and fishes were the highest threatened at 45.5% and 41% threatened respectively, followed by dragonflies and damselflies at 6.7% threatened, and freshwater plants at 2.5% threatened.
- **The role healthy ecosystems and biodiversity play in water provision needs recognition in policy.** The critical role ecosystems (and therefore biodiversity) play in the provision of water (quantity and quality) for human use and for biodiversity, needs to be recognized. Biodiversity requirements need to be built into the decision-making processes that govern water management.
- **An urgent need for Integrated River Basin Management.** Countries within the region need to adopt an Integrated River Basin Management approach (or similar strategy) to ensure that freshwater ecosystems can sustainably provide water, other ecosystem goods, and services in the long term while at the same time supporting biodiversity. This is especially the case for transboundary waters, where it is strongly recommended that the member states fully implement the principles of the UN Watercourse Convention (UNWC) and accept responsibility for protection of connected ecosystems beyond national boundaries.
- **Freshwater springs are a key habitat for freshwater biodiversity.** Permanent rivers and lakes support the greatest numbers of species and threatened species, however freshwater springs and karst systems have the greatest proportion of threatened species. Freshwater springs and seepages are a key habitat for many threatened species in the region as they often provide refuges during times of drought exacerbated by excessive water extraction.
- **Turkey, Israel, and Syria all have seen the greatest number of species extirpated from within their borders.** Turkey supports the greatest number of freshwater species, however it also has the highest number (and proportion) of threatened freshwater species in the region. It also has the greatest number of extirpated species (i.e. species lost from within its borders) with some species now globally extinct. Israel has the greatest proportion of extirpated species, followed by Syria and then Turkey.
- **There are high levels of species richness, and threatened species across the region.** The areas of the highest species richness are found along the Mediterranean coasts of the Levant and Turkey, the Sea of Mamara catchments, Black Sea coast of Turkey, and also within the Aras/Kura catchment in Georgia, Azerbaijan, and Armenia. The areas of the greatest number of threatened species are found in the lower Orontes/Asi catchment in Turkey, the lower and middle Tigris/Euphrates including the Hammar marshes, the Shatt al Arab River, Ras al-Ain spring area and outflowing Khabur/Khabour River (part of the Euphrates catchment) in northern Syria, and the lower Aras/Kura River in Azerbaijan.

- **Freshwater Key Biodiversity Areas can help guide conservation in the region.** There are a number of sites across the region of particular importance for the persistence of freshwater biodiversity. These sites, known as freshwater Key Biodiversity Areas are presented in the accompanying report *Freshwater Key Biodiversity Areas in the Mediterranean Basin Hotspot. Informing species conservation and development planning in freshwater ecosystems*[3].
- **There is an urgent need for collaborative field research and monitoring across the region.** There are very few freshwater biodiversity monitoring programmes in the region. If we are to halt the loss of freshwater biodiversity in this region, it is essential that field monitoring and research programmes are established using modern standardized protocols. This will allow changes in populations to be monitored and identification of species that will benefit from ex-situ conservation to help ensure that no more species become extinct. It is recommended that monitoring, field, and taxonomic research programmes are, where appropriate, undertaken through collaboration with international institutions to assist the region in capacity building.

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الملخص التنفيذي والرسائل الرئيسية

صرَّحَ الأمين العام للأمم المتحدة السابق بطرس بطرس غالي في عام ٢٠٠٣، " أنَّ في هذا القرن المياه ستغدو أكثر أهمية من النفط "[١]، حيث أشار إلى الضغوط المتنامية على مصادر المياه في الشرق الأوسط، التي قد تفضي إلى نزاعات بشرية في المنطقة. فبالرغم من عدم تحقق هذا الخوف بعد، لكن من المتعارف عليه في نطاق واسع انه قد يكون الخطر محدقاً ومتزايداً ليس في منطقة الشرق الأوسط فحسب، لكن في أجزاء أخرى من العالم التي تواجه نفس تحديات نقص المياه في الوقت الحالي والمستقبلي. وفي الغالب ما يتم تجاهل آثار نقص المياه على جوانب التنوع الأحيائي واحتياجاته من أجل البقاء. ليست الغاية هنا التفريق بين حاجة البشر وحاجة التنوع الأحيائي كما يفترض دائماً، لكن! توافر نوعية مياه صالحة للاستخدام البشري هي خدمة يقدمها النظام البيئي "المعافى (الصحي)" وبالتالي تنوع أحيائي[٢] "معافى (صحيّ)". إن النظم البيئية العَفِيَّة للمياه العذبة ("بنية تحتية طبيعية") لا تقتصر على تخزين وتنقية المياه ولكن هي تدعم بقاء التنوع الأحيائي أيضاً، كما تقدم النظم العفيّة (الصحية) العديد من الخدمات القيّمة التي يعتمد عليها البشر (مثال الطعام، الحماية من الفيضانات، الاستجمام، الخ.). ففي منطقة شرق البحر الأبيض المتوسط كما هو الحال في العديد من أرجاء العالم، نادراً ما يأخذ احتياجات التنوع الأحيائي بالحسبان عند عملية صناعة قرار الإدارة الموارد المائية، وعليه غالباً ما تصنع القرارات لتلبية احتياجات البشر (الري في المقام الأول) وانتاج الطاقة. تنص اتفاقية التنوع الأحيائي (CBD) إلى تزايد ضرورة إلمام السياسات وإدارة المعلومات بماهية عمل الدورة الهيدرولوجية ودور النظم البيئية والتنوع الأحيائي في استدامتها[٣].

إن تقرير الاتحاد الدولي لحماية الطبيعة (IUCN) هذا، ومجموعة البيانات المرفقة حول توزيع وحالة التنوع الأحيائي في المياه العذبة في شرق البحر الأبيض المتوسط، مع تقرير المناطق الهامة للمياه العذبة في المنطقة الأوسع لشرق حوض البحر الأبيض المتوسط والبيانات المرفقة يمثل تقدماً كبيراً في توفير المعلومات التي تساعد في ادماج احتياجات التنوع الأحيائي في الخطط التنموية للمياه ضمن إطار الإدارة المتكاملة لحوض النهر. كما نأمل من هذا التقرير أيضاً ان يساعد في تحسين المعرفة عن التنوع الأحيائي في المياه العذبة. فيمثل هذا العمل أشمل تقييم على مستوى الأنواع تم إعداده حول التنوع الأحيائي في المياه العذبة في هذا الجزء من العالم. إضافةً أن هذا التقرير يوفر المعلومات اللازمة لاتخاذ القرارات، فالمعلومات المقدمة هنا هامة جداً لتحقق كل دولة التزاماتها الوطنية في حماية واستدامة استخدام التنوع الأحيائي في إطار اتفاقية التنوع الأحيائي (CBD)، واتفاقية الأراضي الرطبة (رامسار)، والأهداف الإنمائية للألفية (MDGs). فالمعلومات المقدمة حول الأنواع ذات أهمية خاصة لتحقيق أهداف اتفاقية التنوع الأحيائي (CBD) ١١ و ١٢ والتي تنص: "بحلول ٢٠٢٠، ١٧% على الأقل من اليابسة والمياه الداخلية، ... خصوصاً تلك المناطق المهمة للتنوع الأحيائي وخدمات النظم البيئية، أصبحت محمية...، ... بحلول ٢٠٢٠ وقف انقراض الانواع المهددة واستدامة حالة الصون خاصة لتلك الأكثر تدهوراً " بشكل متوالي. كما تقدم هذه المعلومات وتحليلها العون للدول الأطراف في تنفيذ اتفاقية الأمم المتحدة لمجاري المياه (UNWC) التي تهدف إلى حماية وصيانة المجاري المائية في حالتها الطبيعية وقد التي دخلت هذه الاتفاقية حيز التنفيذ اغسطس ٢٠١٤.

ان منطقة شرق حوض البحر الأبيض المتوسط تخدم ما يزيد عن ٤,٤% من سكان العالم، علماً بأن ١,١% فقط من مصادر المياه فيها متجددة[٤]. فعمليات سحب المياه في هذه المنطقة من العالم غير مستدامة إلى حد كبير، وهي تستخدم لأغراض الري في المقام الأول، الأمر الذي أدى إلى انخفاض مستمر لمستويات المياه الجوفية إلى معدلات تنذر بالخطر[٥]. كما لوحظ التقدم الكبير في بناء السدود في جميع ارجاء الإقليم وخصوصاً في تركيا. أضف إلى ذلك التلوث الناتج من مخلفات الاستخدامات الزراعية والمنزلية، مع آثار التغير المناخي الذي أدى إلى زيادة متوسط درجات الحرارة السنوية، وبالتالي تواتر أيام الصيف الحارة للغاية، وانخفاض معدلات الهطول[٦]. بناءاً على ذلك، فإن تجمع هذه المؤثرات تنذر بتضاعف انخفاض وتغييرات جريان وتدفق المياه العذبة في جميع أنحاء المنطقة، وفي بعض الحالات الخسارة الكلية لعدد من المسطحات المائية (مثل بحيرة العمق في تركيا، واحة الأزرق في الأردن) وجفاف موسمي لأحد الأنهار الدائمة (مثل نهر كويك في تركيا وسوريا).

كمساهمة رئيسية نحو توفير المعلومات عن الأنواع في المياه العذبة في الإقليم، يقوم برنامج الأنواع العالمي لدى الاتحاد الدولي لحماية الطبيعة (IUCN)، بالتعاون مع شركائه، بإجراء تقييم حالة الصون لجميع الأنواع الموصوفة من أسماك المياه العذبة والرخويات، اليعسوبيات، والنباتات في مختلف أنحاء شرق حوض البحر الأبيض المتوسط (وفقا للقوائم الحمراء للأنواع المهددة التي يعدها الاتحاد الدولي لحماية الطبيعة) وتحديد توزيعها. كما تم ادماج المعلومات المتوفرة حول الأنواع التي تعتمد في تواجدها على المياه العذبة من البرمائيات ، والطيور، والقشريات، واللبائن (الثديات) لتقدم لمحة أكثر شمولاً لحالة الصون وتوزيعها في جميع أنحاء المنطقة. في المجموع، تم إدراج معلومات عن ١،٢٣٦ نوع في هذا التقرير، مع جمع معلومات عن الأنواع في كل نهر أو حوض بحيرة الفرعية، ويمثل هذا الكم من المعلومات تقدماً كبيراً في المعرفة لتغذية أنشطة التنمية بالمعرفة والنطاق المكاني المناسب لإدارة عمليات الصون. وسوف تتاح البيانات الكاملة، بما في ذلك جميع ملفات توزيع الأنواع، من خلال موقع الاتحاد الدولي لحماية الطبيعة (IUCN) للقوائم الحمراء (www.iucnredlist.org).

تسعة عشر بالمئة (١٩%) من أنواع المياه العذبة التي تم تقييمها هي مهددة عالمياً، علماً أنه عند اعتبار ان هذه الأنواع هي أنواع متوطنة لهذه المنطقة – الأنواع إذا فقدت من المنطقة تصبح منقرضة عالمياً- فإن مستوى التهديد بالانقراض يرتفع ليصل ٥٨,٢% في المنطقة، فهناك ستة أنواع من جميع أنواع السمك تعتبر منقرضة عالمياً (EX)، و١٨ نوعاً (سبعة أنواع من الأسماك و ١١ من الرخويات) مهددة بالانقراض بشكل حرج مع احتمالية انها قد انقرضت فعلياً. لذا هناك حاجة لمسوحات ميدانية لتأكيد ما إذا كانت هذه الأنواع ما زالت موجودة أو انقرضت فعلاً. كما يحدد التقرير أهم محركات التهديد كاستخراج المياه الجوفية أو بناء السدود، والتلوث من المناطق الزراعية أو الحضرية، وفقدان الموائل/ أو تحويلها لمناطق زراعية والإفراط في حصاد أو جمع هذه الأنواع. فالموائل التي تحوي على الحصة الأكبر من الانواع المهددة بالأنقراض هي الينابيع العذبة والسيول، والنظم الكارستية، فغالباً ما تكون الينابيع بمثابة ملاجىء للأنواع عندما تجف الأنهار والبحيرات (إما بشكل طبيعي أو الضخ المفرط/الجائر للمياه) لكن هذه الينابيع هي أيضاً عرضة للضخ الجائر للمياه الجوفية الخاصة بها. فقد تم العثور على أكبر عدد من الأنواع المهددة بالانقراض في ستة مناطق جلية في الإقليم: ساحل بلاد الشام وخليج اسكندرون من نهر العاصي إلى الليطاني، و أعالي حوض الحولة وبحيرة طبريا، توسع سهول نهر دلجة والفرات إلى مصب النهر بما في ذلك أهوار الحويزة حتى نهر ديالى في العراق، ومصب قارون في إيران،

ونهر الخابور بما في ذلك ينابيع رأس العين (اماكن تجمع مياه الفرات) في شمال سوريا، في منطقة البحيرات في تركيا (بما في ذلك منبع نهر مندريس العظيم (Büyük Menderes)، نهر الجسر (Köprü River)، وينابيع كرجوز(Kırkgöz)، ومصب شيرو (Çoruh) وتجمعات البحر الأسود الأخرى في شمال شرقي تركيا، ومصب آراس/نهر كورا في أذربيجان وجنوب أرمينيا. فيعكس هذا التوزيع، التواجد الجغرافي/المكاني الكلي لثراء الأنواع المسجلة في هذا الإقليم فنحن نمتلك القدر الأكبر والأكثر اكتمالاً من المعرفة – مقارنة إلى مراكز ثراء الانواع والمهددات التي يمكن ان يتم التحقق منها عندما تتوفر المزيد من المعلومات.

ان قوائم الاتحاد الدولي لحماية الطبيعة (IUCN) هي واحدة من المقاييس العالمية الأكثر حجيّة لدعم سياسات واجراءات صون الأنواع، ونحن نأمل أن يكون هذا التقييم هو قاعدة لتقييم أكبر للأنواع تبعاً للقوائم الحمراء للأنواع المهددة، وتوفير معلومات ورؤى جديدة وبالتالي تحفيز الأنشطة التي تساعد على حماية تنوع الحياة في شرق حوض البحر الأبيض المتوسط.

الرسائل الرئيسية

- **التنوع الثري لأنواع المياه العذبة في الإقليم:** بالرغم من أن الإقليم ذا طبيعة شبه جافة أو جافة في مساحات شاسعة منه لكنها تدعم مجموعة متنوعة من أنواع المياه العذبة وموائلها والتي تقدم تشكيله واسعة من خدمات النظم البيئية، بما فيها المياه والطعام والدخل. ٣٦٨ نوع من أسماك المياه العذبة متوطنة (أي لا توجد في أي مكان في آخر في العالم)، الرخويات، اليعسوبيات (اليعسوب ومقترنات الأجنحة) ونباتات المياه العذبة، الطيور والبرمائيات، والقشريات، واللبائن (الثديات) أي ما نسبته (٢٩,٨%) من المجموع الكلي من الأنواع وهو ١,٢٣٦ نوع متواجد في إقليم شرق حوض البحر الأبيض المتوسط.

- **الضغوطات على المياه والتلوث أدى إلى تشكيل تهديد مرتفع للتنوع الأحيائي في المياه العذبة:** ان التنوع الأحيائي وموائله في المياه العذبة ترزح تحت ضغوطات كبيرة يسببها الاستخراج المفرط للمياه، والتلوث، وبناء السدود ويزيد الأمر تفاقماً المناخ الجاف للمنطقة. الأمر الذي أدى إلى فقدان العديد من أنهار دائمة الجريان (والتي الآن تجف على فترات متقطعة) وجفاف المناطق الرطبة الأخرى مثل المستنقعات (الأهوار) والبحيرات والواحات. الأمر الذي نتج عنه ان ١٩,١% من أنواع الإقليم قيّمت على أنها مهددة، و٥٨,٢% من أنواع المياه العذبة هي انواع متوطنة مهددة. وبالرجوع للمجموعات التي تم تقييمها من خلال المشروع ٤٥,٥% من مجموعة الرخويات و٤١% من الأسماك هي الأكثر تهديداً يتبعها اليعاسيب والمقترنات الأجنحة ليكون ٦,٧% مهدداً ومن ثم ٢,٥% من نباتات المياه العذبة مهدداً.

- **يجب أن تقدر السياسات الدور الذي تلعبه النظم البيئية العفية (الصحية) والتنوع الأحيائي في توفير المياه:** يجب تقدير والاعتراف بالدور الهام الذي تلعبه النظم البيئية (والتنوع الأحيائي) في توفير المياه (الكم والجودة) للاستخدامات البشرية ولأجل التنوع الأحيائي، والأخذ بالاعتبار متطلبات التنوع الأحيائي عند عمليات صناعة القرار الذي يحكم إدارة الموارد المائية.
- **الحاجة الملحة لإدارة متكاملة لحوض النهر:** هناك حاجة لتبني منهجيات الإدارة المتكاملة لحوض النهر (أو استراتيجيات مشابهة) من قبل الدول في الإقليم، لضمان ان نظم المياه العذبة البيئية يمكن لها الاستدامة في تقديم المياه، ومنتجاتها الأخرى، إضافة إلى الخدمات ذات الأمد البعيد بنفس الوقت التي تدعم فيها التنوع الأحيائي. في حالة المياه عابرة الحدود يتم نصح الدول الأعضاء ان تقوم بتطبيق مبادئ اتفاقية الأمم المتحدة للمجاري المائية (UNWC) وقبول مسؤولية حماية النظم البيئية المتعلقة بخارج الحدود الوطنية.
- **ينابيع المياه العذبة هي موائل مهمة للتنوع الأحيائي في المياه العذبة:** تدعم الأنهار دائمة الجريان والبحيرات العدد الأكبر من الأنواع والأنواع المهددة، بيد أن ينابيع المياه العذبة والنظم الكارستية لديها الحصة الأكبر من الأنواع المهددة بالانقراض. فينابيع المياه العذبة والسيول هي موائل مهمة للعديد من الأنواع المهددة في المنطقة حيث في الغالب تقدم الملجأ لهذه الأنواع في أوقات الجفاف بسبب الضخ الجائر(المفرط) للمياه.

- **تركيا، وإسرائيل، وسوريا جميعها شهدت أكبر عدد للأنواع المستأصلة من داخل حدودها:** بالرغم من أن تركيا تدعم العدد الأكبر من أنواع المياه العذبة، بيد أنها تضم العدد الأعلى (الحصة الأكبر) من أنواع المياه العذبة المهددة في الإقليم. كما ان لديها العدد الأكبر من الأنواع المستأصلة (أي الأنواع المفقودة من داخل حدودها) مع بعض الأنواع التي انقرضت على الصعيد العالمي. إسرائيل لديها الحصة الأكبر من الانواع المستأصلة من حدودها تليها سوريا ومن ثم تركيا.

- **هناك مستوى عالي من ثراء الأنواع، والأنواع المهددة في أرجاء الإقليم:** تم العثور على المناطق الأكثر ثراءً في الانواع على طول سواحل البحر الأبيض المتوسط من بلاد الشام وتركيا وتجمعات بحر مرمرة، وساحل البحر الأسود في تركيا، وتجمعات آراس/كورا في جورجيا- وأذربيجان وأرمينيا. وتتواجد هناك أيضاً أكثر مناطق تضم الأنواع المهددة بالانقراض في مصبات تجمع نهر العاصي في تركيا، ووسط ومصب نهر دجلة والفرات بما في ذلك هور الحمّار ، شط العرب، ومنطقة ينابيع رأس العين، ونهر الخابور وتدفقاته (جزء من تجمعات مياه نهر الفرات) في شمال سوريا، ومصب نهر آراس/كورا في أذربيجان.

- **يمكن للمناطق الهامة للتنوع الأحيائي في المياه العذبة ان تساعد توجيه الصون في الإقليم:** هناك عدد من المواقع في الإقليم ذات أهمية خاصة لاستمرار التنوع الأحيائي للمياه العذبة، فتعرف هذه المواقع على أنها مناطق تنوع أحيائي هامة للمياه العذبة، وفي التقرير المصاحب مناطق تنوع أحيائي هامة للنقاط الساخنة (hotspots) في حوض البحر الأبيض المتوسط. وبالتالي تساعد في تقديم المعرفة لصون الأنواع عند التخطيط للتنمية في الانظمة البيئية في المياه العذبة[٣].

- **هناك حاجة ملحة للتعاون الإقليمي في مجالات البحث الميداني والرصد:** هناك عدد قليل جداً من برامج الرصد للتنوع الأحيائي في المياه العذبة في الإقليم، وإذا ما رغبنا في وقف فقدان التنوع الأحيائي للمياه العذبة في هذا الإقليم فمن الضروري إنشاء برامج بحث ورصد تستخدم البروتوكولات المعيارية الحديثة، الأمر الذي يسمح برصد التغييرات في تعداد الأنواع وتحديد الأنواع التي ستستفيد من عمليات الصون خارج موائلها الطبيعية لضمان لوقف انقراض الأنواع. حيث ينصح ان تتم عمليات الرصد، والابحاث الميدانية والتصنيفات ان تتم بالتعاون مع جهات دولية عند الحاجة لتقوم بتقديم العون في بناء القدرات الإقليمية.

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[٦] CEPF. 2010. Ecosystem Profile – Mediterranean Basin Biodiversity Hotspot. Critical Ecosystem Partnership Fund.

Yönetsel özet ve önemli mesajlar

2003 yılında, eski Birleşmiş Milletler Genel Sekreteri Butros Butros Gali, bu yüzyılda suyun petrolden daha önemli olacağını belirtti[1]. Ortadoğu da meydana gelen gerginliklerin başında su kaynaklarının paylaşımı gelmekte, bu nedenle bölgedeki insanlar arasında çatışmaların çıkabileceğine değindi. Bu konuda öngörülen endişeler henüz gerçekleşmemiş olmasına rağmen, bu sorunun sadece Doğu Akdeniz bölgesinde değil, dünyanın diğer bölgelerinde de benzer şekilde, günümüzde ve gelecekte önemli su sıkıntıları ile karşı karşıya kalma riskinin var olduğunu göstermektedir.Su krizinin, biyoçeşitlilik üzerine olan olumsuz etkisi genellikle gözden kaçmaktadır. Bu saptamanın amacı insani ve biyoçeşitlilik ihtiyaçları arasında bir ikilem oluşturmak değildir. İnsan kullanımı için uygun miktar ve kalitede suyun mevcudiyeti, iyi işleyen sağlıklı ekosistemler ve dolayısıyla biyoçeşitlilik sayesinde oluşmaktadır[2]. Sağlıklı tatlı sulak alan ekosistemleri (doğal altyapı) sadece biyoçeşitliliği desteklemekle kalmayıp, bu tip ekosistemler temiz suyun depolanmasında ve aynı zamanda insanlara kendini güvende olmasını hissettiren önemli faydalar (örneğin; gıda, sel baskınından koruma, dinlenme vb.) sunmaktadır. Ancak, dünyanın birçok yerinde olduğu gibi Doğu Akdeniz bölgesinde de büyük ölçüde insani ihtiyaçlar (öncelikle sulama) ve enerji üretimi için suyun temini üzerine odaklanmış olup su kaynakları yönetimi ile ilgili karar alma süreçlerine biyoçeşitlilik ihtiyaçları nadiren dahil edilmiştir. Biyolojik Çeşitlilik Sözleşmesi, hidrolojik döngü fonksiyonlarının nasıl sürdürülmesi gerektiği konusunda ve ekosistemler ve biyoçeşitliliğin rolünün desteklenmesi hakkında daha iyi bilgilendirilmiş politikaların ve yönetimin kritik öneme sahip olduğunu belirtmiştir[2].

Bu IUCN raporu ile birlikte Doğu Akdeniz'deki tatlı sulak alan biyoçeşitliliğinin dağılımı ve durumu hakkındaki veri seti ve geniş Akdeniz Havzası'ndaki Tatlı Sulak Alan Önemli Biyoçeşitlilik Alanları ile ilgili rapor[3] sayesinde bir Entegre Nehir Havza Yönetimi çerçevesindeki su kalkınma planlaması kapsamında biyoçeşitlilik ihtiyaçlarını birleştirmeye yardımcı bilgilerin sağlanmasında büyük gelişmeler sunmaktadır. Bu gelişmelerin tatlı sulak alan biyoçeşitliliği ve öneminin anlaşılmasında yardımcı olacağını umuyoruz.

Bu çalışma, dünyanın bu kısmı için tür düzeyinde tatlı sulak alan biyoçeşitliliği ile ilgili şimdiye kadar yapılan en kapsamlı değerlendirmeyi temsil etmektedir. Bu rapor kalkınma konusunda karar vericileri bilgilendirmenin yanında, Biyolojik Çeşitlilik Sözleşmesi, Ramsar Sözleşmesi ve Binyıl Kalkınma Hedefleri kapsamında biyoçeşitliliğin korunması ve sürdürülebilir kullanımı için ulusal yükümlülükleri yerine getirmenin esas olduğu bilgisini de vermektedir. Bu tür alanlarda bulunan canlı türlerinin durumları hakkındaki bilgi özellikle Biyolojik Çeşitlilik Sözleşmesi'nde belirtilen Hedef 11 ve 12 için önem arz etmektedir. "*2020 yılına kadar, karasal ve içsulak alanların tamamının, en az %17'si,... özellikle biyoçeşitlilik ve ekosistem hizmetleri için özel öneme sahip alanlar, korunur...*" ve "*... 2020 yılına kadar bilinen tehdit altındaki türlerin yok olması önlenmiş ve özellikle azalan türlerin koruma durumları geliştirilmiş ve sürekli olmuştur.*" Bu rapor kapsamında oluşturulan veri ve analizler, su kaynaklarının doğal hallerinde korunarak sürdürülebilmesini amaçlayan, Ağustos 2014 tarihinde yürürlüğe giren BM Su Kaynakları Sözleşmesi'ni uygulamada devletlere yardımcı olmada önemli bir katkı sağlayacaktır.

Doğu Akdeniz bölgesi, dünya nüfusunun %4,4'ün biraz üzerinde bir nüfusu barındırmasına rağmen yenilenebilir su kaynaklarının sadece %1,1'ini içermektedir[4]. Özellikle, sulama amaçlı olarak sulak alanlardaki suyun çekilmesi sonucu, yer altı sularının sürdürülebilir kullanımının konusunda endişe verici olarak, büyük oranlarda azalmasına yol açmıştır[5]. Bölge genelinde, özellikle Türkiye'deki su kaynakları, önemli ölçüde baraj yapımlarının artmasının yanında, tarımsal ve evsel kaynaklı kirlilikten de olumsuz yönde etkilenmektedir. İklim değişikliğinden kaynaklanan yıllık ortalama sıcaklıklardaki artışla birlikte azalan yağış nedeniyle yüksek yaz sıcaklığına sahip günlerin sıklığında artışlar ortaya çıkmaktadır[6]. Ortaya çıkan bu tehditlerden kaynaklanan etkiler bölge genelindeki tatlı sulak alan ekosistemlerin azalmasına ve değişmesine neden olurken bazı durumlarda ise suyun tamamen kaybolarak bu tür alanların kurumasına (örneğin; Türkiye'deki Amik Gölü ve Ürdün'deki Azraq Ovası) neden olmuştur. Ayrıca, sürekli akan bazı nehirlerde (örneğin; Türkiye'de doğup Suriye'de devam eden ve Qweik Nehri adını alan Sinnep Deresi) su miktarının azalmasına veya mevsimsel olarak en az bir kez kurumasına neden olmuştur.

IUCN, bölgede bulunan tatlı sulak alanlardaki canlı türleri hakkında bilgi sağlanmak amacıyla, ortaklarıyla işbirliği içinde Küresel Türler Programı çerçevesinde, Doğu Akdeniz genelinde tatlı sulak alan balıkları, yumuşakçaları, kızböcekleri ve bitkilerine ait daha önce tanımlanmış tüm türlerin tehdit durum (IUCN Nesli Tehlike Altındaki Türlerin Kırmızı Listesi'ne göre) ve dağılımına ait bir değerlendirme yapmıştır. Bölge genelinde bulunan tatlı sulak alanlardaki türlerin durum ve dağılımına daha kapsamlı bir bakış sunmak için tatlı sulak alana bağımlı amfibi, kuş, kabuklu ve memeli türleri için daha önceki mevcut bilgiler de dahil edilmiştir. Bu kapsamda, toplam 1236 türe ilişkin bilgiler bu rapora dahil edilmiştir. Bu raporda, koruma yönetimi için uygun bir mekansal ölçek oluşturmak ve kalkınma faaliyetlerine bilgi sağlamak amacıyla, her bir nehir veya göl alt-havzasında bulunan türler için bilgiler hazırlanmıştır. Söz konusu türlerin dağılım dosyaları da dahil olmak üzere tüm veri setleri IUCN Kırmızı Listesi (www.iucnredlist.org) web sitesinde yer almaktadır. .

Burada değerlendirilen tüm tatlı sulak alan türlerin %19'u küresel anlamda tehdit altındadır. Bunun yanında, sadece bölgeye endemik türler dikkate alındığında (eğer tür bölgeden kaybolursa küresel olarak nesli tükenmiş olacak) bu türlerin %58,2'sinin küresel anlamda tehdit altında olduğu görülmektedir. Balık türleri açısından, yapılan değerlendirmede, 6 balık türü küresel olarak Nesli Tükenmiş (EX) olarak kabul edilmiş ve 18 tür (7 balık ve 11 yumuşakça) Kritik Düzeyde Tehlike kategorisinde yer almakta ve muhtemelen Nesli Tükenmiş olarak değerlendirilmiştir. Bu türlerin yok olup olmadıklarını teyit etmek için acilen arazi çalışmaları gerekmektedir. Tehditlerin başında su çekilmesi ve barajlar, tarımsal ve kentsel kaynaklı kirlilik, yeni tarım alanları açma nedeniyle habitat kaybı/dönüşümü ve aşırı toplayıcılık tanımlanmıştır.

Tehdit altındaki tür sayısı en fazla tatlı sulak alan kaynakları, tatlı sulak alan sızıntıları ve karstik habitatlara sahip sistemlerde bulunmaktadır. Bu tür su kaynakları, suların depolandığı nehirler ve göller kuruduğu zaman (ya doğal olarak ya da aşırı su çekimi nedeniyle) türler için sığınma alanları olarak görev yapar. Ancak yeraltı sularının fazla çekilmesinden bu tür kaynaklar aşırı etkilenen sistemleri oluşturmaktadır. Tehdit altındaki türler baz alındığında, en fazla türün 6 farklı bölgede içerisinde yer aldığı görülmektedir; Levant kıyısı ve İskenderun Körfezi havzaları; Asi Nehri'nden Litani Nehri ve Yukarı Hula havzası ve Kinneret Gölü/Celile Denizi, İran'da Aşağı Karoun ve Irak'ta Diyala Nehri'ne kadar olan Hawizah bataklıklarını içine alan daha geniş Dicle ve Fırat aşağı ovaları, Kuzey Suriye'de Resulayn kaynaklarını (Fırat havzası) içine alan Habur Nehri, Türkiye Göller Bölgesi (Yukarı Büyük Menderes, Köprü Nehri ve Kırkgöz Kaynakları dahil), kuzeydoğu Türkiye'de Aşağı Çoruh Nehri ve diğer Karadeniz Havzaları, Azerbaycan ve güney Ermenistan'da Aşağı Aras Nehri.

Kaydedilen türler, bunların dağılımı ve bölgedeki tür zenginliği şu ana kadar sahip olduğumuz ve tamamladığımız bilgilerin bir yansımasıdır. Bilgi sahibi olduğumuz bölgenin dışındaki çalışmaların tamamlanmasıyla daha fazla bilgi elde edildiğinde zenginliğin ve tehdidin diğer merkezleri de tespit edilebilecektir.

IUCN Kırmızı Listesi türlerin korunması politikasını ve eylemlerini destekleyen en yetkili küresel standartlardan birisidir. Türlerin Kırmızı Liste durumlarının değerlendirmesine dayalı bu analizin Doğu Akdeniz iç sularındaki yaşam çeşitliliğini korumaya yardımcı eylemleri teşvik edecek yeni bilgi ve anlayışları sağlayacağını umuyoruz.

Önemli mesajlar

- **Tatlı sulak alan türlerinin yüksek bölgesel çeşitliliği.** Bölgenin büyük kesiminin göreceli olarak yarı-kurak ve kurak doğasına rağmen, tatlı sulak alan türlerinin çeşitliliğini ve geniş bir yelpazede su, gıda ve gelir gibi faydalar sunan habitat çeşitliliğini barındırmaktadır. Tatlı sulak alan balıkları, yumuşakçalar, kızböcekleri (yusufçuk ve küçük kızböcekleri), tatlı sulak alan bitkileri, kuşlar, amfibiler, kabuklular ve memelilerden 1268 türün 368'i (%29,8) Doğu Akdeniz bölgesine endemiktir.
- **Su stresi ve kirlilik tatlı sulak alan biyoçeşitliliği üzerinde yüksek düzeyde tehdide yol açmıştır.** Tatlı sulak alan biyoçeşitliliği ve habitatları, kurak iklimin tüm bileşenleri olan aşırı su alımı, kirlilik ve barajların neden olduğu büyük miktardaki su stresinin etkisi altındadır. Bu durum, sürekli akan birçok nehir (zaman zaman kuruyan) ile bataklıklar ve göller gibi diğer sulak alanların yok olmasına neden olmuştur. Bu nedenle, bölgedeki tatlı sulak alan biyoçeşitliliğinin %19,1'i ve bölgenin endemik tatlı sulak alan türlerinin %58,2'si tehdit altında değerlendirilmiştir. Bu proje için değerlendirilen gruplardan tatlı sulak alan yumuşakçalarının %45,5'i yüksek tehdit altında, balıkların %41'i, yusufçuklar ve küçük kızböceklerinin %6,7'si ve tatlı sulak alan bitkilerinin %2,5'i tehdit altındadır.
- **Sağlıklı ekosistemler ve biyoçeşitlilik, su temininde önemli rol alması nedeniyle politik olarak tanınmaya ihtiyaç duymaktadır.** Ekosistemlerin (ve dolayısıyla biyoçeşitliliğin) insani kullanım ve biyoçeşitlilik için suyun temininde (miktar ve kalite) kritik rol alması nedeniyle tanınması gerekmektedir. Bu nedenle biyoçeşitlilik suyun yönetimiyle ilgili karar alma süreçlerine dahil edilmelidir.
- **Acil Entegre Nehir Havza Yönetim planı ihtiyacı.** Bölgedeki ülkeler aynı zamanda biyoçeşitliliğe destek verirken tatlı sulak alan ekosistemlerine uzun vadede sürdürülebilir su, diğer ekosistem ürünleri ve hizmetleri sağlayabilmek için Entegre Nehir Havza Yönetimi yaklaşımını (ya da benzer bir stratejiyi) benimsemesi gerekir. Bu durum, özellikle BM Su Kaynakları Sözleşmesi'nin prensiplerinin tam olarak uygulanmasında güçlü bir şekilde tavsiye edilen ve ulusal sınırların ötesine geçen ekosistemlerin korunması için sorumluluğu kabul eden üye ülkelerdeki sınır ötesi sular için geçerlidir.
- **Tatlı sulak alan kaynakları tatlı sulak alan biyoçeşitliği için önemli bir habitattır.** Sürekli akan nehirler ve göller tehlike altındaki türler dahil türlerin çoğunu barındırır, bununla birlikte tatlı sulak alan kaynakları tehlike altındaki türlerin sayısı bakımından en büyük orana sahiptir. Tatlı sulak alan kaynakları ve sızıntıları genellikle aşırı su çekimi sonucu şiddetlenen kurak zamanlarda bölgedeki tehlike altındaki türler için sığınma sağlayan önemli habitatlardır.
- **Kaybolan en fazla sayıdaki tür Türkiye, İsrail ve Suriye sınırları içinde görülür.** Türkiye en fazla tatlı sulak alan türünü barındıran ülkelerden biridir, aynı zamanda bölgedeki tehdit altındaki tatlı sulak alan türleri bakımından da en yüksek orana ve sayıya sahiptir. Ayrıca, küresel ölçekte nesli tükenmiş bazı türler ile kaybolmuş türler (yani kendi ülke sınırları içindeki kayıp türler)

bakımından en fazla sayıya sahip ülkedir. İsrail, oransal açıdan, en fazla kaybolan türe sahip ülkedir bunu Suriye ve Türkiye takip etmektedir.

- **Tür zenginliğinin ve tehdit altındaki türlerin en yüksek seviyesi bu bölgededir.** Tür zenginliğinin en yüksek olduğu alanlar Levant ve Türkiye'nin Akdeniz kıyıları boyunca, Marmara Denizi havzaları, Türkiye'nin Karadeniz kıyılarında ve ayrıca Gürcistan, Azerbaycan ve Ermenistan'daki Aras havzası içinde bulunmaktadır. Tehdit altındaki türlerin büyük çoğunluğu Türkiye'de Aşağı Asi havzasında, Kuzey Suriye'de Hammar bataklığını içine alan Aşağı ve Orta Fırat, Şatt'ül-Arab nehri, Resulayn kaynak alanı ve dışarı akan Habur Nehri (Fırat havzasının parçası) ve Azerbaycan'da Aşağı Aras Nehri'nde bulunmaktadır.
- **Tatlı Sulak Alan Önemli Biyoçeşitlilik Alanları bölgede koruma haritasının oluşturulmasında yardımcı olabilir.** Tatlı sulak alan biyoçeşitliliğinin devamlılığı için bölge genelinde çok sayıda önemli sulak alan bulunmaktadır. "Tatlı Sulak Alan Önemli Biyoçeşitlilik Alanları" olarak bilinen bu alanlar *Akdeniz Havzası Sıcak Alanı'nda Tatlı Sulak Alan Önemli Biyoçeşitlilik Alanları* raporunda sunulmuştur. Bu rapor tatlı sulak alan ekosistemlerindeki türlerin korunması ve gelişim planlaması hakkında bilgi vermektedir[3].
- **Bölge genelinde işbirliğine dayalı arazi araştırmaları ve izleme çalışmalarına acil olarak ihtiyaç vardır.** Bölgede tatlı sulak alanlarla ilgili az sayıda biyoçeşitlilik izleme çalışması bulunmaktadır. Bu bölgedeki tatlı sulak alan biyoçeşitlilik kaybının durdurulması isteniyorsa, modern olarak standardize edilmiş protokoller kullanılarak oluşturulan alan izleme ve araştırma programlarına ihtiyaç bulunmaktadır. Bu durum, daha fazla tür neslinin tehlike altına girmesini engellemeye yardımcı, olmak üzere ex-situ korumadan yararlanacak türlerin tanımlanmasına ve popülasyonlardaki değişikliklerin izlenmesine imkan verecektir. Bölgede kapasite geliştirmeye yardımcı olacak uluslararası kuruluşlarla işbirliği yoluyla gerçekleştirilen uygun izleme, arazi ve taksonomik araştırma programları tavsiye edilmektedir.

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Chapter 1. Background to freshwater biodiversity in the Eastern Mediterranean

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1.1 Global status of freshwater biodiversity

While covering less than 1% of the Earth's surface, freshwater ecosystems provide a home for around 10% of the world's described species, including a quarter of all vertebrates, and provide humans with a wealth of goods and services (Strayer and Dudgeon 2010). Freshwater biodiversity constitutes a vitally important component of the planet, with a species richness that is relatively higher compared to both terrestrial and marine ecosystems (Gleick 1996). According to the most comprehensive global assessment to date (Balian *et al.* 2007), there are 125,530 described animal species in freshwaters. This includes almost 5,000 molluscs, 12,740 fishes, 5,680 dragonflies and damselflies (Odonata), and 2,832 decapods. However, the study also highlights the severe lack of knowledge for some geographic regions, in particular for the tropics (areas of high diversity), and taxonomic groups (especially the invertebrate groups), meaning that these figures are likely to be significant underestimates of true diversity.

The value of inland wetlands to human society is easily seen through the direct services they provide, such as fish for food or water for drinking, but they also provide many indirect services – nutrient cycling, flood control, and water filtration. For example tropical inland fisheries alone have been valued at USD 5.58 billion per year (Neiland and Béné 2008). Putting a dollar value on these services is extremely difficult, as many have no market value. However, attempts have been made to estimate the annual value of the direct and indirect services of the world's wetlands, with differing results. For example, the Millennium Ecosystem Assessment (MEA 2005) values the annual total goods and services derived from inland waters globally as up to USD 15 trillion, Schuyt and Brander (2004) estimate a value of USD 70 billion, whereas Costanza *et al.* (2014) give a value of just over USD 4 trillion per year.

However, despite its high diversity and importance to humans, freshwater biodiversity has been under threat for many decades, if not centuries. Wetlands have historically been seen as wastelands, with their only value in conversion to more 'profitable' uses such as agriculture. This has led to the loss of 64–71% of global wetlands since 1900, with the highest losses since the 1980s in Asia (Davidson 2014). Major threats to freshwater biodiversity can be grouped under five interacting categories: over-exploitation; water pollution; flow modification; destruction or degradation of habitat; and invasion by exotic species, with global scale environmental changes being superimposed upon all of them (Dudgeon *et al.* 2006). These globally escalating threats have led to freshwater biodiversity falling into a state of

Tropical inland fisheries alone have been valued at USD 5.58 billion per year. Photo © Carsten ten Brink, Online image/Flickr under CC licence 2.0 by-nc-nd

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crisis (Vorosmarty *et al*. 2010), causing a decline greater than is seen in either terrestrial or marine realms with freshwater species populations declining on average by 76% since 1970 (Strayer and Dudgeon 2010, WWF 2014).

Parties to the Convention on Biological Diversity (CBD) at its Sixth Conference of Parties in The Hague, Netherlands (2002), resolved '*to achieve by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional and national level as a contribution to poverty alleviation and to the benefit of all life on earth*' (CBD 2002). Although the '2010 targets' under this CBD commitment were not met (Butchart *et al*. 2010), the premise of the targets remains fundamentally solid. At the CBD 10th Conference of Parties (2010), the targets were reiterated (as the Aichi 2020 Biodiversity Targets) with more emphasis on achieving them over the next ten years. A mid-term review of progress towards the Aichi biodiversity 2020 targets (the IUCN Red List being one of the key indicators to monitor progress) shows that despite the accelerating policy and management responses to the biodiversity crisis, the impacts of these efforts are unlikely to be reflected in improved trends in the state of biodiversity by 2020 (Tittensor *et al*. 2014). Therefore in order to meet these targets, and conserve biodiversity, and secure human well-being, additional effort is needed to reduce pressures on biodiversity.

In keeping with the principles of the Convention on Biological Diversity, biodiversity trends and losses can be monitored by assessing the conservation status of species. There are several methods of determining species status, and the most commonly used tool is the IUCN Red List Categories and Criteria (IUCN 2012), which allows consistency in approach across different taxonomic groups. It helps in determining the relative risk of extinction and providing the basis for understanding if a species is Extinct, threatened (Critically Endangered, Endangered or Vulnerable), Near Threatened, of Least Concern, or lacking sufficient basic data for assessment (Data Deficient). The IUCN Red List of Threatened Species™ publishes the results of the assessments at www.iucnredlist.org. The IUCN Red List also provides basic information on species taxonomy, distributions, habitat and ecology, threats, population trends, use and trade, and research and conservation priorities.

On the IUCN Red List of Threatened Species, only three freshwater obligate taxonomic groups, all crustaceans, have been comprehensively assessed so far and all show a high level of threat (crabs 32% threatened, crayfish 31.5% threatened, and shrimps 27.8% threatened). The amphibians are another comprehensively assessed group which also (mostly) depend upon freshwater to complete their life cycles and are highly threatened (41.2% threatened), especially when compared to other non-freshwater groups that have been comprehensively assessed, for example birds (13.4% threatened) and mammals (25.8% threatened) (Cumberlidge *et al*. 2009, IUCN 2014). In addition, regional freshwater biodiversity studies (like this one) have shown alarming results, with 21% of African freshwater biodiversity threatened, 17.8% of freshwater biodiversity in the Western Ghats (India), 56% of the endemic fishes of the Mediterranean basin, 54% of Madagascan endemic fish, and 38% of all European fishes are threatened (IUCN 2004, Smith and Darwall 2006, Kottelat and Freyhof 2007, Darwall *et al*. 2011, Molur *et al*. 2011).

1.2 Situation analysis for the Eastern Mediterranean

1.2.1 General overview

The Eastern Mediterranean region (Figure 1.1) extends from the European part of Turkey, across Anatolia and to the Kura-Aras watershed, and south to the Levant and Mesopotamia. The region covers part of three Biodiversity Hotspots, the Mediterranean Basin, the Irano-Anatolian, and the Caucasus Hotspots. Hotspots are regions that contain at least 1,500 species of vascular plants (> 0.5% of the world's total) as endemics, and have lost at least 70% of their original habitat (Myers *et al*. 2000; www.cepf.net).

The assessment area also covers 14 freshwater ecoregions, which are large areas that encompass one or more freshwater systems that contain a distinct assemblage of natural freshwater communities and species (Figure 1.2 and Table 1.1) (Abell *et al*. 2008, WWF and TNC 2013). The ecoregions in the Eastern Mediterranean represent three of the 12 major freshwater habitat types identified in the world: temperate coastal rivers; xeric freshwaters and endorheic (closed) basins; and temperate floodplain rivers and wetlands. In general the region is characterized by riverine ecosystems with small lakes, coastal lagoons, endorheic aquatic systems, and single large river systems.

Within the region there are 27 wetlands of international significance which have been designated as Ramsar sites. One of them, the Azraq Oasis in Jordan, was placed in the Montreux Record (for sites that have changed in ecological character as a result of human interference) in 1990 because unsustainable groundwater extraction led to the almost complete desiccation of the site (http://www.ramsar.org).

1.2.2 Threats to freshwater biodiversity in the region

Water provision is a major issue in the Eastern Mediterranean region, which supports 4.4% of the global population (140.8 million people), but contains only 1.1% of the world's total renewable water resources (AQUASTAT 2009). Water withdrawal in the region, which is mostly used for irrigation, has increased by 20.5% between 1997 and 2007, and is primarily drawn from surface waters (71.5%), with ground waters providing one fifth of the region's needs and the remainder coming from unconventional sources such as desalination (AQUASTAT 2009). However, current levels of water extraction are leading to the reduction of groundwater reserves at an alarming rate, for example between 2003 and 2009 the north-central Middle

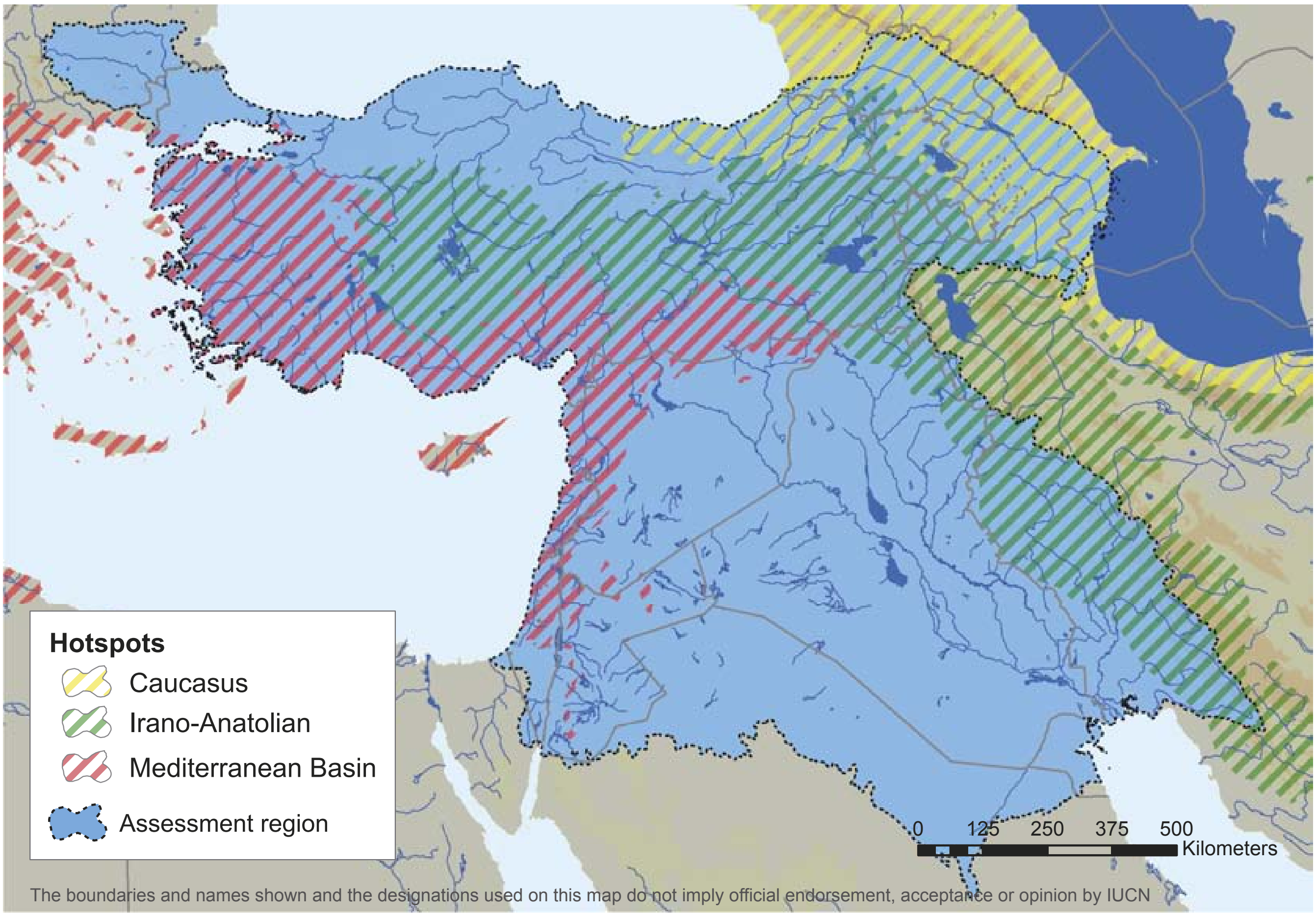

Figure 1.1 Map showing the location of the Eastern Mediterranean assessment region along with the Biodiversity Hotspots.

East lost 17.3 mm/yr in ground water height (equivalent to 91.3 km^3 in volume) (Vos *et al.* 2013). The result of this has been reduced flows in the region's rivers and wetlands, with some once permanent rivers becoming intermittent or even totally dry. For example, Aksehir Lake shrunk by 257 km2 between 1975 and 2006, and dried up completely in 2008 (Sener, Davraz and Sener 2010), and the Qweik River, once the main source of water for the city of Aleppo in Syria, now only flows intermittently and the springs which fed it are dry (UN-ESCWA and BGR 2013). As the population of the region is projected to increase by 61% between 2010 and 2050 (UN 2012), and only 39% of the region's potential cultivated land is currently used (AQUASTAT 2009), it raises the question of where is the water going to come from to support these additional people, and irrigation needs?

Water policies within the region are largely dominated by efforts to increase water supply, and multiply the number of large water infrastructures (CEPF 2010). Increasing demand for flood control, irrigation, and electricity generation is fuelling a wave of dam construction. This situation is most severe in Turkey, which is already one of the world's most active dam building nations (International Rivers 2014), and according to GegenStrömung (2011) plans to build an additional 1,700 dams and Hydro-electric Power Plants (HEPPs), on top of the 2,000 that already exist. Turkey, Iraq, and the Syrian Arab Republic contain more than 93% of the total dam capacity in the region, most of it within the Euphrates–Tigris Basin (AQUASTAT 2009). When dam building or management take place without consideration of the needs of biodiversity and local communities, their impacts can be severe. Dams transform the riverine ecosystem into a lacustrine ecosystem with unnaturally frequent and high water level fluctuations. Dams also affect rivers by changing the flow regime (including flood peaks and seasonal flows) and trapping sediment, physically altering the river channel downstream, water quality can be reduced with changes in temperature, oxygen levels and chemical composition, and they also block migratory routes of fishes.

Water pollution is also a major threat to freshwater biodiversity in the region, and the Asi/Orontes, Gediz and Bakır rivers are examples of extremely polluted water bodies (Minareci *et al.* 2009, Saç *et al.* 2012, UN-ESCWA and BGR 2013). The main sources of pollution are from urban sewage and wastewater (often untreated or insufficiently treated), excessive pesticides and nutrients from agricultural activity (primarily nitrogen and phosphorus, and pesticides, fungicides, and herbicides), discharges and accidents from industrial facilities (including heavy metals and oils), toxic chemicals from mining operations, and dumping of solid waste from a variety of sources.

The physical loss of wetlands is also a significant pressure across the region. Coastal wetlands, especially along the Mediterranean

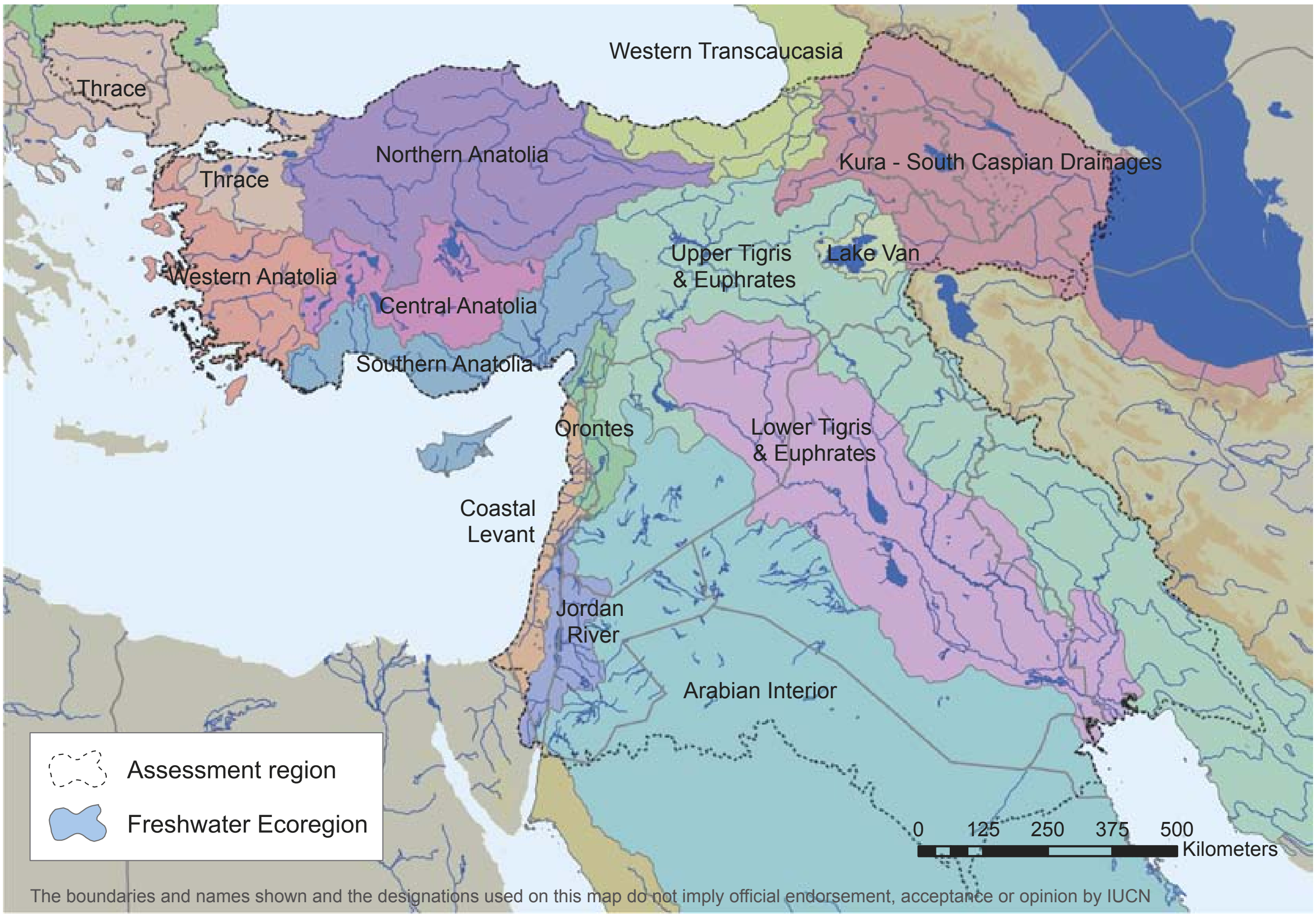

Figure 1.2 Map showing the location of the eastern Mediterranean assessment region along with the freshwater ecoregions Freshwater Ecoregions. © WWF and TNC 2013

and Aegean coasts of Turkey are under pressure from urbanization and tourism development. Even officially protected areas such as the Gediz Delta are under immense urbanization pressure causing very rapid to severe deterioration (BirdLife International 2014), and the Göksu Delta which is potentially threatened by tourism development (Middleton 2013). The expansion of agricultural land is one of the major drivers of freshwater habitat loss, which has led to huge wetlands such as Hula Lake, Amik Lake, and Yarma Marshes being drained and converted for agricultural use.

Freshwaters in the Mediterranean basin are reported to be the most invaded systems around the world, leading to high levels of threat amongst native biodiversity (Smith and Darwall 2006, Clavero *et al.* 2010, Marr *et al.* 2013, Ilheu, Matono and Bernardo 2014). The spread of invasive species has also been associated with important social and economic impacts. For example, between 1958 and 1961, *Pseudophoxinus handlirschi*, a fish restricted to Lake Eğirdir in Turkey, accounted for 20.5% of the total landings in the lake. However the species is now extinct, with no individuals being recorded since the 1980s; it is believed that the introduction of the predatory pike-perch (*Sander lucioperca*) was the main driver of its extinction (EEA 2011, Freyhof 2014a).

Invasive species are a major threat to freshwater biodiversity across the Mediterranean basin. Introduced tilapia at Azraq Oasis, a Ramsar site in Jordan, which is the only location for the native Azraq toothcarp (*Aphanius sirhani*). Photo © Kevin Smith

Table 1.1 Ecoregions present in the eastern Mediterranean assessment region (Abell *et al.* 2008; WWF and TNC 2013).

Ecoregion	Major Habitat Type	Delimitation	Justification
Thrace	Temperate coastal rivers	The junction of Europe and Asia in Turkey, European Turkey, and eastern Greece. The ecoregion is bounded by the Balkan Mountains in the north, the Struma River watershed in the west, Aegean Sea and Sea of Marmara to the south, and the Anatolian Plateau to the east.	The diversity and species composition separates its fauna from those of neighbouring basins.
Southern Anatolia	Temperate coastal rivers	The southern area of Anatolian Turkey and the islands of Cyprus and Crete, including the drainages of the Aksu, Göksu, Seyhan, and Ceyhan rivers. Most of the rivers originate in the Taurus Mountains to the north, and empty into the Mediterranean Sea in the south.	High levels of endemism in certain genera and a relatively diverse fauna.
Coastal Levant	Xeric freshwaters and endorheic (closed) basins	The coastal strip of the Levant from the western slopes of the Jabal an Nusayriyah Mountains in Syria, the Lebanon Mountains in Lebanon and the Judean Hills in Israel, to the Sinai.	Endemic species and species mix unique in the Middle East.
Jordan River	Xeric freshwaters and endorheic (closed) basins	The drainage basin of the Jordan River.	Endemic species, Tethyan relicts, and the varied (for Southwest Asia) cichlid fauna of African origin.
Central Anatolia	Xeric freshwaters and endorheic (closed) basins	Inland drainage basin, which includes the Lake Tuz and Konya basins.	High level of endemism and speciation in the Cyprinidae family in isolated basins.
Western Anatolia	Temperate coastal rivers	The Aegean coast of Anatolian Turkey, from the Sea of Marmara in the north to the Mediterranean Sea in the south. It includes the basins of the Gediz, Küçük (Lesser) Menderes, and Büyük (Greater) Menderes rivers.	Endemisms and species diversity with northern elements, freshwater species related to those of Europe and to those of Southwest Asia, and a diverse fauna of marine origin.
Arabian Interior	Xeric freshwaters and endorheic (closed) basins	The internal basins of the Arabian Peninsula.	Relatively high level of endemism and affinities with Africa.
Western Transcaucasia	Temperate coastal rivers	The river drainage areas and lakes of the Black Sea coast in Russia, Georgia, and Turkey from the Sukko rivulet (north of Novorossiysk) to the Yesil Irmak (Yesilirmak) River basin (exclusive).	It is clearly distinct from the other Caucasian ecoregions by the main divided ridges of the Caucasus.
Northern Anatolia	Temperate coastal rivers	The drainages of north-central and western Anatolian Turkey, from the Sakarya basin in the west to the Kizil and Kelkit basins in the east.	Diversity and species composition separates its fauna from neighbouring basins.
Lower Tigris and Euphrates	Temperate floodplain rivers and wetlands	The lower Tigris-Euphrates river system.	One of the world's major wetlands with large rivers and formerly extensive marsh habitats.
Upper Tigris and Euphrates	Temperate floodplain rivers and wetlands	The upper sections of the Tigris and Euphrates rivers and their tributaries, with adjacent drainages in Iran that flow into the northern Gulf and other neighbouring internal basins, and the Quwaiq River basin in Syria.	Mostly riverine fauna comprising species shared with the Lower Tigris and Euphrates ecoregion, but with many endemics not found in these lowlands.
Kura South Caspian Drainages	Temperate floodplain rivers and wetlands	The whole Kura-Aras catchment (Lake Sevan exclusive) and rivers of the Caspian Sea in southeastern Azerbaijan, as well as the lower reaches of rivers (Kyzyluzen [Safid Rud]) eastward to the Taran River (exclusive).	High number of endemic taxa.
Lake Van	Xeric freshwaters and endorheic (closed) basins	The basin of Lake Van.	Its isolation and relict species.
Orontes	Temperate coastal rivers	The valley of the Orontes River of Lebanon and Syria, and northern tributaries of Turkey and Syria.	High level of endemism and diverse fauna in a small basin. Bahrat Homs is an important wintering and staging area for migratory waterfowl.

Overexploitation and illegal and indiscriminate hunting is a serious problem for many Mediterranean species, affecting many threatened plants, reptiles, fishes, and other species (CEPF 2010). This includes unsustainable hunting and egg collecting, logging and wood harvesting, trapping of animals for the pet trade, collection of plants for horticulture, and fishing. Waterfowl poaching is widely practised within the Eastern Mediterranean region, where law enforcement is weak due to insufficient capacity of the local authorities. The sturgeons, occurring in the Black and Caspian seas and their larger catchments, are a high profile example of overharvesting of a species (though they are also impacted by dams blocking their migratory routes), and have become almost extirpated from Turkish rivers (Ustaoglu and Okumus 2004). Another example is the fish *Mesopotamichthys sharpeyi*, a common commercial species all over the southern part of Euphrates and Tigris drainages a decade ago, it has experienced a population decline of more than 80% since 1977 due to overfishing and the destruction of marshes (Freyhof 2014b). In some parts of the region, inland waters are open access with no catch controls (FAO 2004) and fishermen use prohibited methods such as toxins and very small mesh-size gill nets to catch fish species (Freyhof 2014b).

A compounding threat upon freshwater biodiversity in the region is climate change. According to CEPF (2010) there is a general consensus in predictions that there will be an increase in mean annual temperatures, and that the frequency of extremely hot summer days is expected to increase by 10% in coastal areas, and up to 20% further inland. Precipitation is expected to decrease, particularly over the southern and eastern Mediterranean, and the number of dry summer days and drought spells will increase. These climatic changes will lead to reduced summer flows, which are already impacted by high levels of water abstraction.

It is within transboundary waters such as the Euphrates and Tigris, Jordan River, and Orontes/Asi River that these stressors can often be seen to be the most severe (see Partow 2001, AQUASTAT 2009, Coad and Hales 2013, UN-ESCWA and BGR 2013). The Euphrates River rises in Turkey flowing through Syria and Iraq where it empties into the Arabian/Persian Gulf. According to a UN-ESCWA and BGR (2013) report, water use across the basin is focused on hydropower, irrigation, and drinking provision and as a result water quality and flows have significantly declined, with droughts now forming a major natural hazard affecting water supplies in the basin, and increasing salinity in the lower Euphrates marshes in Iraq. While there are two bilateral agreements in place, there is no basin wide agreement for the Euphrates, and riparian countries hold conflicting positions on International Water Law. According to the UN-ESCWA and BGR (2013) report the outlook, at least in the near term, is not positive with Turkey building the Ilisu dam, political unrest in Syria and Iraq, and water extractions on the rise, concerted efforts will be needed to form a basin-wide

The Ataturk dam on the Euphrates River in Turkey. Due to water abstraction, dams and increasing severity of droughts the Euphrates river flows have significantly declined. Photo © Carsten ten Brink, Online image/Flickr under CC licence 2.0 by-nc-nd

integrated river basin management plan to address the current and future needs of the people and environment.

1.2.3 Regional use and value of wetlands and their biodiversity

Wetlands across the Eastern Mediterranean region provide a wide variety of ecosystem services, including water, food, and income. In Turkey, for example at Güney Marshes and Sultan Marshes, reeds (*Phragmites australis*) and bulrush (*Thypha* spp.) are used as fodder and roofing material and constitute a key source of income in the area. Reed harvesting in the Sultan Marshes is estimated to be 1,500 tonnes/yr and most (up to 300,000 bundles) is exported (Yeniyurt and Hemmami 2011). The loss of Central Anatolian lakes and marshes has not only impacted hydrological and biological aspects, but also activities like fishing and reed harvesting, which contributed to the economy of local communities, as well as losing the potential opportunities from ecotourism (Karadeniz, Tırıl and Baylan 2009).

Many species of waterfowl are hunted in the region for food and sport, and it is an important socio-economic activity across the region, involving large numbers of people particularly in rural areas, for example in Syria there are an estimated 400,000 sport hunters, 200–300 falcon trappers and 20,000 people who hunt for a living (BirdLife International 2010).

Lagoons in the Eastern Mediterranean, such as the Göksu Delta, Akyatan, and Agyatan lagoons in Turkey, are often managed as sealed fisheries where species such as European eel (*Anguilla anguilla*) and flathead mullet *(Mugil cephalus)* are harvested for export (Yeniyurt and Hemmami 2011). However, traditional fisheries are being replaced by the harvesting of the non-native and invasive blue crab (*Callinectes sapidus*) as it generates a considerable income for local communities.

Sea salt harvesting is also an ancient practice in the Mediterranean. The Gediz Delta in western Anatolia harbours huge saltpans, that provide employment for local communities and the management of the saltpans also secures a safe breeding location for flamingoes (*Phoenicopterus roseus*) (Eken *et al.* 2006). Salt harvesting is also found in salt ponds adjacent to the Dead Sea in Jordan and Israel.

The dependence of human populations upon healthy freshwater ecosystems is no more evident than in Iraq. The marshlands in southern Iraq were once among the largest wetlands in the world, covering more than 10,500 km^2, supporting a diverse range of flora and fauna and providing freshwater and livelihoods for almost half a million people. The draining of the wetlands in the 1990s had a very negative impact upon the communities living there, with many having to leave. By 2002, the marshlands had been reduced to less than 10% of their original size. In 2003, the UN and the World Bank identified the draining as a major environmental and humanitarian disaster and restoration plans were launched (Canada-Iraq Marshlands Initiative 2010). Since then around 4,000 km^2 of marshlands have been restored, about 30–40% of the original size, and roughly 90,000 'Marsh Arabs' have returned, also in 2013 1,000 km^2 of the marshes were designated as Iraq's first and only National Park (Yeo 2013).

1.3 Objectives of this study

A lack of basic information on freshwater species distributions and threatened status in the Eastern Mediterranean region has long been a key obstacle facing freshwater ecosystem managers in the region. Specifically, the Eastern Mediterranean Assessment project, aimed to:

i) Collate information for assessments of conservation status and distributions of freshwater biodiversity (fishes, molluscs, plants, odonates), throughout the inland waters of the Eastern Mediterranean region;
ii) Store, manage, analyze and make widely available the biodiversity information throughout the region and globally, using the IUCN Red List and through the work of IUCN, its members, and partners;
iii) Provide the information so that important sites for freshwater biodiversity, known as Key Biodiversity Areas (Darwall *et al.* 2014), can be identified.

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Chapter 2. Assessment methodology

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Seasonal flooded mudflats in the Azraq Oasis Ramsar Site, Jordan, the location of the Eastern Mediterranean freshwater biodiversity IUCN Red List assessment workshop. Photo © Kevin Smith

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2.1 Selection of priority taxa

In the majority of cases, large-scale biodiversity assessments have focused on a limited range of taxonomic groups, most often including those groups that provide obvious benefits to humans through direct consumption, or the more charismatic groups, such as mammals and birds. In the case of aquatic systems, it is the wetland birds and fishes that have received most attention. It is, however, important that we take a more holistic approach by collating information to conserve those other components of the food web essential to the maintenance of healthy functioning wetland ecosystems, even if they are neither charismatic nor often noticed. Clearly, it is not practical to assess all species. Therefore, a number of priority taxonomic groups were selected to represent a range of trophic levels within the food webs that underlie and support wetland ecosystems. Priority groups were selected to include those taxa for which there was thought to be a reasonable level of pre-existing information. The taxonomic groups selected were: fishes; molluscs; odonates (dragonflies and damselflies); and aquatic plants.

Although fish and plants provide a clear benefit to the livelihoods of many people throughout the world (Juffe-Bignoli and Darwall 2012), either as a source of income or as a valuable food supply, benefits provided by the other taxa may be indirect and poorly appreciated but nonetheless important. Given the wide range of trophic levels and ecological roles encompassed within these four taxonomic groups, information on their distributions and conservation status, when combined, will provide a useful indication of the overall status of the associated wetland ecosystems.

These same taxonomic groups have also been assessed for other parts of the world, beyond the Eastern Mediterranean region. As such, the assessments presented here through this regionally focused project also contribute towards building global coverage for these groups. Other regional freshwater biodiversity assessments conducted since 2004 include Continental Africa, many regions of Asia (for example see Allen *et al*. 2010 2012, Darwall *et al*. 2011, Molur *et al*. 2011), and Europe (Smith and Darwall 2006, Riservato *et al*. 2009, Cuttelod, Seddon, and Neubert 2011, Freyhof and Brooks 2011). The reports for these other projects can be downloaded from www.iucn.org All freshwater species of crabs (Cumberlidge *et al*. 2009), crayfish (Richman *et al*. In press) and shrimps (De-Grave *et al*. In prep) have been assessed at the global scale and the data are published on the IUCN Red List of Threatened Species™ (www.iucnredlist.org).

2.1.1 Fishes

Arguably, fishes form the most important wetland product at a global scale, and are often referred to as a 'rich food for poor people' (WorldFish Center 2005). It is estimated that freshwater fishes make up more than 6% of the world's annual animal protein supplies for humans (FAO 2007) and food security and employment for many more (Coates 1995, Dugan *et al*. 2010). For the purposes of this assessment, freshwater fishes are defined as those species that spend all or a critical part of their life cycle in fresh waters. Those species entirely confined to brackish waters are also assessed. There are almost 13,000 freshwater fish species in the world, or about 15,000 species if brackish water species are included (Lévêque *et al*. 2008). Prior to the start of this project in 2013, the risk of global extinction had been assessed for just 74 species of freshwater fish species native to the Eastern Mediterranean region using the IUCN Red List Categories and Criteria.

2.1.2 Molluscs

Freshwater molluscs are one of the most diverse and threatened groups of animals (Vaughn, Gido, and Spooner *et al*. 2004, Lydeard *et al*. 2004). They are mostly unobtrusive, and are not normally considered as being charismatic creatures, rarely attracting the attention of the popular media, unless in a negative light, as some species play a significant role (as a vector) in the transmission of human and livestock parasites and diseases. However, they play a key role in the provision of ecosystem services and are essential to the maintenance of wetlands, primarily due to their contribution to water quality and nutrient cycling through filter-feeding, algal-grazing and as a food source to other animals (see Strayer 1999, Vaughn, Gido, and Spooner 2004, Vaughn 2010, Prather *et al*. 2012). Some species are of high commercial importance to humans as food or ornaments (e.g., clams and some mussels and snails). There are just fewer than 5,000 freshwater mollusc species (Bogan 2008; Strong *et al*. 2008) for which valid descriptions exist, in addition to a possible 4,000 undescribed gastropod species (Strong *et al*. 2008). Only 41 freshwater mollusc species from the Eastern Mediterranean region had been assessed for the IUCN Red List prior to the initiation of this assessment in 2013.

2.1.3 Odonates

Larvae of almost all species of dragonflies and damselflies (order Odonata) are dependent on freshwater habitats. The habitat selection of adult dragonflies strongly depends on the terrestrial vegetation type, and their larvae develop in water where they play a critical role with regards to water quality, nutrient cycling, and aquatic habitat structure. The larvae are voracious predators, often regarded as important in the control of insect pest species. A full array of ecological niches is represented within the group and, as they are susceptible to changes in water flow, turbidity, or loss of aquatic vegetation (Trueman and Rowe 2009), they have been widely used as an indicator for wetland quality. There are approximately 5,680 extant described species. However, even though the group is well studied, it is believed that the actual number is close to 7,000 species (Kalkman *et al*. 2008). Of these, only 70 species of odonates known from the Eastern Mediterranean region had been assessed for the IUCN Red List prior to the initiation of this assessment in 2013.

A male Spearhead bluet damselfly (*Coenagrion hastulatum*). Odonata (dragonflies and damselflies) are susceptible to many types of pressures to wetland ecosystems making them good indicator species. Photo © Jean-Pierre Boudot

2.1.4 Freshwater plants

Freshwater plants are the building blocks of wetland ecosystems, providing food, oxygen and habitats for many other species. They are also a hugely important natural resource, providing direct benefits to human communities across the world. Numerous species are highly valued for their nutritious, medicinal, cultural, structural, or biological properties. They are also key species in the provision of wetland ecosystem services, such as water filtration and nutrient recycling (Garcia-Llorente *et al.* 2011). A freshwater plant is defined here as a plant that is dependent upon wetlands, meaning it would not occur if there were no wetlands (permanent or seasonal/intermittent). The number of freshwater plants in the world is unknown, as identifying which plants would qualify as wetland dependent is not an easy task, as some species are even 'wetland dependent' in only parts of their range. There are an estimated 30,000 wetland dependent plant species, including vascular plants, bryophytes, algae, and a small number of lichens (Lansdown, pers. comm. 2014). Cook (1996) estimates that 'aquatic plants' (a more restrictive definition than 'wetland dependent') represent between 1% and 2% of all plant species, and Chambers *et al.* (2008) identify 2,614 'aquatic' (again a more restrictive definition) macrophytes in the world. One hundred and seventeen species of freshwater plants in the Eastern Mediterranean had been assessed for the IUCN Red List prior to the initiation of this assessment in 2013.

Freshwater plants are key providers of ecosystem services such as water filtration and nutrient cycling. *Juncus heterophyllus.* Photo © Richard V. Lansdown

2.2 Eastern Mediterranean region delineation

This project focuses on the eastern part of the Mediterranean Hotspot in Turkey, Syria, Lebanon, Israel and Jordan as delineated by Myers *et al*. (2000), Mittermeier *et al*. (2004), and CEPF (2010) (see www.conservation.org/How/Pages/Hotspots.aspx and www.cepf.net). We have, however, expanded the project area to incorporate all catchments originating within countries overlapping the Hotspot boundaries, including the Euphrates and Tigris, and all catchments within Turkey (see Figure 2.1). This wider 'catchment' approach takes into consideration the high levels of interconnectivity within freshwater ecosystems, as impacts in one part of a catchment can easily and quickly be transported downstream (or upstream) potentially threatening freshwater biodiversity many miles from the original source of impact. Exclusion of species in those connected parts of catchments outside of the Hotspot boundaries would also not follow the principles of 'Integrated River Basin Management' (IRBM) which call for the management (including conservation) of rivers to be undertaken at the catchment level so the effects of any management proposals are developed with all stakeholders (including biodiversity) throughout the catchment.

2.3 Data collation and quality control

Information was sourced and collated for all known species within the priority taxonomic groups (see Section 2.1). Experts from across the Eastern Mediterranean region and beyond (as necessary) were identified by IUCN, the Royal Society for the Conservation of Nature Jordan (project partner), and through consultation with the relevant IUCN Species Survival Commission (SSC) Specialist Groups.

A number of participating experts were contracted to collate species lists for the region for the priority taxonomic groups, and to input within the IUCN species database (Species Information Service – SIS) all available information on each species. Where needed these experts were trained (remotely) in the use of SIS and application of the IUCN Red List Categories and Criteria (IUCN 2001). The required data fields within SIS are summarized in Table 2.2; some are free text fields allowing assessors to add general information such as species distributions, habitat preferences and ecology, whereas other fields are classification schemes using pre-defined lists to record attributes. Standard classification schemes allow for consistency in analysis across other taxonomic groups and geographic regions. For more

Figure 2.1 Project region map. Map showing the Mediterranean Hotspot and the wider project assessment region.

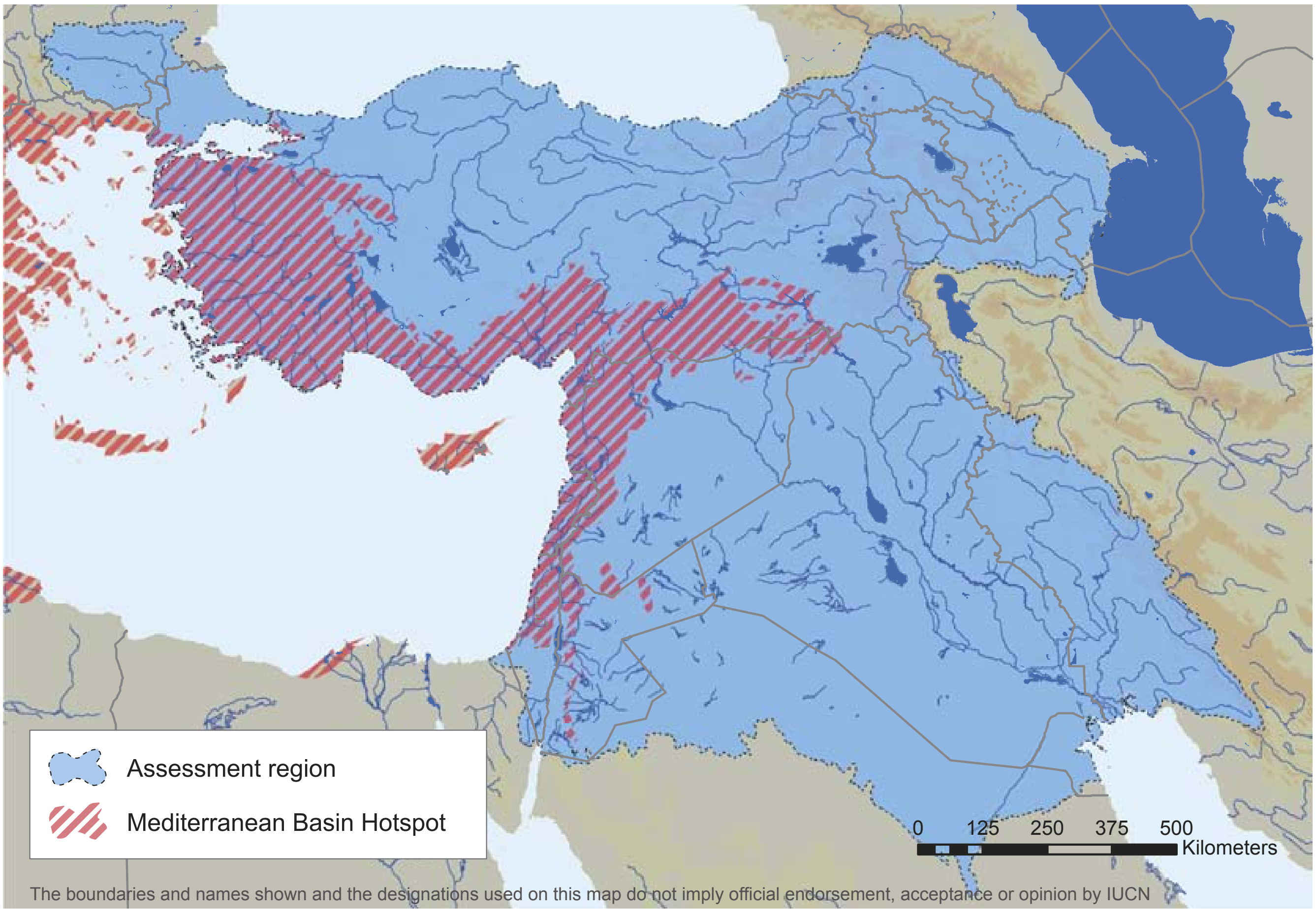

Table 2.2 Data fields within the Species Information Service (SIS) as required to compile a species assessment. Text = text field; CS = predefined Classification Scheme.

	Fields			
Taxonomy	Higher taxonomy	Synonyms	Common names	
Geographic range	General information (text)	Countries of occurrence (CS)	Biogeographic realm (CS)	
Population	General information (text)	Population trend (CS)		
Habitat and ecology	General information (text)	Habitats (CS)	System (CS)	Movement patterns (CS)
Use and trade	General information (text)	Utilization (CS)	Harvest trends (CS)	
Threats	General information (text)	Threats (CS)		
Conservation measures	General information (text)	Conservation actions needed and in-place (CS)	Research needed and in-place (CS)	
Red List assessment	Red List Category and Criteria (CS)	Red List assessment rationale (text)	Assessor and Reviewer names	Assessment and Review date
Bibliography	References			

information on the classification schemes employed visit the IUCN Red List website (http://www.iucnredlist.org/technical-documents/classification-schemes).

Spatial data were sourced for the production of species distribution maps (see Section 2.4). All species from the selected taxonomic groups were then assessed for their risk of global extinction according to application of the IUCN Red List Categories and Criteria version 3.1 (IUCN 2012) (see Section 2.5).

The species information and draft Red List assessments were then reviewed at a workshop where each species assessment was evaluated by independent experts to ensure that: i) the information presented was both complete and correct; and ii) the Red List Categories and Criteria had been applied correctly.

2.4 Species mapping

Species distributions were mapped to individual river/lake sub-basins, as delineated by HydroBASINS which is a digital global coverage of sub-basins at 12 different scales/levels (Lehner and Grill 2013) using GIS software. Most species were mapped to HydroBASIN 'Level 8' and, for restricted range species, 'level 10'. Within the Eastern Mediterranean assessment region there are 3,636 individual sub-basins with an average area of 595 km^2 at 'Level 8', and 16,873 sub-basins with an average area of 128 km^2 at 'level 10'. All geo-spatial results within this report are presented using the 'Level 8' HydroBASINS layer (Figure 2.2).

Sub-basins were selected as the spatial units for mapping species distributions as, even though it is recognized that

Participants of the Eastern Mediterranean Red List assessment workshop held at Azraq Oasis Lodge, Jordan, April 2013. Left to right: Atheer Ali (fish); Richard Lansdown (plants); Güler Ekmekci (fish); Ümit Kebapçi (molluscs); Hossein Akhani (plants); Kevin Smith (IUCN); Jörg Freyhof (fish); Salih Kavak (plants); David Allen (IUCN); Mary Seddon (molluscs); Catherine Numa (IUCN); Manuel Lima (molluscs); Halil Çakan (plants).

species ranges may not always extend throughout a river sub-basin, it is generally accepted that the river/lake basin or catchment is the most appropriate management unit for inland waters (Watson 2004).

Point localities (the latitude and longitude where a species was recorded) and other published data were used in most cases to identify which sub-basins are known to currently contain each species. Using a combination of expert opinion, course scale distribution information and unpublished literature it has also been possible to identify sub-basins where a species is 'probably' present. For many plant species, mainly those with large distribution ranges, the absence of easily accessible information on spatial distributions has limited delineation of range maps to species presences within countries. However, all the threatened plant species have been mapped to HydroBASINS using the same methods as for other taxonomic groups.

2.5 Overlap with other Red List assessment projects

The Red List status of a number of species present within the Eastern Mediterranean region has previously been assessed through other IUCN biodiversity assessments. These include the European and Mediterranean assessments (see Smith and Darwall 2006, Riservato *et al.* 2009, Cuttelod, Seddon, and Neubert 2011, Freyhof and Brooks 2011), the pan-Africa assessment (Darwall *et al.* 2011) and the Sample Red List Index (SRLI) assessment. The species assessments from these other projects are incorporated into this Eastern Mediterranean assessment and can be found on the IUCN Red List of Threatened Species (www.iucnredlist.org).

2.6 Assessment of species threatened status

The risk of extinction for each species was assessed according to the IUCN Red List Categories and Criteria: Version 3.1 (IUCN 2012).

The nine possible Red List Categories are given in Figure 2.3. A species assessed as 'Critically Endangered' is considered to be facing an extremely high risk of extinction in the wild. A species assessed as 'Endangered' is considered to be facing a very high risk of extinction in the wild. A species assessed as 'Vulnerable' is considered to be facing a high risk of extinction in the wild. All taxa listed as Critically Endangered, Endangered or Vulnerable are described as 'threatened'. Species assignment to each of the three threatened Categories is determined according to five criteria with quantitative thresholds (Table 2.3).

Figure 2.2 Sub-basins of the Eastern Mediterranean region, as delineated by HydroBASINS 'Level 8' (Lehner and Grill 2013), used to map and analyze species distributions.

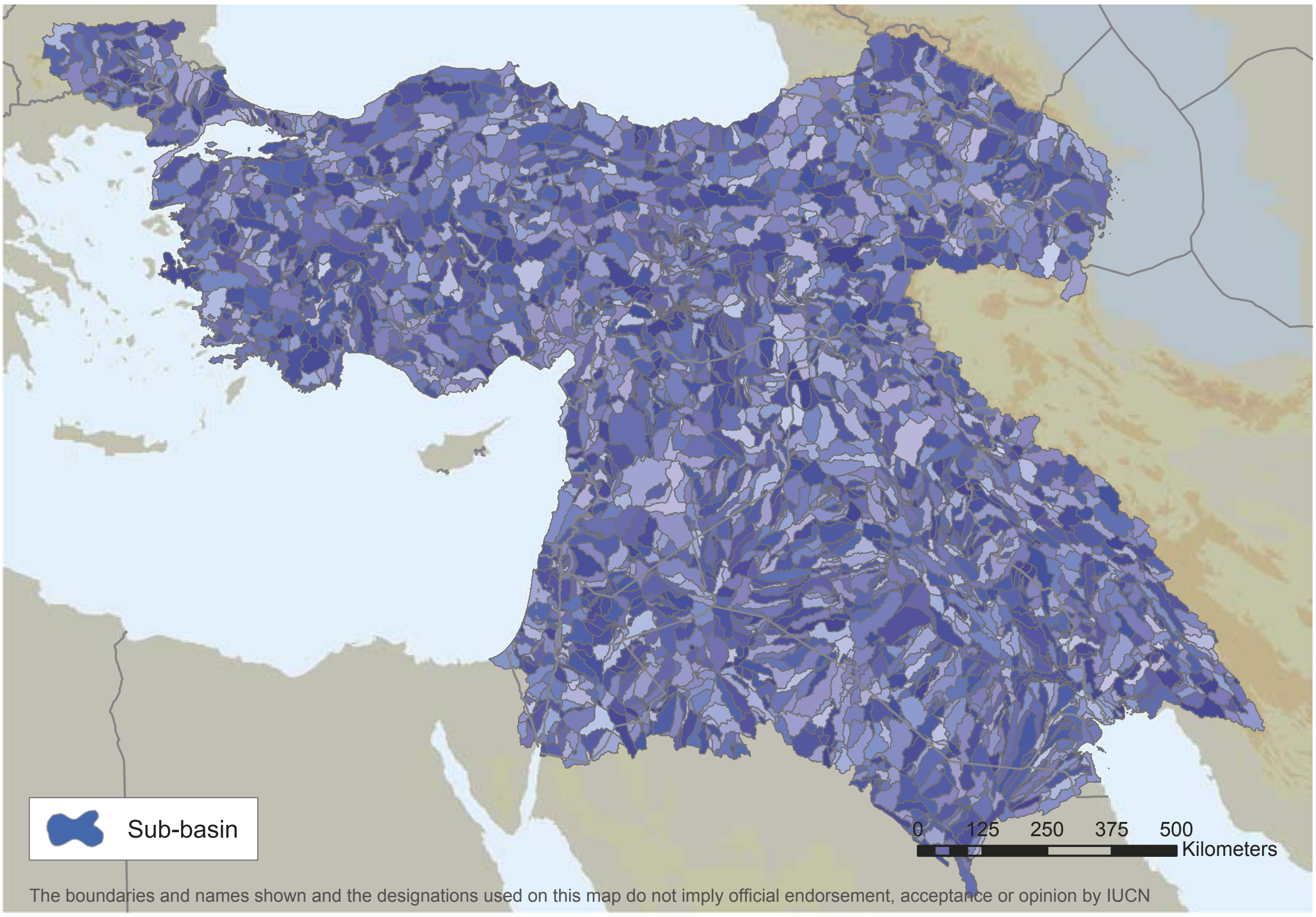

Table 2.3 Summary of the five criteria (A–E) used to determine the category of threat for a species.

A. Population size reduction. Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4

	Critically Endangered	Endangered	Vulnerable
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3 & A4	≥ 80%	≥ 50%	≥ 30%

A1 Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible **AND** understood **AND** have ceased.

A2 Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased **OR** may not be understood **OR** may not be reversible.

A3 Population reduction projected, or suspected to be met in the future (up to a maximum of 100 years) based on (b) to (e) under A1.

A4 An observed, estimated, inferred, projected or suspected population reduction (up to a maximum of 100 years) where the time period must include both the past and the future, and where the causes of reduction may not have ceased **OR** may not be understood **OR** may not be reversible, based on (a) to (e) under A1.

based on any of the following:

(a) direct observation
(b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy (AOO), extent of occurrence (EOO) and/or habitat quality
(d) actual or potential levels of exploitation
(e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)

	Critically Endangered	Endangered	Vulnerable
B1. Extent of occurrence (EOO)	< 100 km^2	< 5,000 km^2	< 20,000 km^2
B2. Area of occupancy (AOO)	< 10 km^2	< 500 km^2	< 2,000 km^2
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented **OR** Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline in any of: **(i)** extent of occurrence; **(ii)** area of occupancy; **(iii)** area, extent and/or quality of habitat; **(iv)** number of locations or subpopulations; **(v)** number of mature individuals.			
(c) Extreme fluctuations in any of: **(i)** extent of occurrence; **(ii)** area of occupancy; **(iii)** number of locations or subpopulations; **(iv)** number of mature individuals.			

C. Small population size and decline

	Critically Endangered	Endangered	Vulnerable
Number of mature individuals	< 250	< 2,500	< 10,000
AND either C1 or C2			
C1. An estimated continuing decline of at least: (up to a max. of 100 years in future)	25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
C2. A continuing decline **AND** (a) and/or (b):			
(a) **(i)** Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
(ii) % of mature individuals in one subpopulation =	90–100%	95–100%	100%
(b) Extreme fluctuations in the number of mature individuals			

D. Very small or restricted population

	Critically Endangered	Endangered	Vulnerable
D. Number of mature individuals	< 50	< 250	**D1.** < 1,000
	Restricted area of occupancy		**AND/OR** **D2.** typically: AOO < 20 km^2 or number of locations ≤5

E. Quantitative Analysis

	Critically Endangered	Endangered	Vulnerable
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations (100 years max.)	≥10% in 100 years

1 Use of this summary sheet requires full understanding of the *IUCN Red List Categories and Criteria* and *Guidelines for Using the IUCN Red List Categories and Criteria*. Please refer to both documents for explanations of terms and concepts used here.

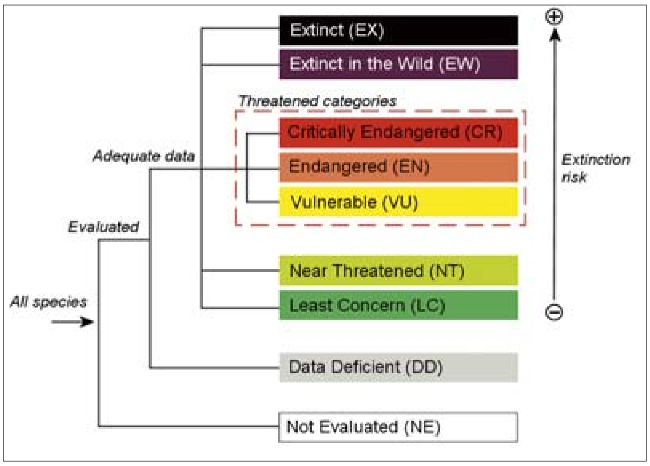

Figure 2.3 IUCN Red List Categories at a global level.

For a more detailed explanation of the Categories and Criteria please refer to the following documentation: The IUCN Red List Categories and Criteria: Version 3.1, which can be downloaded from http://www.iucnredlist.org/technical-documents/categories-and-criteria.

Species summaries and global distribution maps are published on the IUCN Red List of Threatened Species website (www.iucnredlist.org). Species spatial can be downloaded as GIS shapefiles from http://www.iucnredlist.org/technical-documents/spatial-data. For those who may not have access to the internet the species summaries and GIS shapefiles for the species ranges can be found on an accompanying DVD. Due to space limitations on the DVD species range maps are restricted to those parts of the range within the Eastern Mediterranean region. Please see the IUCN Red List website if you want to view or download species full global ranges. An example output is given in Appendix 1. It is important to note that the information included on the DVD will become outdated as species are re-assessed.

2.7 Nomenclature

Taxonomic schemes are constantly changing as results from ongoing studies are made available, in particular with the introduction of molecular techniques. Taxonomy is also a somewhat controversial field and in many cases it is difficult to find a universally agreed taxonomic hierarchy. In this assessment the taxonomy followed is that adopted by the IUCN Red List which, where possible, employs existing published world checklists. Fish classification follows the online Catalog of Fishes maintained at the California Academy of Sciences (Eschmeyer 2014). Odonate classification generally follows the World Odonata List maintained at the University of Puget Sound (Schorr and Paulson 2010). There is currently no widely accepted single taxonomy for molluscs and we therefore follow the standards recommended by the IUCN SSC Mollusc Specialist Group. For plants, where appropriate, we follow the World Checklist of Selected Plant Families hosted by the Royal Botanic Gardens, Kew (WCSP 2014), but other more specialist lists are also followed, such as the Checklist of Ferns and Lycophytes of the World (Hassler and Schmitt 2014) and Algaebase (Guiry and Guiry 2014). For more information on the taxonomic standards of the IUCN Red List visit http://www.iucnredlist.org/technical-documents/information-sources-and-quality#standards.

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Chapter 3. Freshwater fishes

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3.1 Overview of the regional fish fauna

3.1.1 Freshwater fish diversity

The Eastern Mediterranean region covers all of Turkey and the Levant, the southern Caucasus, and Mesopotamia. It overlaps with three Biodiversity Hotspots (Myers *et al.* 2000, www.cepf.net): the Mediterranean Basin, Irano-Anatolia, and the Caucasus, and incorporates 14 freshwater ecoregions (Abell *et al.* 2008, WWF/TNC 2013), most of which are only found within the region (see Chapter 1, Figures 1.1 and 1.2).

In terms of IUCN Red List assessments for freshwater fish, this study fills a large geographic gap between Europe, which has been assessed by Freyhof and Brooks (2011), Africa (Darwall *et al.* 2011), Arabian Peninsula (Freyhof *et al.* in prep) and the on-going assessment of the freshwater fishes of Iran.

According to this assessment, there are 322 species of freshwater fishes present in the Eastern Mediterranean region, two thirds (66.8% / 215 species) of which are endemic to the region, with an additional 10 species that are near-endemics (i.e. with only small parts of their range outside the region). There are also at least 84

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additional 'species' that have been recognized from the area, but most of them currently remain undescribed and therefore have not been included in this assessment.

3.1.2 Geographical factors affecting the distribution of freshwater fishes

Biogeographical and hydrological factors are the major drivers of biodiversity patterns in freshwater fishes in the region. With 14 ecoregions, each with its own set of endemic species, the Eastern Mediterranean region is biogeographically highly structured (Küçük *et al*. 2009). There is a slow but continuous transition from the Mediterranean fauna in Greece and Western Turkey, to the fauna of the Euphrates and Tigris in the east. In Western Anatolia, most genera have close affinities to genera in Greece or to those of the northern Black Sea basin, however there are members of the cyprinid *Capoeta* present, a genus which is absent from adjacent Europe but widespread all over the Middle East except in the southern Arabian Peninsula (Levin *et al*. 2012). This is also the case in Central Anatolia, where most species belong to genera in common with Europe except the cyprinid genus *Pseudophoxinus*, which is almost endemic to the Eastern Mediterranean region and has its highest species diversity in Central Anatolia (Hrbek *et al*. 2004, Perea *et al*. 2010, Küçük *et al*. 2013). Freshwater fishes of the southern Caucasus belong mostly to the same genera as those from the northern Black Sea basin and the Caspian Sea basin, with the Kura-Aras River being mostly inhabited by widespread species of the Caspian Sea basin. However, all these rivers have a considerable number of endemic species indicating their long-lasting biogeographical isolation. The rivers of the Black and Caspian basin also have had recent connections to the upper Euphrates as several species of loaches are found in adjacent headwater streams in the Black Sea basin and in the upper Euphrates (for example *Oxynoemacheilus bergianus*). Another example is the presence of the Levantine cyprinid genus *Acanthobrama* in the Kura and Aras drainage (Perea *et al*. 2010). Mediterranean rivers such as the Seyhan, Asi and Jordan all have a fish fauna which is similar to the Euphrates including typical Mesopotamian species such as the cyprinids *Garra rufa* and *Capoeta damascina*, and the killifish *Aphanius mento* (Krupp 1985). At the species level, a highly endemic fauna inhabits Mesopotamia itself but most species belong to genera that are also found in Europe and Anatolia. Several oriental genera are also represented, for example cyprinids of the genera *Barilius*, *Garra* and *Cyprinion* and a species of Mastacembelid spiny eel, several sisorid and one bagrid catfish, and loaches of the genera *Turcinoemacheilus* and *Paraschistura*. Several Mesopotamian species are more widespread in the Arabian / Persian Gulf basin and may occur south to the Gulf of Hormuz in Iran (Abdoli 2000).

In the Eastern Mediterranean, there are many places with locally endemic fishes. The Melendiz River, one of the few streams in Lake Tuz basin, Turkey, is the only habitat of the cyprinids *Gobio gymnostethus* (CR) and *Squalius cappadocicus* (CR). Other threatened species such as *Capoeta mauricii* (EN) and *Oxynoemacheilus eregliensis* (VU) also occur here making it an important site for fish conservation. Photo © Jörg Freyhof

As in most parts of the world, ecological factors determine freshwater fish diversity within a given biogeographical unit. Species diversity increases with stream order, and in the Eastern Mediterranean region it is typically trouts of the genus *Salmo* that are found in the mountain streams (Turan, Kottelat, and Engin 2009 2012, Turan, Kottelat, and Bektaş 2011). As these streams become slightly larger and warmer, several loaches of the genus *Oxynoemacheilus* occur together with cyprinids from the genera *Capoeta, Barbus,* and *Squalius*, and in larger streams additional cyprinid species and *Cobitis* loaches are also found. In the lower sections of streams euryhaline fishes from the families Clupeidae, Mugilidae, and Gobiidae are common. In the Shatt Al-Basrah canal, in the lower Euphrates drainage, the Bull Shark *Carcharhinus leucas* (NT) is found (Hussain *et al*. 2012), however before river regulation, this shark occurred regularly upriver to Baghdad (Coad 2010). Larger rivers in the region, including a number of Black and Mediterranean Sea catchments and the Euphrates/Tigris are (or were historically) visited by anadromous migratory species such as shads of the genera *Alosa* and *Tenualosa,* and sturgeons (*Huso huso*, *Acipenser* spp.) as well as several migratory cyprinids including *Rutilus frisii* (LC) and *Luciobarbus* species.

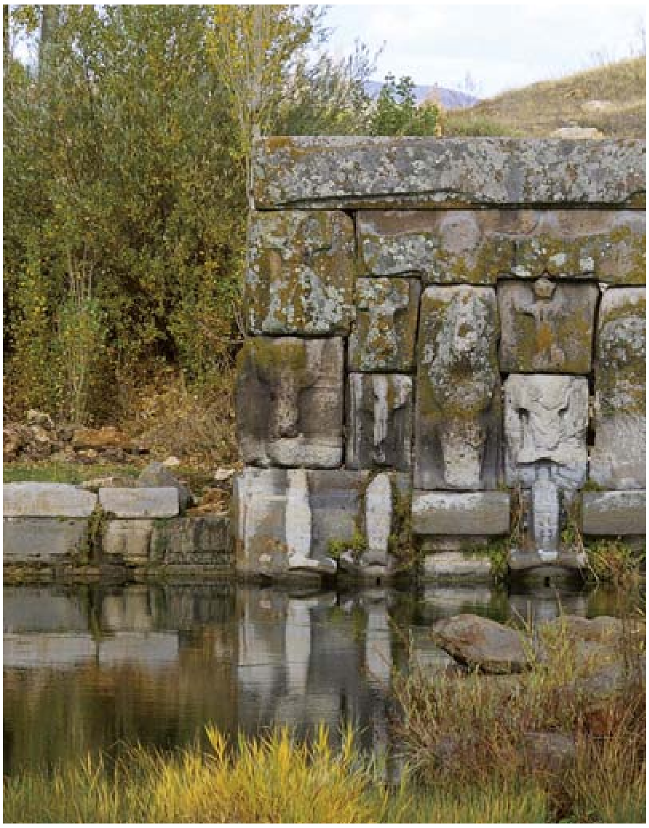
Loaches of the genus *Oxynoemacheilus* are widespread but poorly known in the Eastern Mediterranean region. Thirty-four species have been assessed, all but three are endemic to the region, and 13 species are threatened. From the top: *O. galilaeus* (CR) from Lake Muzarib in Syria, *O. seyhanensis* (CR) known only from a stream in upper Seyhan in Turkey, and *O. tigris* (CR) restricted to the upper Qweik in Turkey. Photo © Jörg Freyhof

Most lakes in the region are relatively shallow, but they contain a highly endemic fish fauna (especially in Central Anatolia), most of which also occur in the lake tributaries. The truly specialized lacustrine fishes are especially vulnerable to the introduction of non-native invasive fishes (Küçük *et al*. 2012), and this has led to three species becoming extinct (*Alburnus akili*, *Aphanius splendens*, *Pseudophoxinus handlirschi*). Only two Central Anatolian specialized lacustrine fishes have survived until today, these are *Aphanius saldae* (not yet assessed but likely to be CR) (in Lake Salda) and *Aphanius sureyanus* (EN) (in Lake Burdur). In Eastern Anatolia and in the Caucasus, there are still three lakes (Lake Hazer, Lake Van, and Lake Sevan) holding endemic lacustrine fish species. In Central Anatolia several lakes, including Lake Aci, Lake Büget, Lake Gölhisar, Lake Söğüt, and Lake Hotamış, have all dried up, however their fish fauna still survive in the lakes spring-fed tributaries which now have a much higher conservation value than the lakes themselves. Springs (and spring-fed streams) are one of the most important habitats for freshwater fish conservation in the region, as they are often the only permanent waters in arid areas becoming refuges for many freshwater fishes. This can be seen in many places in Central Anatolia, the Ammiq wetland in Lebanon, the Damascus basin in Syria and all along the Syrian and Dead Sea coasts. Also, many lakes in the Eastern Mediterranean region have dried out several times during the Pleistocene and most fish species are adapted to survive in streams and springs.

3.1.3 Taxonomic issues

Incomplete knowledge of biodiversity due to taxonomic uncertainty remains a significant stumbling block for conservation planning in the region, including for the identification of Alliance for Zero Extinction (AZE) sites (Ricketts *et al*. 2005), and the delineation for freshwater Key Biodiversity Areas (KBAs) (Darwall *et al*. 2011, Holland, Darwall, and Smith 2012). While the vast barcoding library published recently by Geiger *et al*. (2014) is a remarkable step forward in tackling this issue, efforts are still urgently needed to resolve many taxonomic problems within the region's fish fauna. Although there has been a reasonable amount of taxonomic research on the freshwater fishes of the Eastern Mediterranean, the species richness of several genera is still not completely resolved and there are many undescribed species. Recently, Geiger *et al*. (2014) presented an updated list of freshwater fishes of the Mediterranean Biodiversity Hotspot recognizing 526 species, and suggested the occurrence of an additional 64, mostly undescribed species from the area. The lead author's (of this chapter) own unpublished checklist includes 85 undescribed and unresolved 'species', which occur in

The spring Eflatun Pınar with a Hittite temple from 3,500–3,770 years BCE. This small tributary of Lake Beyşehir is of major importance for fish conservation. It is the habitat of *Capoeta mauricii* (EN), *Cobitis battalgili* (EN), *Pseudophoxinus hittitorum* (EN), and *Aphanius anatoliae* (NT). Photo © Jörg Freyhof



The Şaşal stream, Gümüldür drainage in the Aegean basin, supports the regional endemics *Squalius kosswigi* (EN), *Alburnus demiri* (VU), and *Chondrostoma holmwoodii* (VU). Photo © Jörg Freyhof

Taxonomic uncertainty is harming conservation of freshwater fishes in the region. *Pseudophoxinus elizavetae* (CR) is one of five endemic species to the Sultan marshes, three of which are yet to be described. Photo © Jörg Freyhof

the assessment region. None of these undescribed or unresolved 'species' have been assessed for this study, which focuses only on currently described species. It is important to note that while these have not been included, they represent 21% of the freshwater fish fauna known from the area. An example is the Turkish Sultan marshes, which supports five endemic freshwater fishes. This marsh area has been largely drained and only a group of springs from one groundwater aquifer remains. Only two of the five species (*Aphanius danfordii*, *Pseudophoxinus elizavetae*) have been described, and both of them have been assessed as CR, but the other three, still undescribed species, occur in the same habitat (*Cobitis* sp., *Oxynoemacheilus* sp., and *Seminemacheilus* sp.) sharing the same level of risk of global extinction with the two named species.

3.1.4 Limitations of data availability and reliability

The lack of information is even greater when considering species' ecological needs, and population trends. Such data are virtually absent from the region and we are only aware of very few (e.g. *Aphanius sirhani* CR, *Acanthobrama telavivensis* VU) long-term monitoring programmes focusing on threatened, non-commercial freshwater fishes. In vast areas, and for only a few species, statistics of commercial catches are the only long-term source of trend information, which comes with a variety of caveats. Most of the regions ichthyological experts gained their knowledge as a side product from other studies, and there are limited resources within the region to allow for field visits and research on freshwater fishes. There is an urgent need to set up long-term monitoring programmes focused on threatened species particularly in the areas with high threat levels such as Central and Western Anatolia (see 3.3.2). The situation is urgent in some of these areas as several freshwater fishes may become extinct in the near future, largely unnoticed even by the conservation community. For most of the area studied

Will all free-flowing large rivers be lost one day? The Tigris at Hasankeyf is one of the very last habitats of the riverine specialist *Luciobarbus subquincunciatus* (CR), and hosts several other threatened fish species. But the Ilısu dam if constructed will submerge not only the 12,000-year-old ancient town but also destroy habitats for all riverine fish species. Photo © Jörg Freyhof

There may be fewer leopard barbels, *Luciobarbus subquincunciatus* (CR), than leopards in the Euphrates and Tigris drainage basin. This Mesopotamian fish species seems to be at the very border of extinction. Photo © E. Ünlü

here, published information is scarce or old, and difficult to access. This presents problems in terms of data availability and reliability. Most current information comes from personal communications and recent fieldwork by the authors and contributors to the species Red List assessments. In addition, recent fieldwork has been virtually impossible in Syria and large parts of Iraq due to political instability. One of the most threatened species in the region is *Luciobarbus subquincunciatus* (CR), which was once widespread in the Euphrates and Tigris drainage, but there are now very few recent records and the species may be at the very border of extinction. But recent political instability in Syria and Iraq make it impossible to search comprehensively for this species. Contemporary fieldwork is strongly recommended, when security allows, to gain up-to-date data on the conservation status of freshwater fishes especially in these areas. The lack of information is also true for the threats acting upon freshwater systems in the region which are little known in terms of their distribution and severity, especially the extent of water extraction and the construction of new dams. Fisheries statistics for several threatened species such as *Luciobarbus esocinus*, *L. xanthopterus,* and *Barbus grypus* (now in the genus *Arabibarbus*) (all VU) are only very limited making it difficult to assess the decline of these species, and it is hard to see this situation improving in the future.

3.2 Conservation status

This assessment applied the IUCN Red List Categories and Criteria (IUCN 2012) to identify the global risk of extinction for all (322) currently described species of freshwater fishes in the Eastern Mediterranean region.

Of the 322 species assessed, 123 species (41% of extant species where there is sufficient information to identify an extinction risk) are considered threatened (those assessed as CR, EN, or VU), with an additional 20 species (6.7%) considered Near Threatened (Appendix 2, Figure 3.1). Just over a half (52.3% / 157 species) are assessed as Least Concern being relatively widespread and often inhabiting many independent rivers and streams. Sixteen species (5% of all described species in the region) are considered Data Deficient (meaning there was insufficient information available to make an assessment of extinction risk, due to unresolved taxonomic problems or lack of information),

Figure 3.1 Number of species of Eastern Mediterranean freshwater fish species in each IUCN Red List Category.

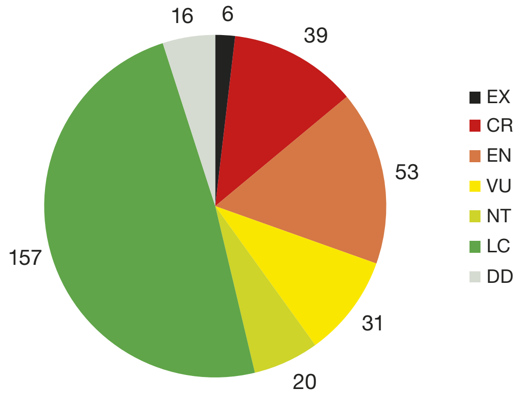
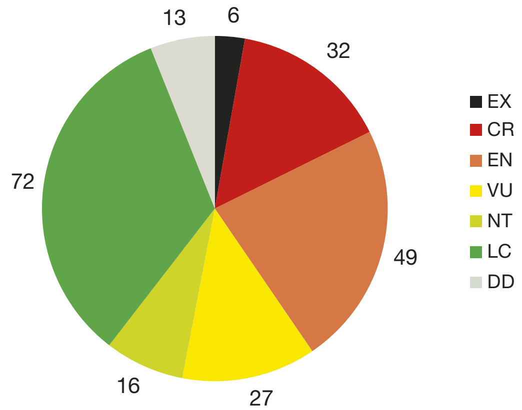


Figure 3.2 Number of Eastern Mediterranean endemic freshwater fish species in each IUCN Red List Category.



and six species (1.9%) are classed as Extinct. It is important to note that 13 species assessments are still classed as *draft* Red List assessments as they are waiting to be passed by the relevant SSC Specialist Group (this includes all nine species of *Salmo* from the region). Two thirds of all the fish species (66.8% / 215 species) are endemic to the Eastern Mediterranean region, but this includes 87.8% (107 species) of all threatened species. When just regional endemics are used, the proportion of threatened species rises to 55.1% (Figure 3.2).

3.3 Patterns of species richness

3.3.1 All fish species

From a global perspective, the freshwater fish fauna of the Eastern Mediterranean region is very species rich for a temperate region. From the region 322 species have been described, but when the currently known undescribed species are included this figure is thought to be about 400. However, at the sub-basin scale (note: species are mapped to sub-basins, see Chapter 2) centres of species richness are much lower when compared to species rich sub-basins in Europe, where up to 94 species are recorded from one sub-basin in the lower Danube River (Kottelat and Freyhof 2007, Freyhof and Brooks 2011). As in Europe, the areas of the highest species richness in the Eastern Mediterranean (2743 species per sub-basin) are situated along the Black and Caspian Sea coasts (Figure 3.3). The areas with next highest species richness (19–26 per sub-basin) are found across the Tigris and Euphrates catchments, and in the middle and upper Aras and Kura drainages in Azerbaijan, Georgia, and Armenia. Most of Central and Mediterranean Anatolia and the Levant have the lowest levels of species richness per sub-basin with between 1 and 18 species per sub-basin, which is similar to Mediterranean areas in Greece, southern and central Italy, North Africa, and the Iberian Peninsula (Garcia, Cuttelod, and Abdul Malak 2010, Freyhof and Brooks 2011). As in these areas, while richness is relative low, local endemism is very high and is mostly due to a few genera, which have many allopatric species endemic to one or few sub-basins. For example, 14 species of *Cobitis*, 14 species of *Aphanius,* and 20 (one EX) species of *Pseudophoxinus* are endemic to Central Anatolia and adjacent southern Anatolia. With very few exceptions, only one species of each genus occurs per basin.

3.3.2 Threatened species

The sub-basins with the greatest number of threatened freshwater fishes (between six and eight) in the Eastern Mediterranean region are the lower Orontes/Asi River in Turkey, the drainages of Lake Işıklı and Lake Beyşehir in south-western Anatolia, lower parts of rivers entering the Caspian Sea coast in Azerbaijan, and in the middle Euphrates in Iraq incorporating the Haditha karst system (Figure 3.4).

Most species in the area are threatened by water extraction, and one example is the Orontes/Asi River which has its source (a spring) in northern Lebanon and flows through Syria to Turkey and is subjected to intensive groundwater extraction for agriculture. This has resulted in the depletion of the water storage in the aquifers, lowering of the groundwater table, and considerable reduction of the spring yield (AQUASTAT 2009). The river hosts six threatened species: the loaches *Cobitis levantina* (EN) and *Oxynoemacheilus hamwii* (EN), the cyprinids *Alburnus orontis* (VU), *Capoeta barroisi* (EN), and *Chondrostoma kinzelbachi* (EN), and the eel *Anguilla anguilla* (CR). Also two NT species (*Squalius kottelati*, *Carasobarbus chantrei*) occur in the catchment. Furthermore, the CR Possibly Extinct cyprinid *Acanthobrama centisquama* is (was) endemic to the Asi, known from Lake Amik, a large freshwater lake which is now dry (drained to grow cotton) in southern Turkey. Other permanent water bodies are very rare in its surroundings and the water table has fallen dramatically (Ozelkan, Avcı Uca, and Karaman 2011). In 2007, the Hatay Airport was constructed in the centre of the old lake bed.

In some Syrian parts of the Asi/Orontes River large-scale water extraction has resulted in such a low water table that many

Lake Meyil in the Lake Tuz basin. This fast drying out obruk (sinkhole) lake is the habitat of one of the last populations of *Hemigrammocapoeta kemali* (now *Garra*) (EN). Photo © Jörg Freyhof

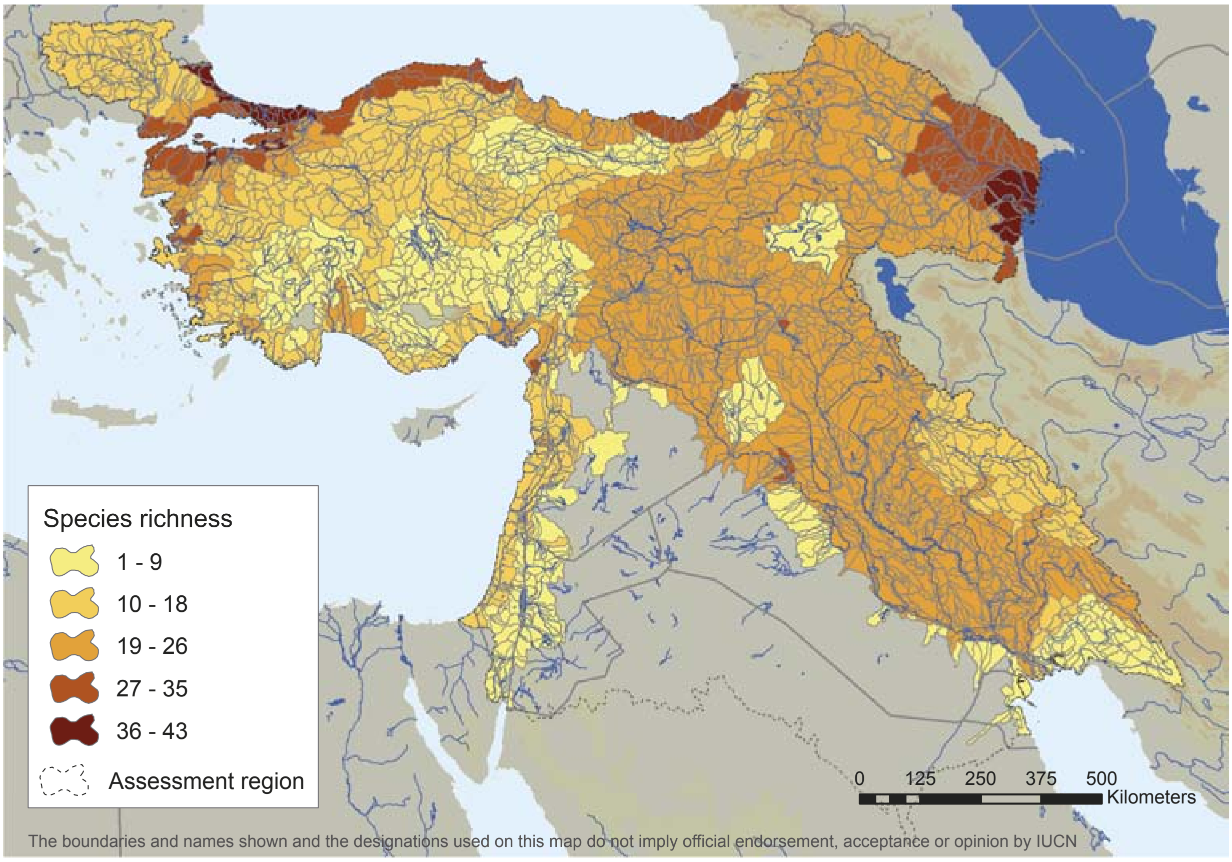
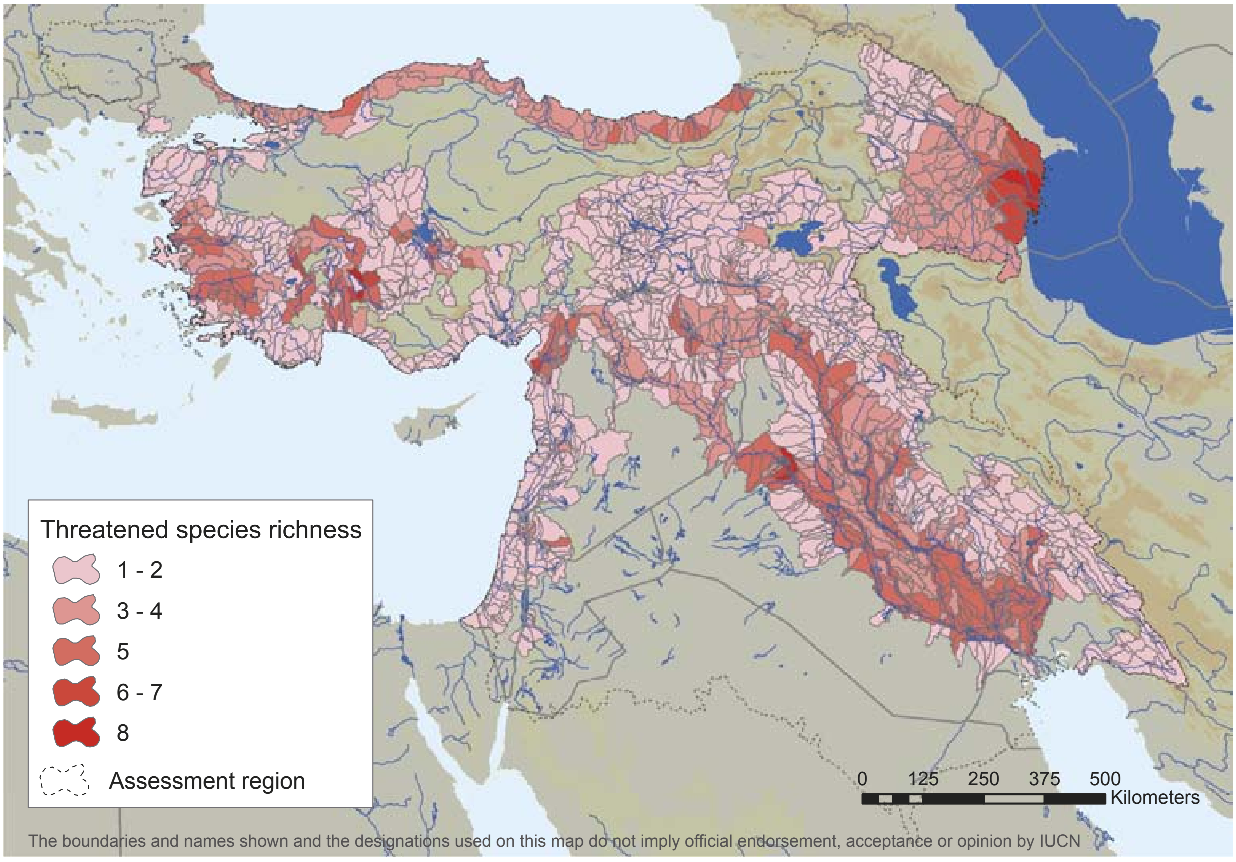


Figure 3.3 Eastern Mediterranean freshwater fish species richness. Species richness = number of species per sub-basin (defined by HydroBASINS 'Level 8', Lehner and Grill 2013).

Figure 3.4 Eastern Mediterranean threatened freshwater fish species richness. Species richness = number of species per sub-basin (defined by HydroBASINS 'Level 8', Lehner and Grill 2013).



The Lower Asi/Orontes River in the Al Ghab region in Syria. Only a few fish species now occur in this highly polluted and almost dried out stretch of the river. Photo © Jörg Freyhof

Lower Asi River downstream of the Al Ghab region in Syria. Large springs feed a clear river full of fishes including several threatened species. Photo © Jörg Freyhof

streams have fallen dry and the river itself almost dries out during summer. Furthermore, large cities pollute the waters in the area to such an extent that in some localized areas the river 'water' is mostly sewage. Now only a few areas of large freshwater springs and spring fields along the riverbed of the Asi allow fish to survive, however pressures will only increase in the future with reduced rainfall due to climate change, and the growing economies and populations increasing the demands for water in the area. The situation is so dire that *Capoeta barroisi* (EN) and *Chondrostoma kinzelbachi* (EN) mostly exist only in the large reservoirs where water is stored for irrigation, as they can no longer inhabit the polluted river. Such combinations of water stressors are a very common situation in the Mediterranean, Azerbaijan, Mesopotamia, and Central Anatolia, and especially across the Levant. Current rates of water extraction are not sustainable and there are not enough water treatment facilities to keep the little water that does remain in good quality.

Between three to five threatened species per sub-basin are found in many areas in the region including parts of the southern Black Sea coastal area, the middle Asi drainage (Karasu and Afrin Rivers), Lake Tuz (Cihanbeyli, Melendiz/Ihlara, and southern tributaries), Lake Burdur drainage, wider Lake Işıklı drainage, Lakes Eber, Çavuşcu (Ilgın), and Akşehir drainage, Lake Eğirdir drainage, lower Bakır River, middle and lower Gediz and Büyük Menderes Rivers, as well as the Köprü and Aksu Rivers in the Gulf of Antalya. Again, apart from along the Black Sea coast, water stress is the main driver of habitat loss of freshwater fishes. Many springs, streams, obruks (sinkholes), and small lakes have dried out in the last 20 years, for example in the Lake Tuz basin. The water level of Lake Burdur continues to decline, and pollution has severely impacted many of the rivers of the Aegean basin (such as the Gediz, the Bakır, and the Küçük Menderes).

Outside of Turkey the same number of threatened species (between three and five) per sub-basin are also found in the mainstream Tigris and Euphrates Rivers including lower parts of their tributaries and the marshes in Iraq and in adjacent Iran, the middle and lower Aras/Kura, upper Asi/Orontes, and Lake Kinneret and its catchment. In Central Anatolia and the Levant, local species richness is low and very few species occur within only one sub-basin (Figure 3.3), however a very high ratio of these have been assessed as threatened (Figure 3.4). The high numbers of threatened species along the Black and Caspian Sea coasts are not only due to the presence of local endemics such as the lamprey *Lampetra lanceolata* (EN), gobies *Ponticola rizeensis* (EN) and *P. turani* (VU), and the loach *Cobitis splendens* (CR) but also due to the occurrence of widespread but declining species such as the European eel *Anguilla anguilla* (CR) and several species of sturgeons (all CR), which may occasionally roam along these coasts and once spawned in the lower parts of the rivers as far upstream as the construction of dams allows them to go.

The sub-basin in the Euphrates and Tigris system with the highest number of threatened species (six) is situated at the middle Euphrates in Iraq. There, two subterranean cyprinid species are endemic to the Haditha karst system (*Typhlogarra* (now *Garra*) *widdowsoni*, *Caecocypris basimi*, both CR). These are found in the same sub-basin as *Luciobarbus xanthopterus*, *L. esocinus*, *Carasobarbus kosswigi* and *Barbus grypus* (now *Arabibarbus*) (all VU) which all occur in the adjacent, but hydrologically connected, Euphrates River. The subterranean species have been severely impacted by high levels of groundwater extraction, and the species in the Euphrates River are threatened by dams and overfishing.

3.3.3 Restricted range and endemic species

There are many range restricted and locally endemic species, which is reflected in the 58 species assessed as threatened under the restricted Extent of Occurrence (B1) Red List criteria. These are found mostly in Anatolia and the Levant, but also occur in

There are many freshwater fish species with tiny global ranges in the Eastern Mediterranean region. *Aphanius transgrediens* (CR) from a spring field in Central Anatolian Lake Acı is just one example. Photo © Jörg Freyhof

Mesopotamia and in the Caucasus, for example the endemic trout *Salmo ischchan* (CR *draft assessment*) in Lake Sevan in Armenia and two *Pseudophoxinus* (both CR) in springs in the Kura basin in Azerbaijan. In Anatolia, particularly along the Mediterranean coast and in Central Anatolia, many locally endemic species occur and this pattern of a high ratio of local or single catchment endemic species is found south to the Jordan River basin. In contrast, most species in Mesopotamia have large distribution ranges occurring throughout the Tigris/Euphrates system from Turkey south to Iraq, with several species also occurring in other tributaries of the Arabian / Persian Gulf. However, there are several genera, for example *Oxynoemacheilus* and *Alburnoides*, where species are very restricted and are found in just one or a few headwater streams of the Euphrates or the Tigris.

3.3.4 Data Deficient species (DD)

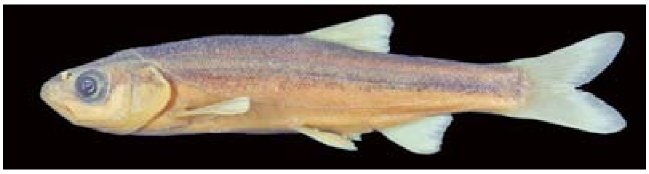
Sixteen species have been assessed as DD, 13 of them are endemic to the region. Seven are due to unresolved taxonomic problems and are likely to be synonyms of other species (*Barbus ercisianus*, *Capoeta kosswigi*, *Gobio battalgilae*, *Luciobarbus kersin*, *Oxynoemacheilus cinicus, O. lenkoraensis*, *Vimba melanops*). The distribution of *Salmo tigridis* (DD *draft assessment*) has been well studied in Turkey where it is highly restricted, however it is expected that the species is much more widespread in the Iranian Tigris, where *Salmo* species have not yet been studied, particularly on their taxonomy. Without this knowledge, the species' full range and therefore threats remain unknown. The other species assessed as DD are so poorly known that not enough information was available to assess their conservation status. *Cobitis amphilekta* has just recently (Vasil'eva and Vasil'ev 2012) been described based on old material (1937) from Azerbaijan, but there has been no targeted fieldwork to search for the species. *Glyptothorax kurdistanicus*, a species likely to be endemic to the Little Zab drainage in Iraq, has been just recently re-discovered but its wider range and threats are unknown. *Oxynoemacheilus araxensis* is still only known from a small tributary in the upper Euphrates from where it has been described (despite its name, the species does not occur in the Arax), but there are indications that the species may also be widespread in the adjacent Yeşilırmak drainage and its threats are unknown. *Oxynoemacheilus ceyhanensis* is known from one site only but is likely to be widespread in the adjacent Ceyhan drainage. *Petroleuciscus kurui* is only known from a small endorheic basin in the upper Tigris catchment in Turkey where the species has not been found since 1974. However, the area is difficult to visit and has not been surveyed since, therefore the species may be still in a good status, or may be highly threatened. *Squalius seyhanensis* was described in 2013 and not enough is known about its suspected wider distribution range and threats.

3.3.5 Extinct (EX), Possibly Extinct (CR PE) and Extinct in the Wild (EW) species

Extinction of freshwater fishes in the Eastern Mediterranean region, as in many parts of the world, is sadly on-going and largely un-noticed. Six species of freshwater fishes, all lake endemics, are assessed as Extinct (EX). *Alburnus akili* was endemic to Lake Beyşehir, *Alburnus nicaeensis* to Lake İznik, *Aphanius splendens* to Lake Gölcük, west of Isparta, and *Pseudophoxinus handlirschi* to Lake Eğirdir, all of them in Anatolia. *Mirogrex hulensis* was endemic to Lake Hula and *Tristramella sacra* to Lake Tiberias, both in Israel. All four extinct species from lakes in Turkey vanished due to the intentional stocking of alien fish species for fisheries purposes. While Lake Hula was drained, the reasons for the extinction of *Tristramella sacra* are not known, but it is thought to be due to the loss of its breeding grounds (marsh areas).

There are seven additional species which are assessed as Critically Endangered, Possibly Extinct (CR PE), meaning that they may be extinct but further research is required to confirm their status. These are *Acanthobrama centisquama*, a species once known from Lake Amik in the Asi drainage in Turkey. This species has not been found since 1977 and while the lake itself has since been drained, there is a small lake close by, Lake Gölbaşı, which may

Gobio battalgilae (DD) has been described as an endemic to Lake Beyşehir basin in Central Anatolia, however it may be a synonym of *Gobio microlepidotus* (VU). Photo © Jörg Freyhof



Pseudophoxinus handlirschi (EX) from Lake Eğirdir. One of the specialized lacustrine fish species which went extinct after the stocking of alien species. Photo © Jörg Freyhof

be inhabited by this species. *Acanthobrama tricolor* has not been found in the lower Barada River in Syria since 1908, but was recorded in the Golan Area of Separation in the late 1980s (H. Esterbauer pers. comm. 2008), the species needs further surveys to its status there. *Caecocypris basimi* is endemic to the *Haditha* karst in Iraq but has not been found since the 1980s, and while a survey in 2012 did not find it, the species may still exist in the subterranean waters which may be deep and inaccessible. *Pseudophoxinus sojuchbulagi* is a small cyprinid endemic to a small spring-stream system in the Kura drainage. It has not been found since the 1950s despite two recent expeditions (N. Bogutskaya pers. comm. 2014, B. Levin pers. comm. 2014). *Cobitis kellei* and *Paraschistura chrysicristinae* were found only once in 1974 in the upper Tigris drainage in Turkey but have not been found since, despite intensive research in the area (E. Ünlü pers. comm. 2014). Nevertheless, it cannot be excluded that a small population(s) may have survived somewhere close by. *Pseudophoxinus syriacus* was still present in 2008 in the very last remnants of the spring of the Barada River in Syria, where the species is endemic, however since then the spring has been almost fully drained and it is feared that the species may since have gone extinct. While writing this report, we learned (M. Bariche, pers. comm. 2014), that in the winter of 2013/14 and all of 2014 so far, there was no rainfall in the Ammiq marshes in Lebanon and the marshes may have dried. There is one endemic fish species, *Tylognathus festai* (now *Garra*), last seen in 2011, which therefore may have gone extinct this year. The same could be true for *Pseudophoxinus ninae*, which is endemic to a single stream in Central Anatolia reported as being dry in 2013 and 2014 (G. Ekmekçi, own observations).

There is an additional species, *Stenodus leucichthys,* which is assessed as Extinct in the Wild, as dam construction has blocked access to the spawning grounds of the species in northern Caspian Sea drainages (the species spends the summer in the central and southern Caspian Sea). The species now only survives due to artificial breeding and stocking in the Volga drainage

3.3.6 Regionally extirpated species

As 87.7% of the threatened species are endemic to the Eastern Mediterranean region, only a few species are at risk of becoming regionally extirpated (i.e. extirpated from the Eastern

Once famous for its large amounts of cold and clear water, Barada spring in the Syrian Damascus basin was drained in 2008. The only endemic species of the spring, *Pseudophoxinus syriacus* (CR) might now be extinct. Photo © Jörg Freyhof

Mediterranean region, but extant elsewhere). The most critical examples are the sturgeons (all CR). There is no evidence that sturgeons still regularly reproduce in any of the rivers in the assessment region. The last populations of sturgeons in the Black and Caspian Sea basins are now restricted to European rivers such as the Danube, the Volga, and the Ural. In the Black Sea basin and outside Europe, the only remaining river regularly used for spawning is the Rioni in Georgia, which is outside of the area assessed for this study. *Acipenser colchicus*, which is now endemic to the Rioni along with *Acipenser gueldenstaedtii*, *Acipenser stellatus,* and *Huso huso*, still spawns in the Rioni. *Acipenser nudiventris* and *A. sturio* seem to be extirpated. Within the Eastern Mediterranean region the Iranian rivers and the Kura (of the Caspian basin) in Azerbaijan and the large southern Black Sea rivers, such as the Sakarya, Kızılırmak, Yeşilırmak and the Çoruh had all once been significant spawning rivers for sturgeons (Holčík 1989), whereas now it is only very occasional. In Azerbaijan, Georgia, and Iran, there are large-scale fish farms, which produce sturgeons for stocking and also meat and caviar production. These activities are largely decoupled from restoration of wild stocks but may result in lower prices for sturgeons and therefore reduce the fishing pressure upon wild populations. However, great efforts need to be made to re-establish wild breeding populations that are fully independent from human activities such as artificial reproduction and stocking. There is a government led programme in Turkey to develop sturgeon brood stocks for reintroduction purposes into the Black Sea (Akbulut *et al.* 2011).

It should also be noted, that the European eel *Anguilla anguilla* (CR) has to be considered to be extirpated from large parts of its former range in the Black Sea and Eastern Mediterranean basin. While eels have experienced a very large decline in the late 20th century, they are still regularly found in the lower parts of rivers and streams close to the Mediterranean Sea in Anatolia and the Levant. Eels used to occur in all Mediterranean and Black Sea rivers, but are now mostly restricted to the lowest parts of the rivers due to many dams restricting their range.

3.4 Major threats to freshwater fishes

There are a number of pressures to freshwater fishes of the Eastern Mediterranean region, most of them a result of human development and climate change (Figure 3.5). These include increased water extraction and the development of dams (included under '*Natural system modifications*' which impacts 90% of threatened and NT fish species), coupled with increasing frequency of droughts (under '*Climate change and severe weather*' affecting 69% threatened and NT fish species) which is leading to habitat loss, increased *pollution* of freshwater systems particularly from domestic/urban effluent and from local agricultural runoff (affecting 47% of threatened and NT fish species), and non-native *invasive species* (affecting 21% of threatened and NT fish species). These threats are unequally distributed over the Eastern Mediterranean region, with some threats being particularly intense in some parts of the region. As many species assessed as threatened have very small distribution ranges, even relatively low environmental stress on these small populations can significantly impact their global population and likelihood of survival.

3.4.1 Water extraction and dams (natural system modification)

3.4.1.1 Surface and ground water extraction

The Middle East is the first region of the world to effectively run out of water (Allan 2001). Surface and ground water are extracted in huge quantities throughout the dry parts of the Eastern Mediterranean region and extraction is rarely sustainable, making it the most important threat for many of the freshwater fishes in arid and semi-arid landscapes. These species survive in freshwater habitats that already have periods of low flow, and any additional extraction can easily result in significant loss of habitat, or even total desiccation. This assessment shows that 90% of the threatened and NT species are impacted by dams and water extraction.

Within the Eastern Mediterranean region, Central and Western Anatolia in Turkey, and the Levant are the areas most intensively impacted by water extraction where pumps abstract surface water from the streams and rivers. In smaller streams it is common practice to dig large holes in the streambed to allow the extraction of water even when the stream has almost fallen dry in late summer. Water is also widely extracted by pump-trucks and transported to more distant places.

All countries considered here have water policies but these are not always enforced in ways that sustain or protect biodiversity. Apart from Israel which introduced a 'water for biodiversity' policy in the early 2000s, we are not aware of any country where there is a water policy that aims to guarantee enough water remains in the lakes, marshes, streams, and rivers to sustain biodiversity's needs (Shacham 2003). In Israel seawater is increasingly desalinated in large amounts reducing stress on naturally available freshwater supplies, and studies show that streams and springs can rapidly return when the amount of water extracted is reduced (Shacham 2003). However, desalination is expensive, requires access to seawater and is powered by fossil fuels and should not be seen as the sole answer to the region's water needs. Allan (2001) pointed out that the rapidly growing water needs of many countries of the Eastern Mediterranean and the Middle East can no longer be met by further exploitation of water resources except through either the development of desalination facilities or the reallocation of water resources from agriculture. Great innovative efforts and financial support are needed to develop desalination systems powered by solar or wind energy not only to conserve freshwater biodiversity but also to benefit the other water needs of the Eastern Mediterranean.

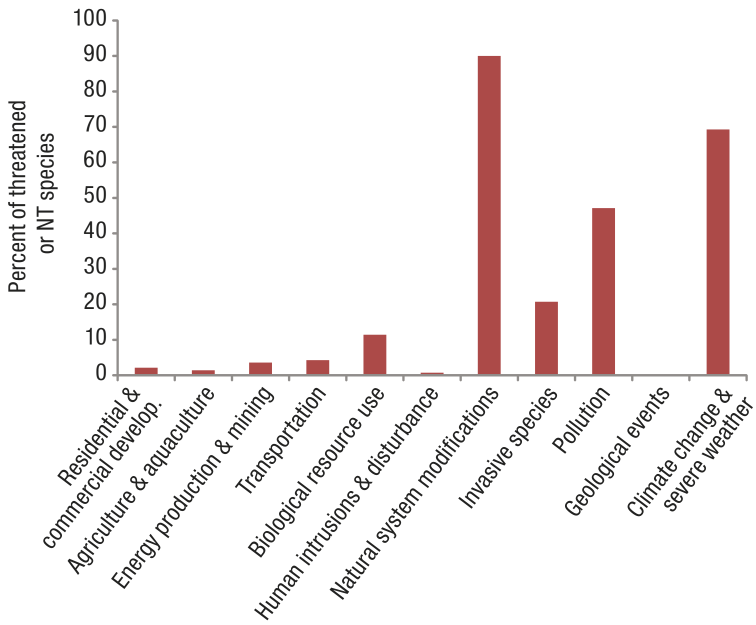
As further evidence for the desperate state of the region's water resources, Voss *et al.* (2013) found that large parts of western Asia are losing groundwater reserves at an alarming rate, with the water deficit being one of the highest in the world, second only to India. The water demands for intensive agriculture and growing populations cannot be met by surface water sources alone. Large spring fed wetland complexes are therefore especially impacted by additional groundwater abstraction, for example the Turkish Sultan marshes, Eşmekaya marshes, Lakes Hotamış and Acı, the Jordanian Azraq marshes and Lebanese Ammiq marshes have all almost or completely dried out. The lowering of water tables is impacting stream flows across the region with many having dried out, the Turkish Küçük Menderes River is one example. Another example is the loss of the Qweik River which once flowed through the Syrian city of Aleppo, but has now virtually vanished. Today only two very small headwater streams remain from this once large river leaving the only endemic fish species, the loach *Oxynoemacheilus tigris* (CR), on the border of extinction. Other examples include the once extensive spring areas at Ras Al Ain in northern Syria, which have almost completely dried out, as has the famous spring of the Barada River near Damascus along with almost the entire Damascus hydrological basin as most of the water is extracted for the city of Damascus.

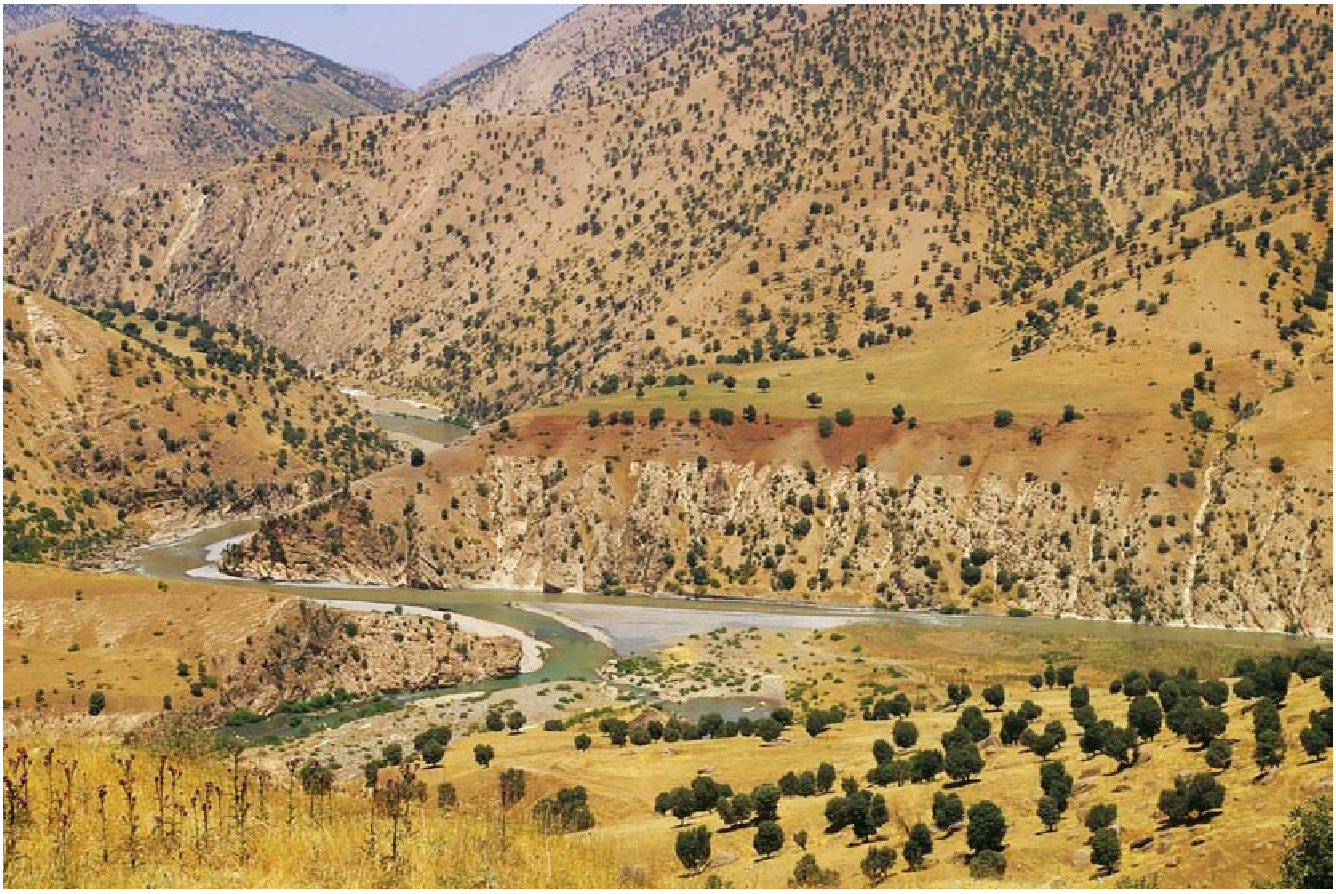
3.4.1.2 Dams

It is impossible to determine the exact number of dams and weirs in the region, even for Turkey where information is available, different sources provide very different numbers. However, according to GegenStrömung (2011), Turkey has more than 2,000 dams and weirs and has plans to build an additional 1,700 within its borders, making it one of the most active dam building countries in the world and leaving hardly any river in the country unaffected (GegenStrömung 2011, International Rivers 2014). Some of the proposed dams – in particular Ilısu and Yusufeli – have triggered strong opposition (International Rivers 2014), and the lack of ESIAs (environmental and/or social impact assessments) for many of the recent dam developments mean that impacts to biodiversity and society remain largely undetermined (GegenStrömung 2011). In the Caucasus, many dams were built during the Soviet times but there is now a growing interest in exploiting rivers as hydropower resources. In the Levant and Mesopotamia dams are found on almost all suitable rivers, but political instability, especially in Iraq, has so far delayed the construction of new dams. The upper Tigris in Turkey as well as Iraqi Kurdistan are still places not impacted by dams, and have almost pristine rivers with rich freshwater biodiversity. However there are plans to build dams in this region; and the highly controversial Ilısu dam in the upper Tigris is the most prominent of several planned dams which would transfer considerable parts of the Tigris drainage into hydropower reservoirs.

While most rivers in the region are dammed, it is usually only a single dam or maybe a few rather than a 'cascade of dams', which essentially changes the river into a series of lakes. However, this is changing as many new dams and weirs are constructed across the region, and especially in Turkey. Construction of new dams, especially for hydropower, is a major concern for freshwater fish conservation across the region. Hydropower is widely presented as a 'green technology' leading many countries to aim towards exploitation of all their hydropower potential. As mentioned above, however, the environmental and social impacts of dams can be quite significant and far reaching. Large dams in Eastern Anatolia, for example, already impact water availability in Syria and Iraq (leading to political tension) and if the Ilısu dam on the Tigris becomes a reality another important part of the free flowing Tigris will be lost. Beyond Turkey, it is likely that other governments in the region will follow the same dam building strategy if political stability would allow them to do so. Several large dams have already been built in Syria and Iraq, massively impacting the biodiversity and hydrology of the Euphrates and Tigris; and their tributary mountain rivers in Iraq, such as the

Figure 3.5 Drivers of threats impacting threatened and Near Threatened freshwater fish species in the Eastern Mediterranean region.





The Chorman River in Iraqi Kurdistan, a tributary to the Tigris, is a habitat of *Barbus* (now *Arabibarbus*) *grypus* and *Carasobarbus kosswigi* (both VU). This is one of very few rivers that have escaped major impacts and are of high conservation value in the Eastern Mediterranean region. Photo © Jörg Freyhof

Great and Little Zab Rivers, have a large hydropower potential which will likely also lead to their damming sooner or later. This will lead to a significant decline in all species (and associated human livelihoods) that depend on larger rivers and streams with a continuous flow of water. In addition, all existing (and proposed) dams along the Tigris and its tributaries are a threat to the recently restored marshes in lower Mesopotamia in Iraq, as they reduce the amount of freshwater reaching the marshes causing them to dry out or become saline as the brackish water borderline is moving northwards in the Shatt Al-Arab (Iraqi Ministry of Environment and Nature Iraq, in prep).

Dams and weirs for capturing runoff. In the Eastern Mediterranean region it is very common, and natural, for sections of streams and rivers to run dry in summer. However, capture dams and weirs which withhold water runoff that would otherwise be 'lost' to human use, leave little or no water to flow downstream. This reduces the habitat availability for freshwater fishes even in ecosystems which are adapted to seasonal droughts where the survival of fishes often relies upon small refuge pools. The continued over-abstraction of water, coupled with increasing frequency and severity of droughts, is leading to the desiccation of these refuge pools and to the extirpation (and extinction) of fishes. Many of the lakes in Central Anatolia that have dried out have done so because of high levels of water extraction from their tributaries and from their aquifers. The most famous (but not only) example are Lakes Burdur, Eber, and Akşehir which are currently in a critical ecological status as significant quantities of water are being extracted directly or retained by dams in their catchments (primary author's observations). The same is true for the former *Ereğli* marshes where, after building a dam on the İvriz stream and draining all the water for human use, the marshes dried out completely in the 1990s.

Dams as migration barriers. Freshwater fish species are often very sensitive to habitat alterations as many have complex life histories, relying upon seasonal changes in their environment such as flow regimes, and some need to perform long distance migrations in order to breed. No other ecological group of freshwater biodiversity shows higher threat levels than anadromous species (e.g. 85% of all sturgeon and paddlefish are threatened (IUCN 2014)), and as there are almost no rivers in the Eastern Mediterranean region which have not been impacted by dams the migration routes of many fishes have been blocked, or seriously compromised. This is a situation which can be partly mitigated by the installation of suitable fish ladders, allowing migratory fishes to pass dams and continue their migration upriver. However, the primary author is not aware of any river in the region, where effectively functioning fish ladders have been installed. Even where fish ladders are in place migratory fishes do not always find the habitats they need as once they negotiate a dam they often then enter impoundments (reservoirs)

The last remains of a vanished river. The Sünnep in Turkey is one of two remaining small streams of the once large Qweik River which flowed through the city of Aleppo. The Sünnep is home to the last population of *Oxynoemacheilus tigris* (CR). Photo © Jörg Freyhof

which have replaced their required riverine spawning habitats. Anadromous fish species not only need to find their way upriver they also need to travel downstream and the authors are not aware of any existing effective way to prevent fishes on their downstream migrations from swimming into the turbines of the dams and being killed or injured. Sadly, the first dam upstream from a river estuary effectively ends the migration for most anadromous species in the region, and all rivers have lost their stocks of sturgeons (all CR), and the once widespread European eel, *Anguilla anguilla* (CR), has lost major parts of its former range.

Hydropeaking and water level fluctuation. Primarily in the Caucasus and along the Black Sea coast, the outflow from dams is managed as regular flood pulses, creating a flash flood downstream every few hours or days; a situation that is devastating for most freshwater fishes leaving the rivers almost empty of fish life below the dam. While reservoirs are suitable habitats for some native fish species this large-scale water level fluctuation in reservoirs (known as hydropeaking) inhibits the formation of a suitable lacustrine environment by preventing establishment of marginal vegetation such as reed belts and submerged vegetation, as well as invertebrate communities. Therefore, reservoirs exhibiting significant fluctuations in water level are usually only inhabited by a tolerant fish community dominated by alien species and carps, most of which are stocked for fisheries.

Future scenarios. Sadly, the future does not look bright for freshwater fish species specialized for inhabiting larger rivers and streams. Within the past 30 years many dams have been built impacting river flows across the region and it is expected, at least in some areas, that the potential hydropower capacity will be fully exploited in the near future. Currently the Eastern Mediterranean region is an area of huge water deficit (Voss *et al*. 2013) and, if policies that govern water extraction and dam building and management do not change, conservation of the remaining fish species in the region will remain a major challenge.

3.4.2 Pollution

Across the Eastern Mediterranean region and especially adjacent to areas of urban development, pollution is a major driver of threat for freshwater fishes impacting just under half (47%) of all threatened or Near Threatened species (Figure 3.5). Most rivers and streams are significantly polluted downstream of urban areas primarily by sewage, for example the Kura downstream of Tiblisi in Georgia, the Tigris downstream of Diyarbakir, and the Shatt Al-Arab River in Iraq (Saleem and Hussain 2013). However, it is in the rivers of western Anatolia such as the Bakır, Gediz, and the Küçük and Büyük Menderes where water pollution is at its most widespread and severe. The Küçük Menderes has virtually vanished and the lower part is filled by sewage from towns and industries, and the Gediz and Bakır are so heavily polluted that no fish seem to occur in the middle and lower

Small dams, such as this one in the Gediz drainage, capture runoff for irrigation and small weirs for flood control are found virtually everywhere in the Eastern Mediterranean region. During dry periods they often leave no water in downstream sections Photo © Jörg Freyhof

parts of the main rivers. There are also high levels of pollution in many other areas, for example the upper Köprü River south of Isparta is flowing mostly with sewage, as is the Asi River and many coastal streams in Syria. However, data about chemical and biological water quality are sparse and there are few continuous monitoring programmes of open surface waters. Therefore, little is known about the extent and intensity of urban and agricultural pollution across the region. As part of the process towards its closer relations and future EU membership, Turkey is aiming to meet the requirements set out in the EU Water Framework Directive and the creation of a reliable inventory of water data and monitoring system is one of the major challenges it faces (Sumer and Mujuk 2011).

3.4.3 Climate change and severe weather

The Eastern Mediterranean region is predicted to become dryer and warmer, with a particular increase in the frequency of hot summer days and high temperature events (CEPF 2010) with reduced rainfall in all of Anatolia (except the northern coast) as well as in all of the Levant and the Mesopotamian region (Chenoweth *et al*. 2011). These scenarios suggest a bleak future for freshwater fishes in large parts of the region, as many areas have already dried out and many fish species, once widespread, are now restricted to small refuges. According to the research undertaken for this study 69% of all threatened or Near Threatened species are already being impacted by the effects of climate change (droughts) (Figure 3.5). The dramatic reduction in river flows (due to water abstraction and increased frequency of droughts) has led to considerable ecological, economic, and political problems that will increase in the future unless there is a radically different approach to water management across the region. A step in this direction has been taken in Israel, where large amounts of freshwater are now gained from seawater desalination. The effects of climate change to the unique and highly endemic freshwater fishes of the Eastern Mediterranean region are not difficult to imagine, as climate change will just speed up the on-going process of the drying out of springs, lakes, and streams in the region.

3.4.4 Invasive alien species

Over a fifth (21%) of all threatened and Near Threatened freshwater fish species are currently being threatened by invasive alien species (Figure 3.5). At least 20 species of alien freshwater fish are introduced and established to the Eastern Mediterranean region. Species such as *Carassius auratus, Carassius gibelio, Chelon haematocheilus, Gambusia holbrooki, Hemiculter leucisculus, Heteropneustes fossilis, Lepomis gibbosus, Poecilia latipinna, Pseudorasbora parva,* and *Rhinogobius similis* are all invasive and have expanded their ranges within the region and are believed to negatively impact native fish communities where they exist. There are also a number of non-native species that do not yet seem to have become invasive, and are restricted to a few sites:

Spring at Gemiş in Lake Acı basin, Central Anatolia. While springs are the treasure box for freshwater fishes in the Eastern Mediterranean, the locally endemic killifish *Aphanius transgrediens* (CR) has vanished from this spring due to alien fish invasion. Note also the large pumping station taking water directly from the spring's source. Photo © Jörg Freyhof

Amatitlania nigrofasciata, Ameiurus melas, Coregonus ladogae, Lepomis macrochirus, Micropterus salmoides, Misgurnus anguillicaudatus, Oncorhynchus mykiss, Oryzias sinensis, and *Poecilia reticulata*. These non-native fish species have been released from aquaria, or have escaped from ornamental fish farms, intentionally introduced to improve fisheries, or have spread accidentally (as by-catch) with commercially introduced alien or native species. Five additional species, *Acipenser baerii, Ctenopharyngodon idella, Hypophthalmichthys molitrix, Hypophthalmichthys nobilis,* and *Mylopharyngodon piceus* are or have been stocked into waters of the Eastern Mediterranean region but have not formed self-sustaining populations.

The most common and widespread alien invasive species in the region are the cyprinids *Carassius auratus* and *Pseudorasbora parva* and the poecilid *Gambusia holbrooki* (Ekmekçi *et al*. 2013). These species occur almost everywhere in the Eastern Mediterranean region, and are known as 'global invaders' due to their widespread introductions across the world. An additional invasive species which is causing significant impacts as a competitor to native fishes is the East Asian cyprinid *Hemiculter leucisculus*. This cyprinid has reached Central Asia as a by-catch of Chinese carps and quickly established and spread in the Aral Sea basin. From there it reached, again as a by-catch with commercial species, the south-eastern Caspian basin and it is already widespread in the southern Caspian. Recently it made its way into the Tigris drainage where it has become established in several areas (Coad 2010). This very powerful invader is likely to follow the track of *Pseudorasbora parva*, which has spread across the complete Western Palearctic within 40 years.

Other major invasive species are native to parts of the Eastern Mediterranean region but have been introduced to other parts. The most famous example is the intentional introduction of predatory percid *Sander lucioperca* to the Central Anatolian Lakes Eğirdir and Beyşehir. Both lakes have a highly endemic fish fauna in which specialized predatory fishes were absent. Soon after the introduction of *Sander* in the 1950s, most native species declined sharply and in each lake one specialized open water lacustrine species went extinct (*Alburnus akili* in Lake Beyşehir; *Pseudophoxinus handlirschi* in Lake Eğirdir*)*. Most native species are now restricted to lake tributaries, which are not inhabited by *Sander*. Other examples are cichlids (such as *Coptodon zillii* and *Oreochromis aureus*) and the catfish *Clarias gariepinus*, which are native to the Jordan basin, but have been introduced into the wider Levant and southern Anatolia. *Coptodon zillii* and *Oreochromis aureus* have been recently introduced to Iraq, where they have spread quickly and are already impacting fish communities in the marshes and the Shatt Al-Arab, the estuarine region of the Euphrates and Tigris, where they have become dominant in the fish communities (Mohamed, Hussein, and Lazem 2013, Falah M. Mutlak pers. comm. 2014). There are fears that the lower Euphrates, Tigris, and the Shatt Al-Arab and adjacent marshes will soon have fish communities that are dominated by alien species, at the expense of native species, especially the endemic herbivorous cyprinid *Mesopotamichthys sharpeyi* (VU), which seems to be the victim of the competition from alien herbivorous cichlids.

The most common alien invasive fish species in the Eastern Mediterranean region are the goldfish *Carassius auratus* and the common carp *Cyprinus carpio*, which occur virtually everywhere (Coad, 2010, Vilizzi, Tarkan, and Ekmekçi 2013). The common carp (itself a VU species) is native to the Black Sea and Caspian Sea basin where it is threatened due to habitat modification and the hybridization of the wild populations with domesticated forms. These domesticated carps have been introduced all over the region where they are particularly dominant in reservoirs. Although there are very few specific studies of the impacts of these alien species on the native fauna in the region, it seems that they out-compete native species, and the situation seems to be especially alarming in the lower Tigris and Euphrates. Research on the effects and distribution of alien species is strongly recommended to better understand their impacts, their behaviour, and how to limit their dispersal.

3.4.5 Harvesting and research

Relatively few native freshwater fish species are harvested in the Eastern Mediterranean region and this does not generally represent a significant threat, with only 11% of threatened or Near Threatened species impacted by overharvesting (Figure 3.5). It is common carp, *Cyprinus carpio* which is the major commercial species in large parts of the area including across its non-native range. It is along the Caspian coast and in the Caspian rivers where freshwater fishes are particularly harvested, where several Gobiids, Percids, Cyprinids, and Clupeids are of major commercial importance. In former times, sturgeons were also fished here during their spawning migrations but as sturgeons have now vanished from the rivers they are now harvested in the sea, but mostly from ranched stocks.

However, overfishing is a threat for several large barbels in the larger rivers of the Euphrates and Tigris drainage. Species such as *Luciobarbus esocinus* (VU), *L. xanthopterus* (VU), *Mesopotamichthys sharpeyi* (VU), and *Barbus grypus* (now *Arabibarbus*) (VU) all have high commercial value and are intensively exploited across their range, and available catch statistics suggest a considerable decline in the populations of these species. The only species of the genus *Mesopotamichthys, M. sharpeyi*, was once an important commercial catch especially in the marshes of southern Iraq and adjacent Iran, but in the last 10 years, the species has declined dramatically due to overfishing and most likely the impacts from alien invasive species. However, one mitigating factor for three of these species (*L. esocinus*, *L. xanthopterus,* and *A. grypus*) is that they benefit from the construction of large reservoirs, where they form large stocks and can migrate to inflowing rivers in spring to spawn. This at least partly offsets the massive losses due to overexploitation. The most important commercial wild and native freshwater fish species in Turkey is the cyprinid *Alburnus tarichi* (NT), which is endemic to Lake Van. This species was the victim of illegal overfishing, which now seems to be mostly under control. The Mesopotamian *Luciobarbus subquincunciatus* (CR) also grows to a considerable size, but does not inhabit reservoirs and is now almost extinct with accidental harvesting being a potential cause. In the Caspian basin, overexploitation is still a massive problem for all sturgeons and also for large cyprinids such as *Luciobarbus brachycephalus* (VU), a migratory species that is also found in the Aral Sea basin. This large barbel has lost access to almost all its spawning grounds in the Caspian basin and as the species is not ranched, it is now close to extirpation in the Caspian basin, where it seems to be restricted to one landlocked population in the Kura in Azerbaijan.

The effects of alien invasive species are often difficult to quantify as scientific data are lacking. The East Asian cyprinid *Hemiculter leucisculus* is an invasive species impacting the Eastern Mediterranean region. Photo © Jörg Freyhof

3.5 Conservation actions and recommendations

3.5.1 Conservation actions in place

There are very few in-situ conservation actions in place for the Eastern Mediterranean freshwater fish species assessed as threatened. The most significant are the re-introductions of the once Extinct in the Wild *Acanthobrama telavivensis* in Israel (now VU), and targeted conservation projects for *Aphanius sirhani* (CR) in Jordan run by the RSCN, and for *Aphanius transgrediens* (CR) in Turkey run by the Hacettepe University. *Acanthobrama telavivensis* survived only in captivity since its habitat dried up in 1999. Then in 2006, following stream restoration supported by changes in water policies in Israel, the species was reintroduced back into the wild where it now survives in self-sustaining populations (Goren 2014). *Aphanius sirhani* is endemic to the Azraq wetlands in Jordan which almost completely dried out in 1992. The species was taken from the wild and bred in captivity, and released back into the wetlands after partial restoration in 2000. The population is now stable, however the long term viability of the wetlands is wholly dependent on artificial water pumping as the wetlands natural water sources (springs) have dried up due to water extraction (Freyhof and Harrison 2014). Many other highly threatened species identified by this assessment would make good flagship species for habitat conservation as was seen in both these cases.

In Turkey, the Caucasus, and Iraq, there are many projects to breed and ranch commercially important fish species such as sturgeons, salmonids, and several cyprinids for fisheries purposes. For example, Iraq has a long tradition of producing large amounts of commercially important fishes such as *Luciobarbus esocinus*, *L. xanthopterus, Mesopotamichthys sharpeyi,* and *Barbus grypus* (now *Arabibarbus*) (all VU). Breeding facilities for salmonids are also widespread, again usually for commercial purposes, but rarely do these fish farms produce native fishes for stocking for conservation. However, ranching of fishes is no alternative to habitat conservation and restoration and should only be seen as a temporary solution. The ultimate goal must be to have self-sustaining wild fish populations that are independent from restocking. In large parts of Europe, ranching of salmonids has been successful to keep commercially high salmonid stocks in largely unsuitable habitats. Rehabilitation programmes for fishes, including salmonids, need to improve the habitats and other requirements of fishes and not just increase the number of fishes for anglers. While legal protection for freshwater fishes themselves is in place in most countries in the region, it does not help to protect freshwater fish habitats from the threats described above. Catch size limits are in place for commercially valuable species, which may address (if enforced) overfishing especially of large barbs in Mesopotamia. It is illegal to catch salmonids in some areas, and sturgeons are protected across the region, however, especially for the sturgeons, illegal fishing is still a considerable problem at least in the Caucasus. Except for salmonids and sturgeons, there are only two (known to the authors) coordinated ex-situ conservation breeding programmes in the countries of the Eastern Mediterranean region, *Acanthobrama telavivensis* and *Aphanius sirhani* (see above). Ex-situ conservation is usually only undertaken as the very last option to save a species at the very brink of extinction. In Turkey, there is a new and dedicated plan to conserve 100 selected species including 10 freshwater fishes, including *Pseudophoxinus elizavetae, Aphanius transgrediens*, *Alburnus nasreddini*, *A. timarensis,* and *Capoeta pestai* for priority conservation actions. Another project in Turkey will start in 2015 to breed *Barbus* (now *Arabibarbus*) *grypus*, *Luciobarbus esocinus*, *L. subquincunciatus, Pseudophoxinus anatolicus,* and *Salmo coruhensis* to balance over-exploitation. Also, it should be mentioned, that Turkey has adopted the EU Water Framework Directive and hopefully new data on freshwater fishes and water quality will soon become available, which will lead to a better understanding of the threats to fishes and also raise awareness for the often critical situation of their habitats.

Fish first. The Azraq wetland in Jordan is the only known location for the killifish *Aphanius sirhani* (CR). The wetlands, which almost dried out completely in 1992 are now partially restored and have managed to save the killifish from extinction. Photo © Jörg Freyhof

3.5.2 Recommendations

This IUCN Red List assessment reveals how many gaps remain in the understanding of the freshwater fish fauna in the Eastern Mediterranean region. There are many endemic freshwater fish species in the area and most are still very poorly known highlighting the urgent need for more research. But more importantly there are only very few significant efforts to conserve this highly diverse and threatened group. While there are large-scale conservation efforts for some enigmatic, but widespread and non-threatened terrestrial vertebrates, freshwater fishes as a major component of the highly endemic fauna are mostly ignored in conservation plans and regulations in most countries. Many species assessed as threatened by this study are legally protected by national laws, however these laws are usually not implemented or enforced when it comes to habitat destruction, water extraction, or the construction of dams. The authors are not aware of any cases where threatened fishes have stopped a planned dam construction, or their needs for water have been considered when water is extracted from streams and springs. Water policies generally consider biodiversity needs but these have rarely been enforced. There is an urgent need to raise awareness for freshwater biodiversity conservation, especially for all the threatened species identified by this study. Significant efforts are needed to be undertaken in freshwater fish conservation and the targets cannot be achieved by breeding and stocking a few commercially important species or by size-regulations for anglers and fishermen. All countries in the study area have signed the Convention on Biological Diversity (CBD) which includes commitments (Aichi Targets) on improving the conservation status of threatened species, and production of national biodiversity strategies and action plans (NBSAPs). On the evidence found through this assessment major steps are needed if the region is to come close to achieving Aichi Target 12 which states 'By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained'...If we fail, more extinct species will undoubtedly be listed in future assessments.

3.5.2.1 Field research and taxonomic studies

Field surveying is essential in order to provide up-to-date knowledge on the overall distribution of species and their threats. We strongly recommend that fieldwork for national and collaborative international scientists, and projects that can help build regional scientific capacity are given more support from an administrative point of view (e.g. permits for research), and also that funding and resources are made available by national and international agencies. Incomplete knowledge of biodiversity due to taxonomic uncertainty remains a significant stumbling block for conservation planning. The taxonomy of several freshwater fish species needs to be resolved by applying an integrated molecular and morphological approach by well-trained taxonomists, which do not exist in all countries in the region. The large scale molecular study recently published by Geiger *et al*. (2014), considering almost all freshwater fishes of the Mediterranean Biodiversity Hotspot, is a major step forward in this field. Furthermore, targeted and publicly open national scientific collections should be set up to allow scientists to store their materials in a good order while allowing for the scientific intellectual property to remain within countries.

3.5.2.2 Public data availability

It is strongly recommended to bring together all site scale records as well as all monitoring time series of all Eastern Mediterranean region freshwater fish species in an open access online database like the Global Biodiversity Information Facility (GBIF), to make them available for analysis and all conservation activities and planning. We also encourage that data and metadata should be published in open access data journals. Positive steps have been taken, for example recently in Turkey the Ministry of Forestry and Water Affairs has established the National Water Information System which will include all monitoring data including biological data and will be freely available.

3.5.2.3 Field guides

The freshwater fish biodiversity of the Eastern Mediterranean region is poorly documented and much information is out-dated. As an addition to further ecological and taxonomic research, the publication of an (online and freely available) field guide of the freshwater fishes would be highly beneficial for scientists in the region. It would need to include pictures of fishes and sites, information about the distribution, ecology, identification characters, and threats. The online guide should be directly linked to GBIF, to have up-to-date distribution data, and the IUCN Red List to provide the conservation context. Furthermore, a citizen scientists recording system for freshwater fishes based on smart-phone technologies would be useful, allowing local scientists and citizens to add their own data.

3.5.2.4 Key Biodiversity Areas

Building on the assessment information published in this report, and on the IUCN Red List the freshwater Key Biodiversity Areas (KBAs) of the Eastern Mediterranean region have been identified and validated through regional stakeholder workshops. The results of this work will be published in a separate report, *Freshwater Key Biodiversity Areas in the Mediterranean Basin Hotspot* (Darwall *et al*. 2014).

3.5.2.5 Monitoring and ex-situ conservation

We are not aware of a comprehensive freshwater fish monitoring programme within any of the countries in the Eastern Mediterranean. There are some more limited efforts, for example in Jordan, where *Aphanius sirhani* has been monitored at Azraq since 2000 and also fishes in the Mujib, and Southern Ghore are monitored. In Israel there is monitoring at a number of localities, and in Turkey and Iraq, fisheries data are collected. Critical sites for freshwater fish such as KBAs (and especially Alliance for Zero Extinction (AZE) sites) are a priority, and need to be monitored following standardized protocols. Such sites should be regularly visited to assess the population status of freshwater fishes and to collect long-term population and habitat quality trend data. Some considerable efforts are urgently needed, as a number of species are on the brink of becoming extinct and may not get the opportunity of last minute in-situ or even ex-situ conservation measures. We strongly recommend that fish breeding facilities, regional zoos, and aquaria engage with conservation biologists and assist in these often relatively expensive ex-situ actions. While there are capacities for ex-situ conservation in several European and regional zoos, such facilities have yet to be established in Turkey as national laws hinder international cooperation.

A geographically distributed fish-monitoring network should be established engaging local experts to gather monitoring data and be able to react in the last moment before species go extinct. It is important to note that great care must be given to maintain genetic diversity in the captive brood stocks to avoid genetic bottlenecks in captive populations. Therefore, it is favourable to closely monitor the wild populations that are in immediate danger of extinction, and only when monitoring shows a fatal population decline, actions for ex-situ conservation should be taken. We recommend that these species are in urgent need of a monitoring programme, and some may possibly already require ex-situ conservation actions: *Acanthobrama tricolor*, *Alburnus nasreddini*, *Aphanius danfordii*, *Aphanius fontinalis*, *Aphanius meridionalis*, *Aphanius richardsoni*, *Aphanius saldae*, *Aphanius sirhani*, *Aphanius transgrediens*, *Carasobarbus kosswigi*, *Chondrostoma fahirae*, *Chondrostoma holmwoodii*, *Chondrostoma kinzelbachi*, *Garra festai*, *Garra kemali*, *Garra widdowsoni*, *Gobio hettitorum*, *Gobio insuyanus*, *Luciobarbus subquincunciatus*, *Oxynoemacheilus galilaeus*, *Oxynoemacheilus panthera*, *Oxynoemacheilus phoxinoides*, *Oxynoemacheilus tigris*, *Pseudophoxinus alii*, *Pseudophoxinus anatolicus*, *Pseudophoxinus burduricus*, *Pseudophoxinus drusensis*, *Pseudophoxinus elizavetae*, *Pseudophoxinus evliyae*, *Pseudophoxinus fahrettini*, *Pseudophoxinus firati*, *Pseudophoxinus hasani*, *Pseudophoxinus hittitorum*, *Pseudophoxinus meandri*, *Pseudophoxinus maeandricus*, *Pseudophoxinus ninae*, *Pseudophoxinus syriacus*, *Pseudophoxinus atropatenus,* and the undescribed species from Sultan marshes (*Seminemacheilus* sp., *Oxynoemacheilus* sp., and *Cobitis* sp.).

3.5.2.6 Training and dissemination

Often the relevant information is not provided in the right format or language to those who could potentially undertake monitoring or conservation actions on the ground. In the context of biodiversity conservation there is an urgent need to train specialists from the region in 'secondary' taxonomy. We need scientists able to train others (including researchers from other disciplines) in species identification, and to write local identification tools including their translation into local languages. Local awareness-raising, and conservation projects are also recommended, especially at key sites that contain small narrow endemic species such as in the Central Anatolian lakes and springs.

3.6 Case study: The marshes of Mesopotamia

Near the city of Basra in Iraq, the Euphrates and the Tigris form one of the most important natural and cultural sites on the planet – the marshes of Mesopotamia, known as the cradle of civilization. Until the early 1990s, these marshes were mostly intact. Each spring, the two rivers flooded and inundated an area the size of Belgium. However, dams upstream on the Euphrates in Turkey and Syria were built, significantly reducing the flow of water into the marshes. Then after the first Gulf War Saddam Hussein ordered the marshes to be drained as revenge for the Marsh Arabs' opposition to him, turning most of the remaining wetland area into desert. After Saddam's capture in 2003, local people destroyed dykes allowing the water to flow back into the areas once flooded. Today the reeds are growing again, wildlife is returning and more Marsh Arabs are returning, rebuilding their huts, raising cattle, and resuming their traditional way of life. It is estimated that 30–40% of the original wetlands have been restored, and further restoration projects are planned (Yeo 2013). In addition in 2013, Iraq's first national park was designated here covering 1,000 km^2. Today this restored ecosystem and its future depends entirely upon water from the Tigris river. However, upstream dam projects in Turkey, Iraq, and Iran are planned which will hold back water in the Tigris river system especially in springtime, reducing the flow of water once again into the marshes and threatening its future.

The harvesting of reeds in the Mesopotamian marshes. Photo © Ulrich Eichelmann

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Chapter 4. Freshwater molluscs

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4.1 Overview of the regional molluscan fauna

4.1.1 Freshwater mollusc diversity

Freshwater molluscs fall into two main groups, the Bivalves and the Gastropods, and are found in a wide range of freshwater habitats, and have varied life-history strategies, with life-spans that vary from three months (pea-clams) to over 120 years (pearl mussels). They find their highest levels of endemism and diversity in ancient lakes, large river basins and artesian basins (Seddon 2000) and all of these habitats can be found within the Eastern Mediterranean region.

The geographic range of this study covers all of Turkey, the southern Caucasus, the Levant and Mesopotamia. It includes 14 freshwater ecoregions (Abell *et al.* 2008, WWF and TNC 2013): from Thrace in the West of Anatolia, east to the Kura-South Caspian ecoregion, and south to the Jordan River and Levant ecoregions in the west, and the Tigris- and Euphrates ecoregions in the east (see Chapter 1 Figure 1.2). This study completes the assessment of the circum-Mediterranean region, covering the large geographic gap between Europe, which has been assessed by Cuttelod, Seddon, and Neubert (2011), North Africa (Van Damme *et al.* 2010), and the Arabian Peninsula (Neubert, Zuhair, and Van Damme in prep).

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Unfortunately, much of the knowledge on the freshwater molluscan fauna of the Eastern Mediterranean is dated, with the only recent reviews for Turkey (Yıldırım 1999, Yıldırım *et al.* 2006a, 2006b, Yıldırım and Kebapçı 2009, 2012, 2012), Lebanon (Bößneck 2011) and Israel (Milstein, Mienis, and Rittner 2012). Knowledge for Syria and Jordan relies mostly on literature from the 1930s (Germain 1936, Pallary 1939). Schütt's (1983a, 1983b) and Kinzelbach's (1987, 1989) reviews of the region provide further data on the large river systems in Turkey, Syria, and Jordan. There are recent taxonomic revisions for some species groups in the Hydrobiidae, Bithyniidae (Glöer and Yıldırım 2006b), Lymnaeidae (Glöer and Yıldırım 2006a), Planorbidae (Glöer and Rahle 2009), and Acroloxidae (Shirokaya *et al.* 2012), revealing cryptic species lineages, and it is likely that further research will reveal more of these, especially with advances in molecular systematics.

In general the freshwater molluscs of the circum-Mediterranean are much more diverse than some continental faunas such as Africa with around 560 species (Seddon *et al.* 2011), and Europe with 856 species (Cuttelod, Seddon, and Neubert 2011). According to this study, 150 species of freshwater molluscs are present in the Eastern Mediterranean region, 94 of them endemic. This is a region of active malacological research, and hence this first assessment is likely to be outdated quickly, as taxonomic research and ongoing surveys in little-known areas continue (e.g. Glöer *et al.* 2014).

4.1.1.1 Gastropods

Within the region, the greatest diversity is seen in the freshwater gastropods with 123 species. The endemic species, of which there are 85, are found in the families Hydrobiidae, Bithyniidae, Neritidae, Melanopsidae, Cochliopidae, Assimineidae, Planorbidae, Lymnaeidae, and Acroloxidae. Within the families Hydrobiidae, Bithyniidae, Lymnaeidae and Planorbidae, many range restricted species have been found in the last 15 years, with new species described from Turkey, Lebanon, Jordan, Iraq, and Iran, as discussed above.

There are at least 123 species of gastropods native to the Eastern Mediterranean region, found in a variety of habitats. A *Melanopsis buccinoidea* and six *Theodoxus jordani* at Banias springs in Israel. Photo © Anita Gould. Online image/Flickr under CC licence 2.0 by-nc

The freshwater gastropods are generally divided into two informal groups, the 'Prosobranchs' and the 'Pulmonates'. In many parts of the world, 'pulmonates' are associated with smaller water-bodies as they are tolerant of seasonal drying, whereas 'Prosobranchs' are generally more sensitive to desiccation and are usually found within permanent water bodies.

Prosobranchs

The highest levels of diversity and endemism are observed in the small 'spring-snail' species of the families Hydrobiidae and Cochliopidae, which occur throughout the region, but have the greatest diversity in Turkey.

The Hydrobiidae family is the most diverse group among freshwater molluscs and one of the major centres for diversity of this family is the Mediterranean region where an exceptionally high amount of crenobiont (found in springs) and stygobiont (subterranean) endemic species and genera occur. Within the Eastern Mediterranean region there are 48 species found in the many springs, wells, caves, and aquifers. The species from the recently recognized Bythinellidae family (included within Hydrobiidae in this assessment) are found in nutrient poor cold springs and small streams from Northern Africa to western Turkey. The Holarctic family Cochliopidae is represented in the study area by only three species, however their taxonomy is not fully resolved. There are 11 species of Bithyniidae in the region, and all are endemic. The Assimineidae is a family of mainly marine and brackish water species, represented by three species, one being endemic to the coastal Iraqi marshes. Although common in the fossil strata of the Levant, the cosmopolitan family Viviparidae is represented by two species which are found in lakes and marshes of Turkey and Southern Mesopotamia. Species of the cosmopolitan family Neritidae (10 species in the region) (Schütt and Sesen 1989, 1992) and the Mediterranean centred Melanopsidae (13 species) are mostly endemics of the study area, found in springs and lotic systems, with one species found in lakes (*Theodoxus heldreichi*). Diversified in the tropics, the family Thiaridae is presented with a single native and two introduced species. The holarctic ectobranch family Valvatidae can be found in many habitats. In the Levant the family is represented by only *Valvata saulcyi,* whilst in Turkey there are four additional species.

Pulmonates

Although relatively tolerant to harsh conditions and favouring passive dispersal, native representatives of the pulmonate families in the area have mainly Palearctic affinities and become rarer towards the south of the region. However, all existing groups in the area show cryptic speciation as demonstrated by recent studies (Glöer and Naser 2007, Yıldırım and Kebapçı, 2009, Shirokaya *et al.* 2012).

Two lake-limpet species of the Holarctic family Acroloxidae are found in the region; one is relatively widespread, while the other is endemic to Turkey. These acroloxid limpets live on microalgae growing on rocks in clean lakes and springs. The cosmopolitan families Lymnaeidae (seven species) and Planorbidae (17 species) are species rich and representatives of these families are common across the area. Recent updates on the taxonomy of the genera *Stagnicola* (Lymnaeidae) and *Gyraulus* (Planorbidae) have revealed the presence of cryptic taxa, once believed to be belonging to common species. Populations of Lymnaeidae show a considerable degree of ecophenotypic shell plasticity, whilst intra- and interspecific variation is not very pronounced.

Some species of freshwater gastropods are known to be intermediate hosts for parasitic trematodes (flat worms) some of which are agents for important livestock and human diseases such as Schistosomiasis and Fascioliasis. These species are considered as dangerous pest species, and attempts are made to control their populations in order to limit the spread of the diseases. However, the molluscicides used are usually non-species specific, and often affect all molluscs.

The aquarium and garden centre trade can mediate rapid colonization of gastropod species into non-native areas, where they can cause significant impacts to native freshwater systems (Padilla and Williams 2004).

Many of the freshwater gastropods are hermaphroditic and self-fertilization occurs in some taxa. In general, gastropods prefer eutrophic habitats including ephemeral ponds and man-made habitats.

Melanoides tuberculata is the only native member of the Thiaridae family in the region, but has become an invasive species in many parts of the world. Photo © AFPMB Online image/Flickr under CC licence 2.0 by-nc-nd

4.1.1.2 Bivalves

The freshwater bivalves are divided into two main groups, the larger freshwater mussels of the Unionoida and the smaller bivalves of the Veneroida. For the Veneroida three distinct families are present within the region, including the bysally attached Quagga and Zebra mussels (Dreissenidae) which are more common in lakes and the slower sections of large rivers, the basket clams (Cyrenidae) which include the freshwater clams of the genus *Corbicula*, and the minute fingernail clams (Sphaeriidae).

Most freshwater bivalves possess a common suite of adaptations to life in freshwater. These include larval brooding, and direct development, in the case of the sphaeriids and cyrenids, and, obligate larval parasitism on freshwater fishes, in the case of unionoid freshwater mussels (Wächtler *et al*. 2001, Cummings and Graf 2009). Despite these common characters derived from shared environmental pressures, these bivalve taxa represent different evolutionary lineages and, as a result of their disparate life histories, demonstrate a range of patterns of dispersal and abundance.

The traditional concepts of the western Palearctic bivalve genera and species are holdovers from the early 20th century which have only recently started to be re-evaluated using modern analytical methods and species concepts. This is likely to lead to the discovery of more cryptic taxa within the freshwater bivalves of the Eastern Mediterranean region than the 27 species presented here (M. Lopes-Lima pers. comm. 2014).

Unionoida

All unionoid species are strictly freshwater inhabitants, and in the Eastern Mediterranean these molluscs are often locally abundant inhabitants of both rivers and lakes.

At present the diversity of Mediterranean freshwater mussels is relatively low (with 13 species) compared to the North American and African fauna and slightly higher than the North and Central European (Bogan 2010). It lies largely in the genera *Margaritifera*, *Unio*, *Anodonta*, and *Potomida*.

The genus *Margaritifera* (Margaritiferidae) is widespread in the Holarctic region, where most species typically occur in oligotrophic streams and rivers. However some species are present at lower latitudes in Southeast Asia, in the southeast basins of North America, and in the Mediterranean area and have distinct habitat preferences for slow flowing lowland rivers. Within the Eastern Mediterranean region, only one species *Margaritifera homsensis* is present from the Margaritiferidae family.

Within the Unionidae family (12 species in the region) the genus *Anodonta* is a widespread Holarctic genus that, in the western Palearctic, reaches its southern limit in countries around the Mediterranean basin. The genus *Unio* is the more species-rich with almost 20 species occurring in the Palearctic region from the Iberian Peninsula and Morocco in the west to the Transbaikal region in the east. Additional species of this genus occur in the Nile basin and in South Africa. As for *Potomida*, generally described as a monotypic genus, it is restricted to the Mediterranean area with a disjunct distribution in the Iberian Peninsula, northwest Africa, southern France, western Greece, southern Turkey, and the Levant, represented by distinct lineages (M. Lopes-Lima pers. comm. 2014).

Veneroida

Similarly, the Veneroida (14 species in the region) occupy a wide range of habitats, with the mussels from the Dreissenidae family present in brackish waters, freshwater lakes, and slow sections of rivers. *Corbicula* spp. (Cyrenidae), of which there is only *C. fluminalis* in the region (note: *C. consobrina* is treated as a synonym of *C. fluminalis*), and is probably the dominant bivalve in the region, have a wider habitat plasticity, generally occupying the middle and lower sections of rivers and streams as well as pools, lakes, channels, reservoirs and other man-made structures, being also capable of withstanding higher levels of salinity. As for the pea or fingernail clams (Sphaeriidae), they are in general more cosmopolitan taxa, occurring in all types of aquatic environments that possess a high dispersal potential via attachment to other animals (insects, fish, amphibians, and mammals).

4.1.2 Geographical factors affecting the distribution of freshwater molluscs

The whole circum-Mediterranean region is geologically recent. During Late Miocene times (11.6-5.3 million years ago) the Mediterranean Sea extended over large parts of the adjacent lands, while most of eastern Europe and parts of Asiatic Russia and Turkey were covered by the Paratethys Sea, stretching out from the Rhône Basin in France to the Aral Sea and connected with the North Sea. During Mio-Pliocene times this vast but shallow sea was divided in basins that became brackish or fresh, such as the Pannonian basin system, the Euxinian lakes basin (presently the Black Sea), and the Caspian and Aral Sea basins. At the onset of the Pliocene (5.3 Ma) the Mediterranean was closed off from the Atlantic at Gibraltar and evaporated, leaving hypersaline to brackish lakes at the bottom.

For millions of years the molluscan fauna of the whole region has shown spectacular changes in composition and morphological evolution due to the existence of vast lakes with marked salinity gradients and fluctuations and the possibility of migration among these ecosystems (Werner *et al.* 2007, Wesselingh 2007). During Plio-Pleistocene times (c. 2.5 Ma) these large lakes and their freshwater malacofauna disappeared either due to tectonic uplift (Lake Pannon), marine invasion (Euxinian lakes) or increased salinity due to endorheism and desiccation/desertification (Caspian Sea and Aral Sea). During the Pleistocene, severe climate fluctuations created large arid areas, making many once habitable regions inhospitable for molluscs.

The modern malacological fauna of the Eastern Mediterranean region is a small relict of the Mio-Pliocene endemic one. However, the high species richness and degree of endemism in such families as the Hydrobiidae, Neritidae, Melanopsidae, and even in the Dreissenidae, and possibly in the *Potamida* group (Unionidae), is directly linked to the evolutionary radiation of saline tolerant freshwater taxa in the lakes that existed in former times.

An important part of the present fauna (e.g. Viviparidae, Bithyniidae, Valvatidae, Thiaridae, most pulmonate taxa, probably also *Unio*, *Anodonta*, *Corbicula,* and most Sphaeriidae) consist of geologically recent arrivals that either reached the region from the Palearctic through a narrow corridor west of the Euphrates (e.g. *Valvata, Lymnaea,* etc.) or from the east via the Tigris-Euphrates system (e.g. *Bellamya*, *Corbicula*). Taxa of the lakes in the Paratethyian region succeeded in extending their range as far east as the Euphrates (Dreissenidae) and west to Lake Tiberias/Sea of Galilee (Hydrobiidae). The Danubian fauna is represented in Lake Sapanca in northwestern Turkey (Schütt 1988).

Several Palearctic taxa presently occurring in northeastern Africa and the Lower Nile, such as the gastropods *Valvata nilotica* and *Theodoxus niloticus,* are morphologically near-identical to Levantine species and probably reached Africa from that region during Late Pleistocene-Holocene times (D. Van Damme pers. comm. 2014). Recent molecular research has equally proved a distinct relationship between Levantine *Unio* and the African representatives of the genus *Unio* (M. Lopes-Lima pers. comm. 2014). However, there is no evidence that Afrotropical elements reached the Levant (Sivan, Heller, and Van Damme 2006).

4.1.3 Limitations in data availability and reliability

Much of the knowledge of the freshwater molluscan fauna for the Eastern Mediterranean is dated, with recent reviews for only Turkey (Yıldırım and Kebapçı 2012), Lebanon (Bößneck 2011), and Israel (Milstein, Mienis, and Rittner 2012). Knowledge for Syria and Jordan relies on literature from the 1930s (Germain 1936, Pallary 1939). Schütt's (1965, 1983a, 1983b) and Kinzelbach's (1987, 1989) reviews of the region provide further data on the large river systems in Turkey, Syria, Lebanon, and Jordan. From the adjacent countries formerly of the Soviet Union, Zhadin (1952) and Kantor *et al.* (2010) provide lists of species and their distributions, and for Europe, Bank, von Proschwitz, and Falkner (2006) give lists for Greece. Some of the species in these lists, but not yet recorded from the Eastern Mediterranean as defined for this project, are likely to be discovered in the region in the future, as there are many areas with little survey effort. With few recent checklists to draw from, the compiling of the final species list for the region has been a difficult task and it is likely that a number of species may have been missed.

The taxonomy of most groups is either presently under revision or is in urgent need of revision. It is also likely that new species will be discovered, particularly with advances in molecular systematics, from the cryptic species lineages presented in recent taxonomic revisions for some species groups, namely the Bithyniidae (e.g. Glöer and Georgiev 2012), Lymnaeidae, and Planorbidae (Glöer, Falinioski, and Pesic 2010, Glöer and Georgiev 2012).

4.2 Conservation status

This IUCN Eastern Mediterranean project is the first study that provides a comprehensive overview of the conservation status of the region's freshwater molluscan fauna. In this project the conservation status of each species of freshwater mollusc was assessed by applying the *IUCN Red List Categories and Criteria: Version 3.1* (IUCN 2012).

There are 145 species that have been identified and assessed for the Eastern Mediterranean region, however as discussed above (section 4.1.3) this will be an underestimate of true species diversity. There are an additional five species that were only recently identified to be in the region, but this was unfortunately too late to be included in this project, these are the gastropods *Pseudobithynia saulyci*, *P. yildirimi*, *Pyrgorientalia zilchi,* and *Sadleriana minuta*, and the bivalve *Pisidium sogdianum*. These species will be assessed by the IUCN SSC Mollusc Specialist Group for publication in the first IUCN Red List release of 2015. It is important to note that of the 145 species assessments, 14 species are classed as *draft* Red List assessments and still need to be independently reviewed. See Appendix 2 of the report for a full species list for the region.

Of extant species where there is sufficient information to identify an extinction risk 45.5% (55 species) are classed as threatened, an additional nine species (7.4%) are considered Near Threatened, and just under half (57 species or 47.1%) are Least Concern (Figure 4.1). There are an additional 24 species (16.6% of all species in the region) that are assessed as Data Deficient, meaning there was insufficient information available to make an assessment of extinction risk, due to unresolved taxonomic problems or lack of information on current distribution. There are no species classed as Extinct or Extinct in the Wild.

Almost two thirds (94 species or 62.7%) of the Eastern Mediterranean molluscan fauna is endemic to the region (note four of these are Not Assessed). Of the extant endemic species where there is sufficient information to identify a risk of extinction over three quarters (53 species or 76.8%) are threatened, with 10.1% (seven species) Near Threatened, and only 13.0% (nine species) assessed as Least Concern (Figure 4.2). Of the 90 endemic species that were assessed, 21 species (23.3%) are assessed as Data Deficient.

4.3 Patterns of species richness

Apparent regional variations in the distribution patterns of species and threatened species richness in part reflect regional differences in the status of taxonomic research, levels of survey work, and numbers of range restricted endemic species, which are often threatened. These factors should be taken into consideration when interpreting the species distribution maps.

4.3.1 All freshwater mollusc species

There is a general trend of increasing species richness towards the north and west due to the arid nature of the environment in the southern part of the region. Although representatives of the Palearctic fauna predominate across the Levant and Arabian Peninsula, there are immigrants from the Oriental fauna. The isolated position of Anatolia from the European mainland and the barrier provided by the Anatolian mountain belts may explain the general decrease in the number of species with Palearctic affinities as we move to the south of the region.

Figure 4.1 Number of species of Eastern Mediterranean freshwater mollusc species in each IUCN Red List Category.

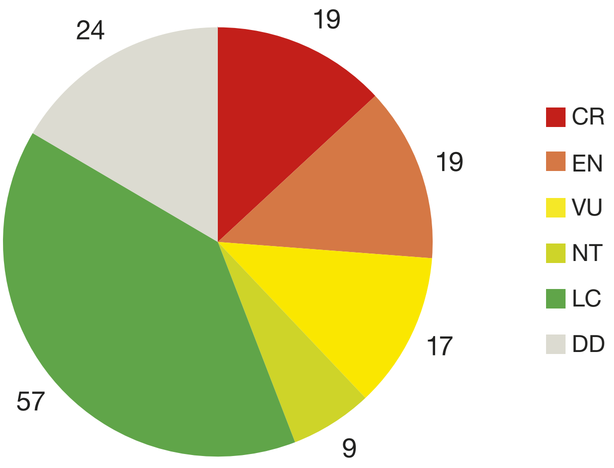


Figure 4.2 Number of species of Eastern Mediterranean endemic freshwater mollusc species in each IUCN Red List Category.

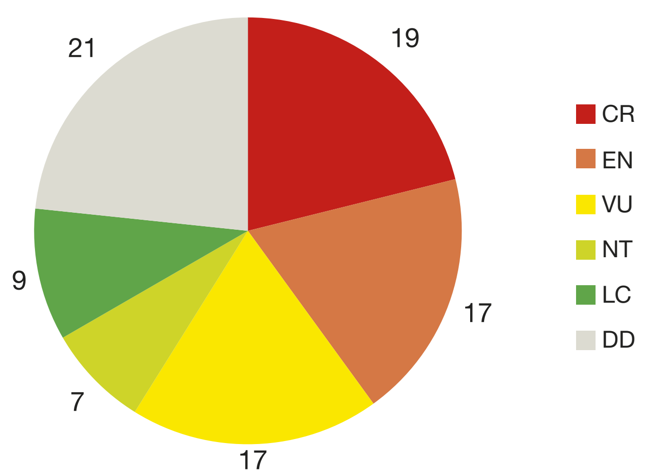


Figure 4.3 shows that the sub-basins with the highest species richness (22-26 species) are the Kırkgöz karst springs in Antalya, the lower Orontes in Turkey, and the Karasu River upstream of Amik Lake (including Gölbası Lake), and a river catchment and swamp area to the west of the Tarsus River in Turkey. Areas of high richness (17-21 species per sub-basin) are found in lower parts of rivers along the Mediterranean coast of Turkey, lakes Burdur, Eğridir, Beyşehir, and Eber, the catchments of lakes Acı, Salda, Burdur, and Eğridir, and the Litani River basin including the Aammiq marshes.

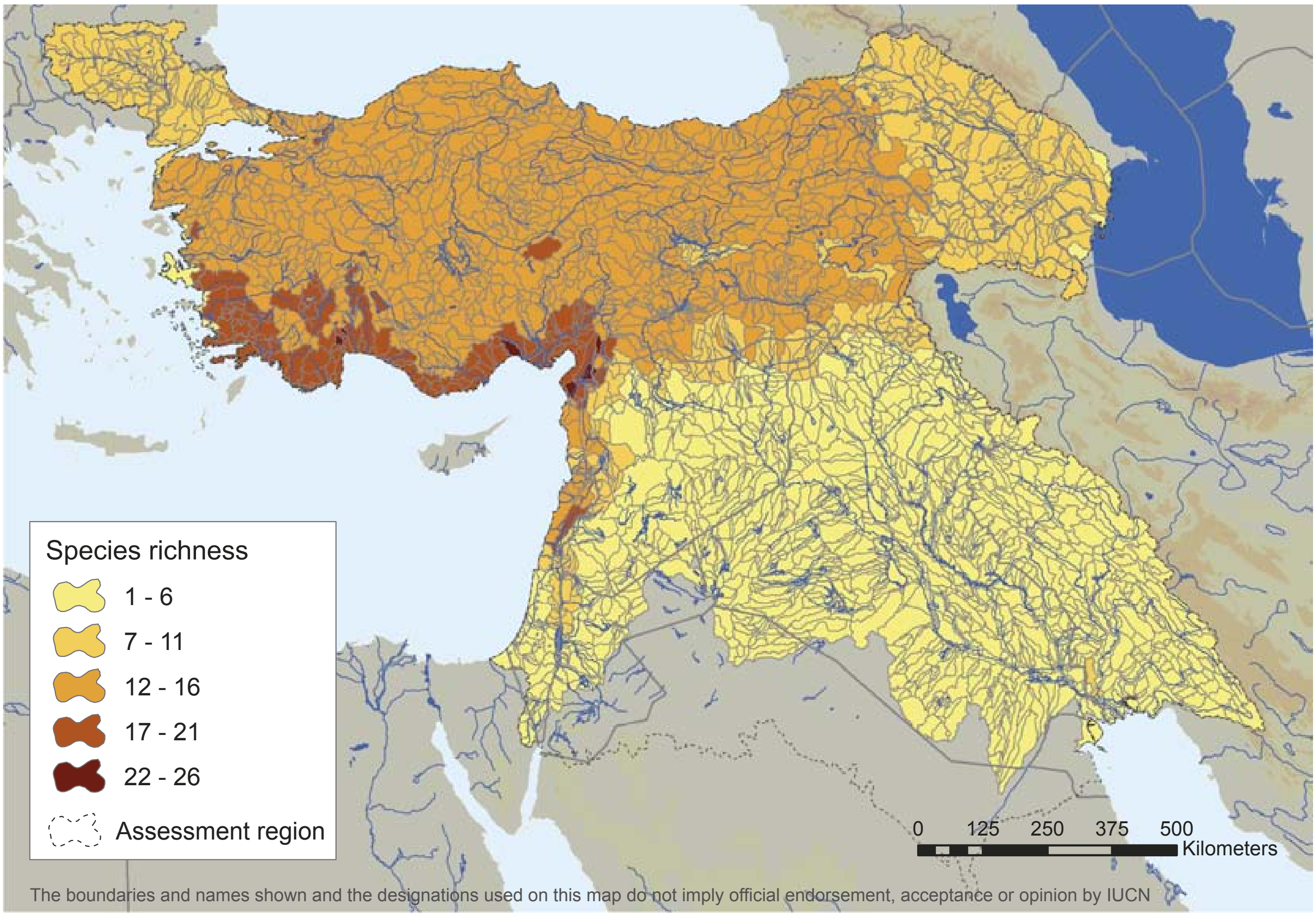
4.3.2 Threatened species

The greatest diversity of freshwater molluscs is found in the spring snails. Apart from their tendency to be found in restricted habitats and their low dispersal abilities in general, they have a low tolerance to changes in environmental conditions which can rapidly lead to extinction. This is especially valid for restricted range species. Due to the abundance of single site species and widespread threats to freshwater habitats, threatened species are concentrated in the Lakes Region of Turkey (Figure 4.4). The sub-basins containing the highest number of threatened species are the Kırkgöz springs (seven threatened species) in Antalya, Turkey, which also contain the highest diversity of single site endemics in the region (six species), followed by Eğridir Lake in Isparta, Turkey (five threatened species). Sub-basins containing between three and four threatened species are found in four general areas; Lakes Region of Turkey (Lake Beyşehir, and the catchments (springs) of lakes Acı, Işıklı, Burdur, and Eğridir) and the Küçük Menderes River; Gulf of Iskenderun in Turkey (in a river and marsh to the west of the Tarsus River, the lower Asi/Orontes, and the Karasu River above Amik Lake including Gölbası Lake); western Levant (Lake Homs in Syria and in the upper Asi River in Lebanon, the Nahr al Kabir on the border between Syria and Lebanon, the coastal rivers of Lebanon including the Litani, Lake Tiberias/Kinneret and its catchment, and the Zarqa River including the Rumeinin springs/waterfalls); and Ras al-Ain springs at the headwaters of the Khabour River (upper Euphrates) in northern Syria.

4.3.3 Restricted range and endemic species

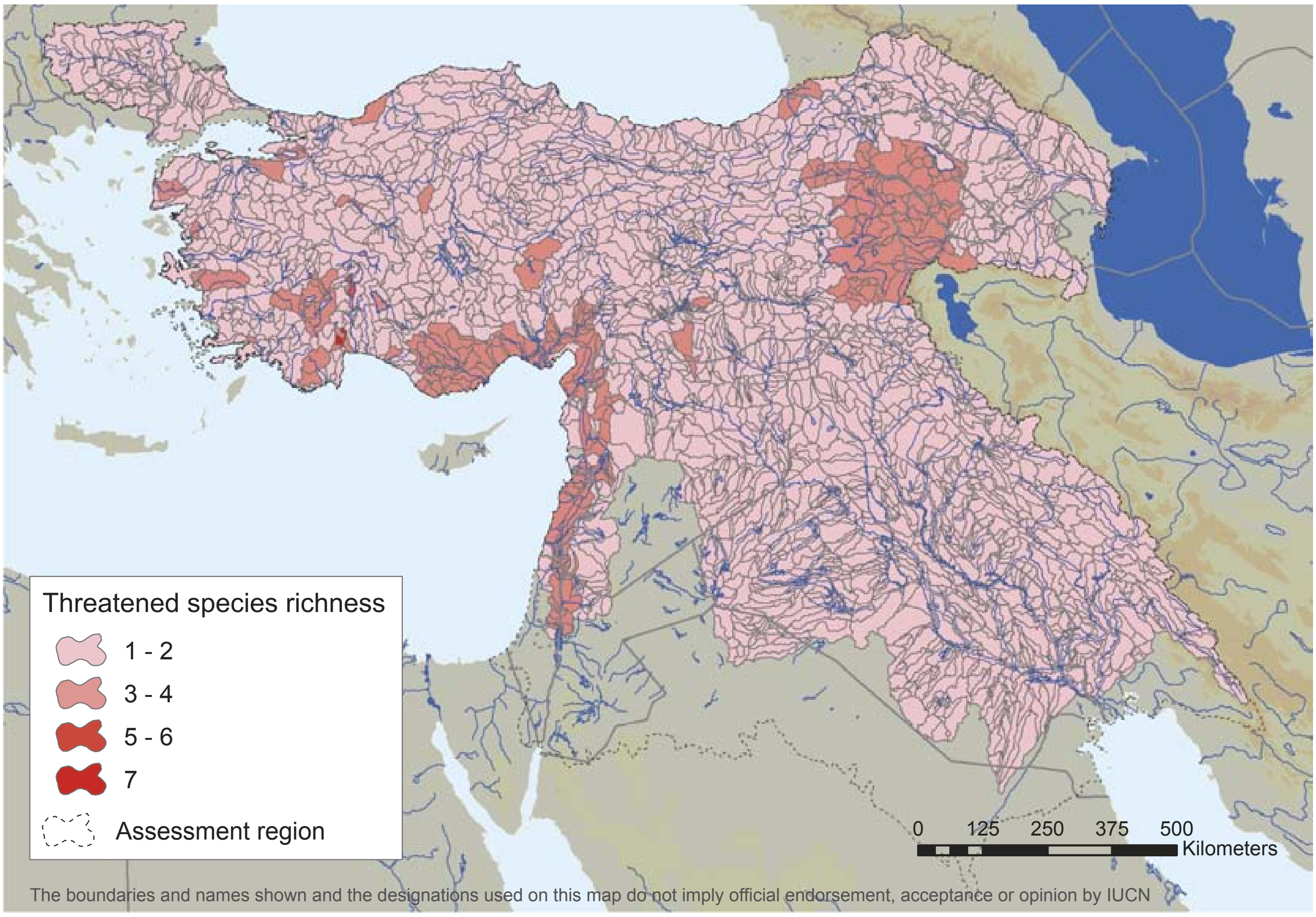
In Anatolia, particularly along the Mediterranean coast and in Central Anatolia, some species reach the southern limit of their European range, but many locally endemic species also occur (Yıldırım and Karaşahin 2000). This high ratio of local or single catchment endemic species extends south to the Jordan basin. In contrast, most species in Mesopotamia have large distribution ranges occurring all over the Tigris-Euphrates system from Turkey south to Iraq.

Figure 4.3 Eastern Mediterranean freshwater mollusc species richness. Species richness = number of species per sub-basin (defined by HydroBASINS 'Level 8', Lehner and Grill 2013).



Kırkgöz karst springs in Antalya contain more threatened freshwater mollusc species than anywhere else in the region. Photo © Ümit Kebapçı

Figure 4.4 Eastern Mediterranean threatened freshwater mollusc species richness. Species richness = number of species per sub-basin (defined by HydroBASINS 'Level 8', Lehner and Grill 2013).



River systems
The Eastern Mediterranean contains several major river systems that have endemic species present in their catchment. The main endemism in the freshwater mussels is found in large rivers such as the Orontes, Jordan, and the Tigris-Euphrates. By contrast, most of the pea-clam species are more widespread with mainly pan-European distributions, reaching their eastern limit in the Eastern Mediterranean region. Some of the Dreissenid mussels are endemic to this region and are restricted to the large lakes and rivers in Turkey.

Lakes
The Eastern Mediterranean contains several important lake regions that have endemic species present in their catchment. These lakes vary in geological longevity and origin, and are fed by subterranean springs and intra-lacustrine springs within the lake complexes. Notable lakes in the region are Eğirdir, Beyşehir, Acı, and Işıklı in southwestern Turkey. In northwestern Turkey, lakes Iznik and Sapanca with their catchments are important for freshwater gastropod biodiversity. The Gölbaşı lakes (in Adıyaman) are another lake system in eastern Turkey with a considerable level of freshwater mollusc endemism. Gölbaşı Lake (in Hatay, Turkey), Lake Homs (Syria), and Lake Tiberias/Kinneret (Israel) are the other important lakes for gastropod diversity in the south.

Recent work on the taxonomy of species in the region has revealed the existence of many new cryptic species, providing a new insight into the degree of endemicity within the Turkish Lakes Region (Yıldırım and Kebapçı 2009).

Springs and groundwaters
Species with an extremely restricted range, sometimes of only a few square metres, are the Anatolian spring snails (e.g. Hydrobiids and Cochliopids) that exist in only one or two springs or wells. Although their range underground may be more extensive, they are assessed as threatened on a precautionary basis as the extent of their range in artesian aquifers is uncertain. Some species may be truly restricted to the wells whereas others, which are only found at outlets during flood events are likely to be distributed more widely in the aquifers supplying the outlets.

4.3.4 Data Deficient species

The two main reasons for Data Deficiency in molluscs are taxonomic uncertainty and poor geographic knowledge, making it impossible to map their distribution. There are species with little distribution data, beyond the information provided in their original descriptions, some dating back to the 19th century. The regions with the highest proportion of Data Deficient species due to poor geographic knowledge are Syria, Jordan, and parts of Turkey and Lebanon.

In terms of taxonomic uncertainty, the high level of taxonomic confusion within the freshwater molluscs is largely a consequence of too many species being described by members of the 19th century French 'Ecole Nouvelle' and the competing German malacologists, which considered all morphologically differing populations as different species. Few recent taxonomic revisions have been made so that, for quite a number of species described between 1850 and 1920, there remains doubt as to their

Gölbaşı Lake (in Hatay, Turkey) is the remnant of the former Lake Amik on the Karasu River. Many freshwater species are now confined to this small lake. Photo © Manuel Lopes-Lima

İncirlipınar springs in the headwaters of the Büyük Menderes River, Turkey, is the type locality for the EN gastropod *Graecoanatolica dinarica*. The springs are threatened by a fish farm and eutrophication. Photo © Ümit Kebapçı

taxonomic validity. Conversely, due to the lack of distinctive morphological characters, traditional taxonomic techniques used to identify species have proven to be inadequate. The use of molecular markers has now proved that a high number of distinct but 'cryptic' species exist in the region, which were previously unrecognized (i.e. species that are morphologically very close but genetically highly distinct).

4.3.5 Possibly Extinct and regionally extirpated species

While no species have been confirmed as being Extinct, there are 11 species that have been assessed as Critically Endangered Possibly Extinct (CR PE). This means that further surveys are required to confirm whether the species is extinct. Most of the CR PE species come from the smaller spring-snails (Hydrobiidae) with a restricted range in Turkey: *Hydrobia anatolica, Graecoanatolica conica, Graecoanatolica brevis, Falsiprygula beysehirana, Islamia pseudorientalica, Kirelia carinata,* and *Belgrandiella cavernica*. The other CR PE species are all from the Melanopsidae family, and are restricted to karstic spring complexes in Syria and Turkey: *Melanopsis germaini* (stream species not springs), *Melanopsis infracincta*, *Melanopsis khabourensis,* and *Melanopsis pachya*.

There are other gastropod species that have been extirpated from significant parts of their ranges: *Graecoanatolica lacustristurca* (EN) is considered extinct in Lake Beyşehir, but remains at other sites, *Heleobia longiscata* (DD) is extinct in Israel, and the subspecies *Pseudorientalia natolica smyrnensis* is no longer recorded from the İzmir area in Turkey.

All of the large bivalves (*Unio terminalis*, *Potomida littoralis*, *Leguminaia saulcyi,* and *L. wheatleyi*) are locally extinct in all of the Levant coastal rivers (in Israel, Lebanon, Syria, and Turkey) with the probable exception of Nahr al-Kabir which forms the Lebanese-Syrian border and is inaccessible to researchers (M. Lopes-Lima, pers. comm.).

There are also the mainly Palearctic species that extended their southern limit to the Levant, Ethiopian Highlands, and Maghreb during the (colder and wetter) early Holocene period and are now retreating to the north in the current warmer and drier climate (*Pisidium milium, Segmentina nitida, Gyraulus crista, Gyraulus albus, Acroloxus lacustris* (in Israel), *Valvata cristata* (in the Lakes Region of Turkey), all LC species).

4.4 Major threats to freshwater molluscs

There are multiple drivers of threat to freshwater molluscs in the Eastern Mediterranean region, and in the majority of cases it is usually a combination of threats that lead to declining populations. Figure 4.5 shows that the major threats are water abstraction for domestic supplies and agriculture, and dams (all included under '*Natural system modification*') which affect 68.8% of threatened and Near Threatened species, water pollution from agricultural and urban areas which impacts 56.3%, followed by climate change leading to increasing droughts (29.7%). The loss of habitats due to urban and agricultural expansion is also a threat to freshwater molluscs, affecting 20.3% and 14.1% of threatened and Near Threatened species respectively.

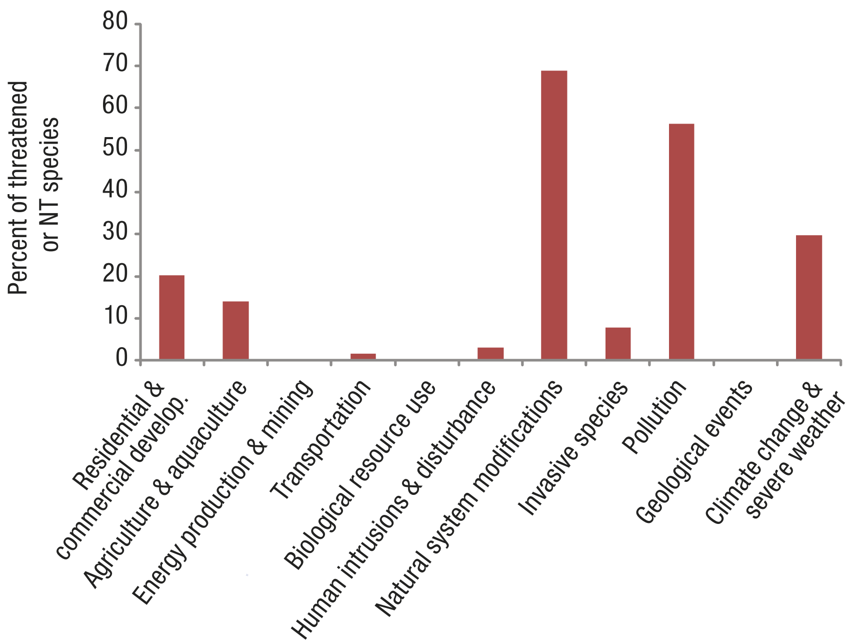
4.4.1 Water abstraction and dams (Natural system modifications)

The threat category *Natural system modifications* includes water abstraction and dams, and impacts over two thirds (68.8%) of the threatened and NT freshwater molluscs. Surface and ground water are abstracted in huge quantities throughout the arid parts of the Eastern Mediterranean region and abstraction is rarely sustainable, leading to an alarming reduction in groundwater levels (Voss *et al.* 2013). The exact number of dams in the region is unknown, however Turkey is one of the most active dam building nations in the world with more than 2,000 dams and weirs already constructed, with plans to build an additional 1,700, including the controversial Ilısu dam (GegenStrömung 2011, International Rivers 2014).

Throughout the Mediterranean region, including Turkey and the countries of the Levant, the human needs for water are already higher than the available water resources. The water demands for intensive agriculture and growing populations

Many rivers in the region now have intermittent flows due to dams holding back water and water abstraction. Left: The Karasu River below the Tahtaköprü dam. Right: The Tahtaköprü dam reservoir, both photos © Jörg Freyhof

Figure 4.5 Drivers of threats impacting threatened and Near Threatened freshwater mollusc species in the Eastern Mediterranean region.



cannot be satisfied by extraction from surface waters alone. In many areas, large spring-fed wetlands have been severely impacted by groundwater extraction and withholding water by dams, for example the Amik Lake wetlands in Turkey (now drained), the Turkish Sultan marshes, lakes Avlan, Hotamış, and Acı, the Jordanian Azraq wetlands, the Hula marshes in Israel, and the Mesopotamian marshes in Iraq, which almost completely dried out. This loss of wetlands has massively impacted freshwater mollusc populations across the region. Spring-snail species have declined or even been lost from headwaters as they are often 'sanitized' and 'improved' for water abstraction purposes, destroying habitats and lowering the water table to such an extent that springs no longer flow. The lowering of groundwater tables is impacting stream flows across the region and many have dried out, for example the Qweik River, which once flowed through the Syrian city of Aleppo and now is just an intermittent and highly polluted stream (UN-ESCWA and BGR 2013), and also many of the formerly permanent Levantine coastal streams from Israel to Turkey. This reduction in freshwater flow in rivers and streams is also leading to increased salinity in the lower parts of rivers, making these areas uninhabitable for many mollusc species.

Furthermore, the damming of rivers also impacts bivalve species through the blocking of their migratory fish hosts from reaching the mussel beds within the rivers upstream of dams.

4.4.2 Pollution

In many areas the impact of reduced flows in river and stream systems caused by over-abstraction (4.4.1) is compounded by pollution and nutrient enrichment from urban and agriculture effluents, transforming what flow remains into hypertrophic streams. This situation can also be seen in the bigger river systems, such as the Orontes River where large sections of the middle and lower part of the river are almost devoid of freshwater life due to excessive inputs of urban and agriculture runoff, and also in the downstream parts of the Jordan River which is heavily polluted and almost no water reaches the Dead Sea (Barinova *et al.* 2010, UN-ESCWA and BGR 2013).

Across the Eastern Mediterranean region and especially adjacent to areas of urban development, pollution is a major threat to freshwater molluscs, and impacts 56.3% of all threatened or Near Threatened species (Figure 4.5). Within the Eastern Mediterranean region, Western Anatolia (Turkey) is acutely impacted by water pollution, here all major rivers, such as the Bakır, Gediz, and the Küçük and *Büyük* Menderes, are heavily polluted. The upper parts of the Küçük Menderes have virtually vanished as all tributaries have dried out due to water extraction and the remaining lower part of the river is filled by untreated sewage from towns and industries. The Gediz and Bakır are also so polluted that little freshwater life can survive in the middle and lower parts.

Despite the scale of pollution in the region, little is known about the true extent and intensity of pollution, particularly from agricultural and industrial sources. Comprehensive data on chemical and biological water quality in the Eastern Mediterranean region is lacking, and with the exception of Israel, there are no country-wide surface water quality monitoring systems in place.

4.4.3 Climate change and severe weather

Due to the impacts of climate change the Eastern Mediterranean region is predicted to become dryer and warmer, with a particular increase in the frequency of hot summer days and high temperature events (CEPF 2010) with reduced rainfall in all of Anatolia (except the northern coast) as well as in all of the Levant and the Mesopotamian region (Chenoweth *et al.* 2011).

This changing climate is compounding already reduced water flows due to over-abstraction, and is impacting almost one third (29.7%) of threatened and NT species (Figure 4.5). The future, especially for the local spring endemic species, is looking bleak as there have already been a number of local and possible global extinctions of freshwater molluscs due to reduced water levels (see the Possibly Extinct spring snails in section 4.3.5).

Within parts of the Mediterranean, reduced rainfall and water abstraction has impacted the Orontes/Asi and the Jordan river systems, and severely affected the coastal streams of the Levant, many of which are almost gone (Ü. Kebapçı and M. Lopes-Lima pers. obs. 2013). Also within the Lakes Region of Turkey, six lakes (lakes Pınarbaşı, Kestel, Gencali, Avlan, Söğüt, Karagöl) are largely dried out. Unfortunately, the freshwater mollusc fauna was recorded in only three of these lakes (Avlan, Söğüt, Karagöl), therefore it is likely that a number of species, unknown to science, have been lost (Kebapçı and Yıldırım 2010, Ü. Kebapçı pers. comm. 2014). It is a similar situation for the marshlands of Turkey, where the Eşmekaya marshes (in Aksaray), Ereğli marshes (Konya), and Gavur Lake (Kahramanmaraş) have all been severely reduced in size, and none of them had undergone malacological surveys.

The Orontes River is impacted by water abstraction and pollution, but has lots of mussels in localized stretches. Orontes River on the Turkey-Syrian border. Photo © Manuel Lopes-Lima

It is therefore difficult to establish the likely degree of loss of the freshwater molluscs that would have been present and lost at these sites. Such marshland reductions have also been recorded around the Sea of Galilee/Kinneret with reported localized extinctions (H. Mienis pers. comm. 2012).

4.4.4 Other threats

The major widespread threats to the region's freshwater molluscs are discussed above, however it is worth noting that some areas, particularly along the coastal regions of Turkey, are suffering from a loss of wetland habitats due to development (impacting 20% of threatened and NT species), primarily for tourism.

Invasive mollusc species are also present in the region and are believed to be impacting a number of threatened and NT species (7.8%, see Figure 4.5). However, while new records of invasive snail species are increasingly being published, for example Nasarat, Amr, and Neubert (2014) who report two new invasive species in Jordan, the impact upon native species is yet to be documented.

4.5 Conservation actions and recommendations

This assessment has revealed many gaps remaining in the exploration and understanding of the freshwater molluscan fauna of the Eastern Mediterranean region. While almost two thirds of the freshwater mollusc species are endemic to the region, most are still very poorly known, highlighting the urgent need for more research. However, more importantly, there exists no comprehensive government supported initiative for the conservation of this highly diverse and threatened group. Whilst large-scale conservation efforts for widespread and unthreatened vertebrates exist, freshwater molluscs are frequently considered as pests that require extermination rather than as a major component of the endemic fauna providing ecosystem services vital to maintaining the health of river systems. Consequently molluscs are largely ignored in conservation planning and legislation in most countries in the region.

4.5.1 Field research and taxonomic studies

Field surveying is essential in order to provide up-to-date information on the overall distribution of species, their threats, and the abundance of sub-populations and the connectivity between them. While the region has been a focus of small research projects which have demonstrated the levels of endemicity reported here, further data is required on many species' distribution, growth, life span, age of maturity, and dispersal ability which are all crucial to inform effective conservation planning and management. In addition, in light of the cryptic lineages already identified within the region, in particular for the large mussel species that maintain healthy river systems, taxonomic research is urgently needed, as well as data on geographic genetic diversity patterns, evolutionarily significant units (ESUs) and/or management units (MUs).

We strongly recommend an increase in field surveys and taxonomic research, particularly through further cooperation projects for national and international scientists, as these will help build regional scientific capacity. This will require further investment from national agencies, including funding, administrative assistance with research permits and other resources.

4.5.2 Monitoring and ex-situ actions

Anecdotal information suggests that in all countries in this region there has been a substantial decline in the quality and extent of freshwater habitats since the 1980s, and that mollusc populations have been declining over the past 10 to 30 years. Monitoring programmes are urgently required to track the population trends of many of the threatened species, and especially for those with highly restricted range which are susceptible to the lowering of water tables and reduced flows, some of which are already possibly extinct. Such projects will need to adopt strict monitoring protocols so that ex-situ conservation actions can be taken before further species become extinct.

4.5.3 Environmental flows

In many regions, there is a lack of basic data about the levels of ongoing water abstraction and its impact upon native species. The environmental flows, including the quality, quantity, and timing of water flows, required to maintain the highly endemic and threatened mollusc species, need to be identified, and incorporated into the decisions that govern water management in the region. However, this will require significant changes in current water use policy across the region. Hence there is an urgent need to raise awareness across different sectors and stakeholder groups on the importance of freshwater molluscs and their conservation status.

4.5.4 Protected Areas

Building on the IUCN Red List assessment information published in this report, the freshwater Key Biodiversity Areas (KBAs) of the Eastern Mediterranean region (including for molluscs) have been identified and validated through regional stakeholder workshops. The results of this work are published in a separate report, *Freshwater Key Biodiversity Areas in the Mediterranean Basin Hotspot* (Darwall *et al*. 2014). A network of protected areas needs to be established using the results of these Key Biodiversity Areas (KBAs), and managed appropriately; for freshwater species this means using integrated river basin management approaches. In addition, management of the existing protected areas across the region needs to ensure that actions are taken to conserve the freshwater biodiversity within them, as they are often focused upon only terrestrial mega fauna. The high level of endemicity and range restricted species especially within the Levant, where water

Field surveys are urgently required as much of the data on the region's freshwater molluscs are outdated. Manuel Lopes-Lima with local fishermen surveying bivalves in Gölbaşı Lake (in Hatay, Turkey). Photo © Manuel Lopes-Lima

resources are already extremely low and urban development is still growing, means such a network of protected areas, if effectively managed, will be vital for conserving freshwater mollusc species.

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Chapter 5. Odonata (dragonflies and damselflies)

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Red-veined Dropwing (*Trithemis arteriosa*) a LC species found across Africa, and the Levant. Photo © Jean-Pierre Boudot

5.1 Overview of the regional odonate fauna[1]

The first significant contribution to our understanding of the Odonata fauna in the Eastern Mediterranean was made by W.G. Schneider, who described five new species from southern Turkey in 1845. Some decades later Selys (1887) in his seminal work on Asia Minor, gave an updated picture of the regional fauna and compared it to that of surrounding regions. Subsequent decisive works were presented, in several country-related papers for Turkey (Morton 1914, Schmidt 1953, 1954a, Dumont 1974a, 1977, Dumont, Demirsoy, and Verschuren 1987, Dumont, Borisov, and Seidenbusch 1995, Schneider 1983, 1984a, 1985a, 1986a), Iraq and surrounding areas (Morton 1919, 1920a,b, 1921, Sage 1960a,b, Asahina 1973, 1974), what was then referred to as Palestine, and now as Israel and Palestine (Morton 1924, Schmidt 1938), South Caucasus countries (Akramowski 1948, 1964, 1975, Shengelia 1975), Iran (Schmidt 1954b, Blom 1982, Hacet and Aktaç 1997, Lohmann 1990, 1992, 1993), the Levant (Dumont 1974b, 1991, Schneider 1981a,b,c, 1982a,b, 1984b, 1985b, 1986b, 1987a,b, 1995), the Near East (Schneider 1985c,d) and Lebanon (Schneider and Moubayed 1985). More recent records and syntheses appeared after the turn of the millennium, dealing with Lebanon (Dia and Dumont 2011), Iran (Heidari and Dumont 2002, Sadeghi and Dumont 2004, Kiany and Minaei 2009, Sadeghi and Mohammadalizadeh 2009, Sadeghi and Kiany 2012, Ghahari *et al.* 2012), the South Caucasus countries (Dumont 2004, Tailly, Ananian and Dumont 2004, Tailly and Tabarroni 2006, Schröter 2010, Ananian 2012, Ananian and Tailly 2012), Turkey (Kalkman, Wasscher, and Van Pelt 2003, Kalkam *et al*. 2004, Kalkman, Lopau, and Van Pelt 2004, Van Pelt 2004; Kalkman 2006, Kalkman and Van Pelt 2006, Hacet and Aktaç 2004, 2006, 2008, 2009, Salur and Özsaraç 2004, Salur and Kiyak 2000, 2006, 2007, Pisica and Popescu-Mirceni 2008, Hacet, 2009a,b, 2010, Ayten and Özgökçe 2009, Miroglu and Kartal 2008, Miroglu 2011, Miroglu, Katal, and Salur 2011, Salur, Dogan, and Yagiz 2012, Salur, Miroglu, and Okçu 2012, Olthoff and Ikemeyer 2012), Jordan (Katbeh-Bader, Amr, and Schneider 2002, Katbeh-Bader, Amr, and Abu Baker 2004), Syria (Mousatat *et al*. 2010), and the overall Mediterranean Basin (Boudot *et al*. 2009).

Whereas many papers dealt with the descriptions of new species (e.g. Marinov 2001 who described a new Corduliidae species from the Eastern Rhodope), others pointed to the dramatic degradation of the hydrological systems with respect to their Odonata fauna in the Eastern Mediterranean region, a process which is particularly extreme from southern Turkey to the whole Levant and Mesopotamia (Schneider 1982b, Dumont, Demirsoy, and Mertens 1988, Seidenbusch 2001, Herkenrath and Evans 2002, Mousatat *et al.* 2010, Schneider and Schneider 2010, Dia and Dumont 2011).

Onychogomphus assimilis, one of the species described by W.G. Schneider in 1845, now threatened (VU) due to habitat loss from urbanization, tourism development, and gravel mining from streams. Photo © Jean-Pierre Boudot

The Eastern Mediterranean is a transition region covering parts of both the West and East Palearctic, linking the western and south-western Asian fauna to the African and the European. There are 124 Odonata species in the region, 96 of them are Palearctic species (77.4%) (including several subspecies or local forms of which the systematics is still unclear) (Figure 5.1). Due to paleotropical inputs, the remaining taxa includes 17 (14%) Afrotropical species and six (5%) Indomalayan. Four species are cosmopolitan to subcosmopolitan, as their ranges encompasses several biogeographic realms (these are *Pantala flavescens* [a neo- and paleotropical migrant with local/sporadic reproduction in the Palearctic and the Nearctic], *Sympetrum fonscolombii* and *Anax imperator* [widespread in Africa and Europe, more regional in central and south-western Asia], and *Ischnura senegalensis* [almost the whole Paleotropics]). While *Agriocnemis sania* is restricted to the north of Africa and the Levant, it may pertain to the *A. pygmaea* complex, widespread throughout the Indomalayan area with significant regional variations of which the systematic value is poorly known.

Turkish Anatolia and the South Caucasus countries share a lot of species and show some homogeneity in the composition of their Odonata fauna. The Levant (Syria-Lebanon-Israel-Jordan-Palestine) and southern Turkey harbour a distinctive

[1] **Taxonomic notes:** The poorly known *Coenagrion vanbrinkae* Lohmann 1993 is considered here as at most a subspecies of *C. ornatum* (Selys, 1850) and is treated with the latter. *Calopteryx waterstoni* Schneider, 1984, endemic from the North-east Anatolia, is similarly treated as a member of the *C. splendens* complex, although assessing it at the full species rank would be equally justified. *Coenagrion persicum* Lohmann 1993 is treated with reserves as a valid species but more knowledge is needed to know whether it should be treated as a synonym of *C. pulchellum* or not. *Agriocnemis sania* Nielsen, 1959 is considered distinct from *A. pygmaea* (Rambur, 1842) but this should deserve more attention by additional researches as both taxa are closely related and the later shows significant regional variations (Pinhey, 1974). *Cordulegaster mzymtae* Bartenef, 1929 is considered as a subspecies of *C. insignis* Schneider, 1845 due to the existence of probable hybrids. Further researches are needed to know whether this is justified or not. *Crocothemis erythraea chaldaeorum* Morton, 1920 is maintained at the subspecific rank and is treated with the nominotypical subspecies although further researches are needed about this poorly known taxon.

Odonata fauna which includes a fairly high number of Eastern Mediterranean endemics (see below). The number of species recorded from each country (or part of country) included in the region is shown in Table 5.1. It shows that the greatest number of species (based on the up-to-date distributional data), almost 100, is found in Turkey, followed by a number of countries with similar diversity (50-60s); including Syria, Israel, Armenia, and the parts of Bulgaria and Georgia that fall within the region. The countries with relatively low diversity are Iraq, Jordan and Lebanon (41–47 species), and Palestine (25) and Kuwait (11) support the fewest species.

The 124 species of Eastern Mediterranean Odonata are found within 10 families, five pertaining to the Zygoptera (damselflies) suborder and five to the Anisoptera (dragonfly) suborder (Table 5.2). There are almost two Anisoptera species for every one Zygoptera, and the Libellulidae (skimmers) is clearly the best represented family containing one third of all the regional Odonata species. Eleven species are strictly endemic to the region (six Zygoptera and five Anisoptera) and are found in the Calopterygidae, Coenagrionidae, Platycnemididae, Gomphidae, and Libellulidae families. The Zygoptera have twice the proportion of regional endemics (14% species are endemic to the region) compared to the Anisoptera (6.2%).

The endemic species are particularly concentrated in the Levant and southern Turkey (*Calopteryx hyalina*, *C. syriaca*, *Coenagrion syriacum*, *Pseudagrion syriacum*, *Onychogomphus macrodon,* and *Gomphus davidi*), with others in Anatolia, Iraq, and Iran, some with a relatively large range (*Platycnemis kervillei*, *Libellula pontica,* and *Brachythemis fuscopalliata*), and some with a smaller range (*Gomphus kinzelbachi* and *Coenagrion persicum*). Near regional endemics that have restricted ranges are known from the Balkans (e.g. *Somatochlora borisi* which is found in the Eastern Rhodope area in Bulgaria, Greece, and Turkish Thrace, extending out of the Eastern Mediterranean region as defined for

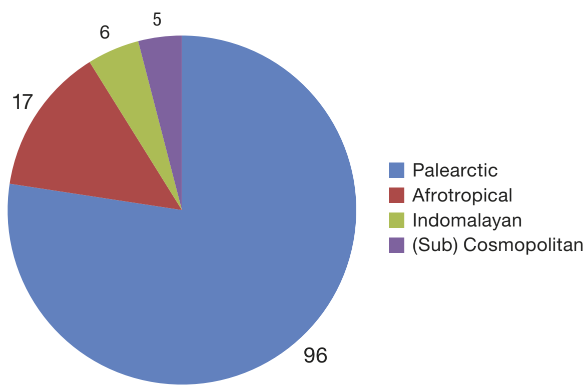
Table 5.1 Number of Odonata species in each country (or part of each country) in the East Mediterranean region. The table shows two figures for each country: 'Red List' presents the number of species from the region coded to each country according to their IUCN Red List assessment; 'Distribution Data' presents data from an up-to-date distribution database held by the authors. As some species assessments are five years old, the distribution data represents a more accurate figure of true diversity for each country.
* indicates those countries that are only partially within the region.

Countries	Number of species (Red List)	Number of species (distribution data)
Armenia	50	60
Azerbaijan	49	56
Bulgaria*	N/A	64
Georgia*	53	62
Greece*	N/A	55
Iran*	66	52
Iraq	38	41
Israel	56	64
Jordan	41	44
Kuwait	10	11
Lebanon	41	47
Palestine	28	25
Saudi Arabia*	N/A	3
Syria	55	67
Turkey	96	99

Table 5.2 Number of total and endemic Odonata species within each family.

Suborder	Family	Number of species	Number of regional endemics
Zygoptera	Calopterygidae	4	2
	Coenagrionidae	26	3
	Euphaeidae	1	0
	Lestidae	9	0
	Platycnemididae	3	1
Total Zygoptera (Damselflies)		43	6
Anisoptera	Aeshnidae	12	0
	Cordulegastridae	5	0
	Corduliidae	5	0
	Gomphidae	17	3
	Libellulidae	42	2
Total Anisoptera (Dragonflies)		81	5
Total Odonata		**124**	**11**

Figure 5.1 Zoogeographic origin of the Eastern Mediterranean Odonata fauna.



this project by just 35 km or less) and the eastern shores of the Black Sea (e.g. *Coenagrion ponticum* from Turkey, Georgia, and south-west Russia).

5.2 Conservation status

5.2.1 Threatened species

The application of the IUCN Red List Categories and Criteria (IUCN 2012) shows that of the 124 species (listed in Appendix 2), eight (6.7%) are threatened, and are assessed as Endangered (EN) or Vulnerable (VU), with no species assessed as Critically Endangered (the highest threat category). A further six species (4.8%) are close to meeting the thresholds for a threatened category, and are therefore assessed as Near Threatened (NT) (Tables 5.3 and 5.4, Figure 5.2). The majority (88.3%) of the Eastern Mediterranean species are not threatened or Near Threatened at the global scale (although some of them are declining within the region, see Appendix 2).

However, the proportion of threatened (and Near Threatened) species increases dramatically when only the endemic species are considered (Tables 5.3 and 5.4, Figure 5.3). Four (44.4%) of the nine endemic species that can be assigned a threat category, are threatened, with an additional two species being Near Threatened and three species Least Concern, showing that the endemics are significantly impacted by the regional pressures to freshwater systems and are threatened at the global scale. Among the six threatened and Near Threatened endemics, several are confined to the Levant and southern Turkey, a region in which hydrological systems and water bodies have suffered significantly from very rapid degradation.

5.2.2 Data Deficient species

Four species, two being endemics (*Coenagrion persicum*, *Gomphus kinzelbachi*), are poorly known and are assessed as Data Deficient (DD) (Table 5.4, Figures 5.2 and 5.3). *Cordulegaster vanbrinkae* was described in 1993 from the Elburz Mountains in northern Iran (outside the region) where it was only recorded again in 2013 (Schneider *et al.* 2014). It has also been recently discovered in two new localities within the Eastern Mediterranean region, including two nearby forest streams in south-east Armenia in 2010 (Ananian and Tailly 2012), an additional site was discovered in south-east Azerbaijan in 2012 and 2013 just outside the Eastern Mediterranean region (Skvortsov and Snegovaya 2014). More information is needed on the species' range, and on the threats to the sites in the South Caucasian countries and northern Iran. *Coenagrion persicum* is an Iranian taxa described in 1993 from one single male and one exuvia. It was found to be closely related to *C. pulchellum* but additional studies are needed to identify its systematic position. *Gomphus ubadschii* extends from western Anatolia to Central Asia. It is separated from the closely related *G. flavipes* by the Marmara Straight, the Black Sea, and the Caucasus range. In Central Asia a gap seems to exist between these two species in Kazakhstan, with *G. ubadschii* south of the Balkhach Lake and *G. flavipes* to the north. *G. ubadschii* seems to be scattered across the Eastern Mediterranean region but most records date from before 1996. Accordingly, its present conservation status is poorly known as since this date several Anatolian rivers have been degraded and

The threatened (VU) Turkish Red Damsel (*Ceriagrion georgifreyi*) is restricted to a narrow strip of coast from Israel to southwest Turkey and three Greek islands, where it is impacted by increasing levels of drought. Photo © Jean-Pierre Boudot

Table 5.3 Threatened and Near Threatened Odonata species in the Eastern Mediterranean region.

Family	Scientific name	Common name	IUCN Red List Category	Endemic to the East Mediterranean region
Calopterygidae	*Calopteryx hyalina*	Clear-winged Demoiselle	EN	Yes
Calopterygidae	*Calopteryx syriaca*	Syrian Demoiselle	EN	Yes
Coenagrionidae	*Ceriagrion georgifreyi*	Turkish Red Damsel	VU	
Gomphidae	*Onychogomphus assimilis*	Dark Pincertail	VU	
Gomphidae	*Onychogomphus flexuosus*	Waved Pincertail	VU	
Gomphidae	*Onychogomphus macrodon*	Levant Pincertail	VU	Yes
Corduliidae	*Somatochlora borisi*	Bulgarian Emerald	VU	
Libellulidae	*Brachythemis fuscopalliata*	Dark-winged Groundling	VU	Yes
Coenagrionidae	*Coenagrion syriacum*	Syrian Bluet	NT	Yes
Coenagrionidae	*Ischnura intermedia*	Dumont's Bluetail	NT	
Gomphidae	*Anormogomphus kiritshenkoi*		NT	
Cordulegastridae	*Cordulegaster bidentata*	Sombre Goldenring	NT	
Cordulegastridae	*Cordulegaster heros*	Balkan Goldenring	NT	
Libellulidae	*Libellula pontica*	Red Chaser	NT	Yes

Figure 5.2 Number of Eastern Mediterranean Odonata species in each IUCN Red List Category.

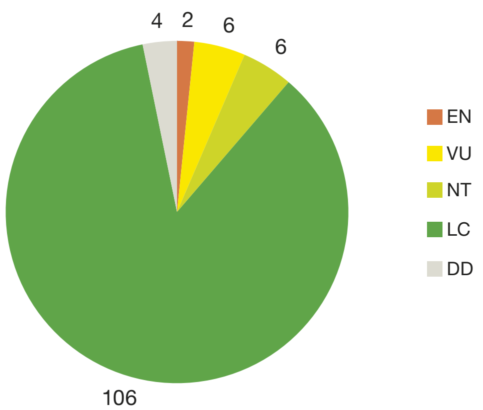


Figure 5.3 Number of Eastern Mediterranean endemic Odonata species in each IUCN Red List Category.

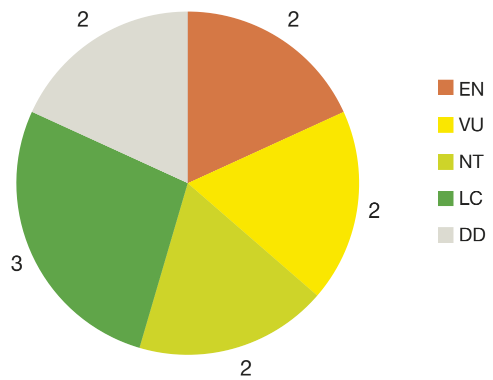


Table 5.4 Number of Odonata species in each Red List Category in the Eastern Mediterranean region.

IUCN Red List Category	Number and % of all species	Number and % of all regional endemics
Extinct	0 (0%)	0 (0%)
Extinct in the Wild	0 (0%)	0 (0%)
Critically Endangered (CR)	0 (0%)	0 (0%)
Endangered (EN)	2 (1.6%)	2 (18.2%)
Vulnerable (VU)	6 (4.8%)	2 (18.2%)
Near Threatened (NT)	6 (4.8%)	2 (18.2%)
Least Concern (LC)	106 (85.5%)	3 (27.3%)
Data Deficient (DD)	4 (3.2%)	2 (18.2%)
Total number of taxa assessed	**124**	**11**

The Dark-winged Groundling (*Brachythemis fuscopalliata* VU) is endemic to the Eastern Mediterranean region where its populations are declining due to pollution and habitat loss. Photo © Jean-Pierre Boudot


The Syrian Clubtail (*Gomphus ubadschii*) is a DD species due to a lack of information on its status in the eastern parts of its range in Central Asia. Photo © Jean-Pierre Boudot

the impacts to the species is therefore unknown, it is likely that the species is at least Near Threatened. *Gomphus kinzelbachi* is a rare endemic from eastern Iraq and western Iran. Only five records exist, ranging from 1937 to 2002, and therefore more surveys are required to understand the conservation status of this species.

5.3 Patterns of species richness

5.3.1 All species

The odonate species of Turkey, Levant, Bulgaria, and Armenia have been relatively well studied during the past 30 years, allowing for an accurate picture of species distribution. However, field inventories in Georgia, Azerbaijan, western Iran, Iraq, and northern Saudi Arabia are much rarer and often old. Based on the collected data, comprehensively compiled and mapped to sub-basins (see Chapter 2), the areas holding the highest numbers of species (between 41 and 50 species) are primarily along the coast of southern Turkey from the Sandras Mountains and Köyceğiz Lake through the Dalaman Plain, Fethiye Bay to the Esen River catchment, and the coastal areas south of Alanya; the upper Hula Valley in Israel and Lebanon; forested areas near Bolu in north-western Turkey; forests to the west of Tbilisi in Georgia (upper Kura catchment); and the Biala Reka (Bulgaria), Oreinis

Toparlar stream is within the Köyceğiz catchment, one of the sub-basins with the highest diversity of Odonata in the region. However while the upper reaches are in good condition, as the stream descends into the alluvial coastal plain water is extracted to such an extent that the stream is dry. Photo © Jean-Pierre Boudot

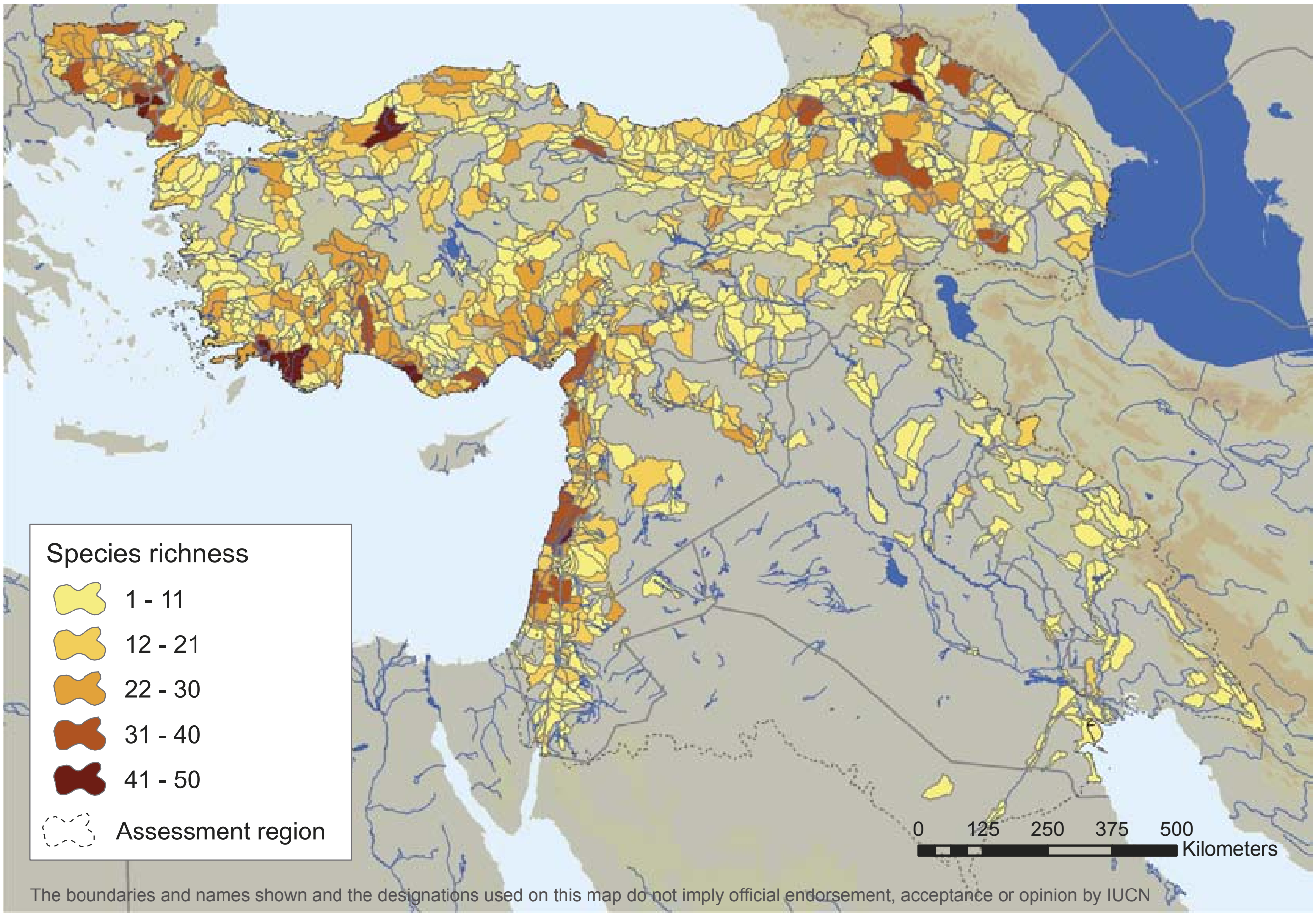


Figure 5.4 Eastern Mediterranean Odonata species richness. Species richness = number of species per sub-basin (defined by HydroBASINS 'Level 8', Lehner and Grill 2013).

Evros, and Poilia Wildlife Refuge (Greece) in the upper Evros Catchment (see Figure 5.4).

Areas of high species richness (31–40 species per sub-basin), include the Jordan River Valley in Israel and Jordan; coastal Israel north of Tel Aviv to Haifa; coastal Lebanon and the Litani River; the Karasu River and Amanos Mountains on the Gulf of İskenderun, Turkey; lower Göksu River and its delta, the Köprü River valley, both in southern coastal Turkey; many sub-basins of the Evros River in Turkey, Greece, and Bulgaria; Kelkit River valley in Tokat, northern Turkey; upper Çoruh River in the Yalnizcam Mountains in north-eastern Turkey, southern Caucasus mountains in Georgia (Kura catchment); and the Aras River valley in Armenia.

5.3.2 Threatened species

There are only eight threatened odonate species in the region (Near Threatened not included), but the vast majority of the areas containing these species are along the Mediterranean coasts of southern Turkey and the Levant, with a few threatened species found in the upper Euphrates (Syria) and the Kura/Aras River catchments in Armenia and Georgia (Figure 5.5). The two sub-basins containing the highest number of threatened species in the region (four species) are found in the middle Asi/Orontes in Syria and the Hula valley in Israel and Lebanon. In both these areas the threatened species found are *Brachythemis fuscopalliata* (VU), *Calopteryx hyalina* (EN), *C. syriaca* (EN), and *Onychogomphus macrodon* (VU). Three threatened species are found in the lower Ceyhan River in south-eastern Turkey on the Gulf of İskenderun (*B. fuscopalliata* (VU), *O. flexuosus* (VU), *O. macrodon* (VU)), and the coastal rivers of Lebanon (*C. hyalina* (EN), *C. syriaca* (EN), and *O. macrodon* (VU)).

5.4 Major threats to Odonata

The major threats to the Eastern Mediterranean Odonata species are from the loss and physical degradation of aquatic habitats, due to wetland drainage for development, high levels of water extraction, water pollution, and climate change (Dumont, Demirsoy and Mertens 1988, Seidenbusch 2001, Bou Zeid and El Fadel 2002, Dia and Dumont 2011, Mousatat *et al.* 2011) (Table 5.5). The Red List assessment data shows that *natural system modifications* (i.e. water abstraction and dams) and *pollution* are the two most significant drivers of threat to Odonata in the region, impacting 79% and 71% of threatened and NT species respectively (Figure 5.6), and both *residential and commercial development* and *climate change and severe weather* both affect half of all threatened and NT species.

The destruction of swamps, marshes, and lakes by large scale drainage has historically impacted Middle Eastern benthic fauna. Examples include the drainage of Amik Lake and its marshes in southern Turkey, Antakya province, which was initiated in 1940 to develop cotton culture, and the destruction of the Hula Lake ecosystem in northern Israel from 1951 to 1958. Both resulted in a severe decline in water resources, and the extinction of several endemic species. Attempts at rehabilitation and reconstruction have since been developed in the Hula Lake area, by re-flooding parts of the Hula depression. More recently, the destruction of

Figure 5.5 Eastern Mediterranean threatened Odonata species richness. Species richness = number of species per sub-basin (defined by HydroBASINS Level 8, Lehner and Grill 2013).

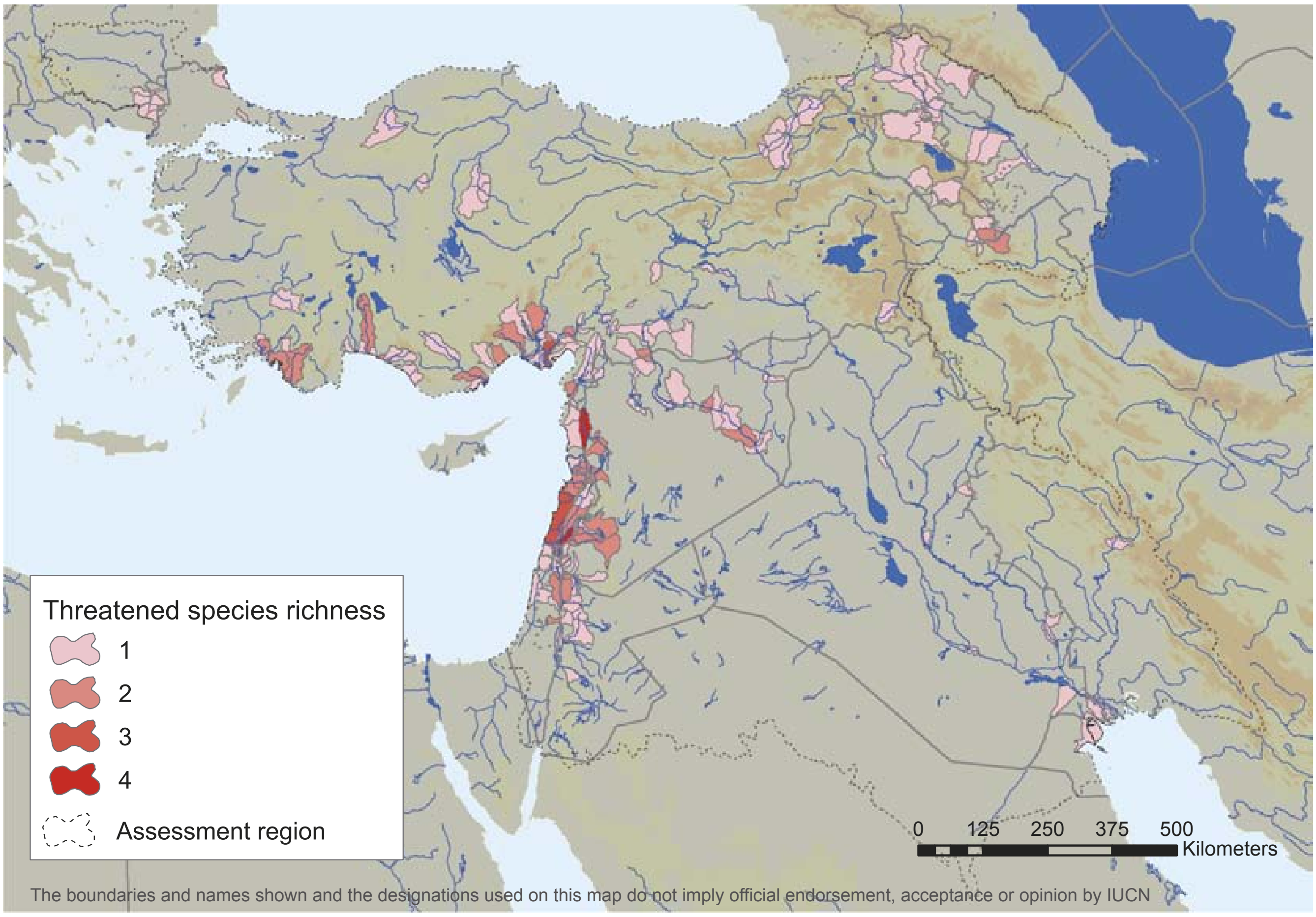
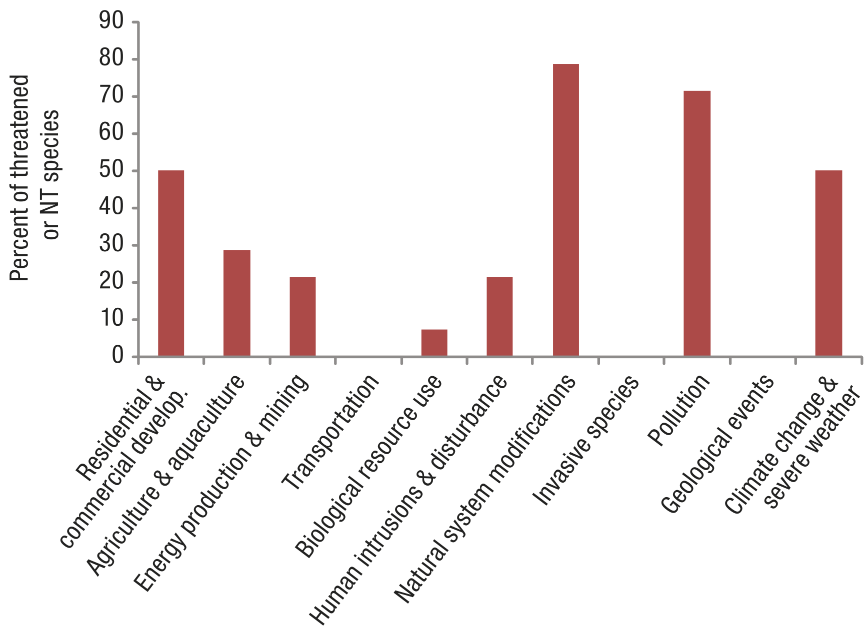


Figure 5.6 Drivers of threats impacting threatened and Near Threatened odonate species in the Eastern Mediterranean region.



the lower Euphrates marshes for political reasons between the two Iraq wars resulted in the near extinction of many of the dependent species, among which was *Brachythemis fuscopalliata* (VU), a well-known Middle East endemic.

Many formerly permanent streams in the East Mediterranean region have become intermittent, becoming fully dry in the summer. This has been caused by a change in climate compounding already severe water shortages due to increasing levels of ground and surface water (at springs) extraction primarily for irrigation, and the channelization of rivers and brooks in agricultural areas. Dam construction is also increasing throughout the whole region, especially in Turkey, and has resulted in the loss of

The Syrian Demoiselle (*Calopteryx syriaca*) an EN species endemic to the southern Levant where it is impacted by water extraction and drought. Photo © Izhar Laufer online image under Creative Commons 2.0 licence by-nc-nd

Table 5.5 Main threats and conservation status of the Eastern Mediterranean endemic species.

Family	Species	Main threats	IUCN Red List Category (global)
Calopterygidae	*Calopteryx hyalina*	Water extraction, dams, channelization, water pollution, drought	EN
Calopterygidae	*Calopteryx syriaca*	Water extraction, dams, channelization, water pollution, drought	EN
Gomphidae	*Onychogomphus macrodon*	Water extraction, dams, channelization, water pollution, drought	VU
Libellulidae	*Brachythemis fuscopalliata*	Water extraction, dams, channelization, water pollution	VU
Coenagrionidae	*Coenagrion syriacum*	Water extraction, dams, channelization, water pollution, drought	NT
Libellulidae	*Libellula pontica*	Water extraction, dams, channelization, water pollution	NT
Coenagrionidae	*Coenagrion persicum*	Unknown	DD
Gomphidae	*Gomphus kinzelbachi*	Water extraction, dams, channelization, water pollution	DD
Coenagrionidae	*Pseudagrion syriacum*	Water extraction, dams, channelization, drought	LC
Platycnemididae	*Platycnemis kervillei*	Water extraction	LC
Gomphidae	*Gomphus davidi*	Water extraction, dams, channelization, water pollution	LC

The Euphrates River in southern Turkey, taken in 1993, now submerged by the reservoir of the Birecik irrigation and hydropower dam. Photo © Jean-Pierre Boudot

flourishing populations of regional endemic species, which are often replaced by more ubiquitous ones.

Agricultural, domestic, and industrial pollution affects virtually all of the inland water systems in the region. It is expected that this will increase in line with development, leading to increasing pressure on benthic organisms such as odonates. Pollution is severe in some stretches of major large rivers in Anatolia, the lower Ceyhan River and Adana Peninsular being one of the most serious examples of a former endemic-rich habitat now largely devastated due to pollution, in this case by uncontrolled oil discharges and other industrial and agricultural effluents. Regional endemics such as *Brachythemis fuscopalliata* (VU) have been extirpated from the Adana Peninsula, an area of intensive cotton production, due to the continued use of fertilizers and pesticides (Dumont, Demirsoy, and Mertens 1988). Gravel mining of river beds is also a threat to odonates, as it destroys benthic habitats and has led to the loss of huge populations of the Southwest Asian *Onychogomphus assimilis* (VU) in southern Anatolia.

5.5 Conclusion and conservation recommendations

The freshwater ecosystems in the Eastern Mediterranean region have been under significant pressure over the past century. This has led to a serious situation for the endemic odonate species, with more than half (six species) assessed as threatened or Near Threatened. Most of these are confined to the Levant and the southern coast of Anatolia, an area where human pressure is high and political instability often makes successful conservation action difficult. The main threats are associated with habitat loss and physical destruction of wetland habitats (mostly due to water abstraction, draining of wetlands, and dams) but pollution and increasing rainfall deficit due to climate change are also significant pressures. It is also important to note that the four Data Deficient species identified in this study, two of which are endemic, may well become threatened species when more information is available.

Long-term conservation of the Odonata fauna in the Eastern Mediterranean region depends upon the conservation of the

The Blue-eyed Goldenring (*Cordulegaster insignis*) is a widespread but localised LC species, restricted to seepage springs and headwaters in hilly and mountainous areas which are threatened by water extraction and drought. Photo © Jean-Pierre Boudot

remaining standing water and rivers under a low level of pollution and relatively natural flow regimes (i.e. no channelization, no drainage, no dam construction). Seepage springs and headwaters in mountains and hilly regions are particularly important and need protection as they harbour highly specialized species which cannot live in other habitats (e.g. *Sympetrum haritonovi* (LC) which has lost some of its rare known localities in the past two decades due to mountain agriculture and road construction; also *Cordulegaster insignis* (LC) which is threatened by the drying up of its spring habitats). Restoration and rehabilitation of formerly destroyed or degraded marshes should be undertaken whenever possible.

Lastly, it is important to make sure that the threatened and endemic species are monitored in the field and regularly re-assessed for the IUCN Red List as threats in the region are changing rapidly.

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Chapter 6. Freshwater plants

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6.1 Freshwater plants included in the assessment

Wetland-dependent plants provide a wide range of functions in freshwater ecosystems. They supply water with oxygen, fix atmospheric carbon, recycle nutrients, regulate water temperature and light, as well as protecting against erosion. They also provide vital habitats and food for fishes and aquatic invertebrates, which themselves support other animals and humans. Many species of wetland-dependent plants, such as rice (*Oryza sativa*) and water-chestnut (*Trapa natans*) are eaten by people, while others have been used for a variety of other purposes, such as papyrus (*Cyperus papyrus*) for writing and *Saccharum ravennae* which is now widely cultivated as an ornamental plant. Some species are used for construction, such as common reed (*Phragmites australis*) which is used for thatching roofs, erosion control, making furniture, and as an ornament. Plants that are dependent upon wetlands are vulnerable to many anthropogenic pressures, from direct habitat loss through drainage and conversion to other land uses, to pollution and the secondary effects of hyper-eutrophication such as algal blooms.

Important wetlands in the region include rivers such as the Euphrates, Tigris, Orontes, Jordan, and the Litani, many of which have played a significant role in the development of human civilization, as well as supporting a wide range of aquatic plant, fish, and bird diversity, providing significant ecosystem services to the communities that protect them (Carp 1980). The wetland communities known as Ma'adans have lived near, and have depended for their livelihood on the wetlands of southern Iraq, fed by the Tigris and Euphrates for over 5,000 years. Reed beds in the area provide these people with a source of income and are used for boat and house construction. The lakes are an important fishing ground and provide them with food, and other human activities across the wetlands include bird hunting and raising buffalos. These isolated communities maintain a culture and way of life that has changed little for hundreds of years, their symbiosis with wetlands is remarkable.

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Trapa natans formerly an important crop throughout its native range. Photo © R.V. Lansdown

The aim of this project was to assess the conservation status of vascular plant species occurring in wetlands in the Eastern Mediterranean region (see Chapter 2, Figure 2.1); no taxa below species level were assessed separately nor were hybrid combinations. The definition of which plants may be considered aquatic is not straightforward. The following definition is considered the most clear and unambiguous available: 'Vascular aquatic plants are interpreted as all Pteridophytina and Spermatophytina whose photosynthetically active parts are permanently or, at least, for several months each year submerged in water or float on the surface of water' (Cook 1996). However, not only is little known about the tolerance or requirements of many plants (for example some 'photosynthetically active parts' such as the leaves of many *Rubus* species may remain submerged for several months but they would never be considered 'aquatic' in a strict sense) but the duration of tolerance of inundation is unknown. In addition, there are plants which often germinate in temporary water bodies after the water has dried out (for example *Cyperus fuscus*) but which rarely, if ever grow in water. Therefore, the decision was taken to extend the range of taxa included to cover species such as *Phyla nodiflora*, which is restricted to the edge of shallow semi-permanent and permanent water courses, as well as *Isoetes olympica* which is capable of growing in shallow, seasonally inundated depressions (and has even been found in a wet corner of a vineyard). Thus, the aim of the project was to consider the conservation requirements of all plants occurring in the Eastern Mediterranean region which can be considered to be dependent upon wetlands; that is species which would not occur if there were no wetlands.

A fundamental principle of these assessments was not to pre-judge the conservation condition, such as by selecting species known or believed to be of conservation concern, as this approach is likely to support existing areas of concern, but overlook taxa which are not already known to be at risk.

The vascular plant taxa covered by this assessment can be grouped as follows:

- Species which are always completely submerged (obligate submerged aquatics) such as the naiads (Najadaceae).
- Species which are always submerged with sexually reproductive parts emergent (held above the water or at the surface), such as *Stuckenia amblyophylla* or *Groenlandia densa*.
- Species which are always emergent, the roots and base of the plant are submerged, but some photosynthetic parts and sexually reproductive parts are held above the water, such as *Eleocharis*, *Schoenoplectus,* and *Typha* species.
- Species which are always floating, without roots or with roots hanging in the water column, such as hornworts (*Ceratophyllum* sp.) and duckweeds (Lemnaceae).
- Species which are always amphibious, growing from the land over the water or adopting a variety of the above forms, such as some *Persicaria* species.
- Species which always grow on the margins of wetlands and those associated with ephemeral wetlands.

The following were excluded from the assessment:

- Taxa known or suspected not to be native to the region. However, this distinction is not always straightforward, particularly when considering long established cultivated plants, such as *Acorus calamus* and *Nymphaea* species.
- Hybrids and taxa below species level.
- Strict halophytes, again this involves a degree of judgement, there are large areas of the Near and Middle East in which most of the plants of seasonal and some permanent wetlands must be tolerant of quite high salt levels. However, to have included all wetland-dependent vascular plant species, therefore including both coastal and inland halophytes would have significantly increased the number of species beyond the capacity of the project.

There are areas of taxonomic uncertainty affecting wetland-dependent plants, in particular, the taxonomy of *Ranunculus* subgenus *Batrachium* is very poorly elucidated and the subject of a number of different concurrent treatments (Lansdown 2007). Equally, there are specimens of a *Callitriche* from Israel, identified as *C. mouterdei*, which are clearly one of the *C. hermaphroditica* group but not *C. truncata*. No other member of the *C. hermaphroditica* group has been recorded from the region and this is either an undescribed species or a significant

Damasonium bourgaei is widespread throughout the region in suitable habitat, but is not well distinguished from other *taxa*. Photo © R.V. Lansdown

extension in the range of another species. It is also certain that more than one species of *Damasonium* occurs in the region. There are credible records of *D. bourgaei* from Turkey east to Iran and all previous records of *D. alisma* appear to refer to this species. However, records of *D. alisma* from inland waters and at medium to high altitude are likely to be of a different species. In the Ceyhan Delta in southern Turkey, *D. bourgaei* occurred with another unidentified *Damasonium* species (A.J. Byfield pers. comm.). An unconfirmed record of *D. polyspermum* from the Homs area in Syria (Ewald *et al*. 2010) would represent a massive range extension for the species and needs to be confirmed before it can be accepted.

6.2 Limitations of this assessment

The assessment presented here is a major step forward in gaining an understanding of the conservation status of freshwater plants in the Eastern Mediterranean. However, it is important to note that the information on plants in the region is not uniform and the involvement of regional specialists in the project was in some cases affected by the political instability. Therefore to identify all freshwater plant species for the region, particularly for some lesser studied habitats, taxa, and countries, would involve a considerable amount of time and money far beyond the scope of this project, involving a review of herbaria and a much wider review of literature and engagement with species experts (if political stability allows). As a result, there are a number of areas of bias in this assessment, in particular species from Turkey, and within Turkey, from the coast of the Sea of Marmara have been treated in more detail, and freshwater plants from some habitats and countries have not been fully represented in this assessment. As the project progressed, particularly in the production of this report, a lot of information became available on wetland-dependent plants in the region but too late to be included in the actual Red List assessments.

Therefore the assessment has better representation of species from lowland habitats and countries that are politically stable, and are likely to be relatively common species, or those more restricted range species that are better studied. In addition, a lot of the information (species distribution in particular) may post-date significant levels of wetland modification across lowland areas in the region. Due to these reasons, it is likely that this assessment under-represents the true level of species diversity and threat in the region.

A key recommendation coming from this work is that an additional freshwater plant project is undertaken to fill in the species, habitats, and geographic gaps that exist in this assessment.

6.3 Wetland dependent plants and wetland habitats in the region

6.3.1 Overview

The region covered by this report extends from the Mediterranean coast to the mountains which straddle the borders of south-eastern Turkey, Iran, and Armenia with the highest peak, Mount Ararat (Ağrı Dağı), exceeding 5,000 m altitude. The northern and eastern parts of the region are dominated by mountains which extend from the Taurus mountains in south-western Turkey, eastward into Armenia and Azerbeijan, and then south-eastwards through Iraq to the Persian Gulf (see Figure 2.1). There is a second mountain range which runs along the eastern Mediterranean coast through Syria and Lebanon, south through Mount Hermon on the border between Lebanon and Syria, to Khalil governorate in Palestine. The eastern part of the region is dominated by the floodplains of the Tigris and Euphrates, which arise in the Anti-Taurus Mountains of central Turkey and flow southwards eventually to meet in the marshes of southern Iraq. Most of the region is characterized by dry arid climate, with extensive deserts. The extreme altitudinal range and relationship with the major water bodies: the Mediterranean, the Black Sea, the Caspian Sea, and the Persian Gulf, influence the climate, with consequences for the distribution and extent of wetland habitats. In particular, whilst annual rainfall throughout the region is mainly less than 500 mm, it rises to 2,500 mm on the Black Sea coast of Turkey. Available information suggests that of the 31 types of natural wetland of the Ramsar Convention classification, the region includes all except three (non-forested peatlands, forested peatlands, and tundra wetlands) (Mirabzadeh 1999). The topography and related elements of the climate drive the nature and distribution of wetland habitats throughout the region, these are described below.

6.3.2 Wetlands and wetland plants

High altitude wetlands in the region are mainly represented by wet flushes, seepages, wet peaty depressions or saddle wetlands, and alpine lakes, whilst at the highest levels, nivation (late snow-lie) hollows support a range of wetland-dependent bryophytes and in the mountains of Lebanon the endemic *Ranunculus schweinfurthii* (VU) (Rhazi *et al*. 2010). The highest lakes and tarns typically support few plants, although charophytes, as well as a range of pondweeds, including occasional *Stuckenia amblyophylla* may occur in deeper water. These water bodies generally also have sparse vegetation on the margins, but occasionally support more diverse vegetation which is usually dominated by *Eleocharis palustris* (Parolly 2004). Montane lakes and those at medium altitude such as Beyşehir Gölü, Karamik Gölü, Karadiken Gölü, Akşehir, and Eber Gölleri, and in the mountain ranges of Kılıç Dağı, Tecer Dağları, and Munzur Dağları in Turkey support a number of notable species including *Baldellia ranunculoides* (NT), *Salvinia natans,* and *Thermopsis turcica* (CR) (Seçmen and Leblebici 1984, Byfield, Atay, and Özhatay 2010). Montane lakes elsewhere in the region such as Gahar and Neor in Iran probably support a similar range of species, but are poorly known.

Much of the vegetated habitat above the tree line, as well as in open areas in high altitude coniferous woodland is characterized by wet meadows and pasture, dominated by grasses and sedges. In mountain areas such as Sultan Dağları, Kaz Dağı, Silphan Dağı, Ispiriz Dağı, and Yüksekova in Turkey and east into northern Iran these habitats support a wide range of species in swards which can, in places, be remarkably species-rich (Byfield, Atay, and Özhatay 2010). In wetter flushed areas, along the sides of streams and in pools, more wetland-dependent species may also occur (Sharifi *et al*. 2014). These nutrient-rich pastures, hay meadows, lawns, wet anthropogenic grasslands and carpet-turfs of wet or periodically flooded sites are broken up by springs and flushes which are often dominated by or have a high representation of bryophytes.

Seepages, springs and the overflows from tarns in the high mountains coalesce to form streams which are initially fast-flowing and steep, cutting through rock to form gorges and steep-sided valleys. These are typically dominated by bryophytes, although some vascular plants can also exploit these conditions. Along rivers flowing into the Caspian Sea, the steep rocks and high moisture along deep valleys and gorges support shade tolerant species, particularly ferns (Akhani *et al*. 2010). Wherever there is a decrease in slope, flow rates in rivers decline and allow the development of sedge and rush dominated marshy habitats (Parolly 2004). As streams become larger, they remain flashy, rising and falling dramatically in response to rainfall and snow-melt, but they begin to develop a wider range of channel habitats, including cobble and pebble bars and islands, eroding banks and cliffs which support diverse acrocarpous moss and liverwort stands, as well as backwaters sheltered from the flow by rock outcrops and bars. In the fastest flowing water courses, it is the backwaters which often support the only populations of obligate aquatic plants.

Shaded wetlands typically support fewer aquatic plants but *Alchemilla bursensis* (NT) occurs along the margins of streams

Baldellia ranunculoides (NT) is threatened by drainage and destruction of wetlands throughout its range. Photo © R.V. Lansdown

Mawat Gorge in Iraq. Photo © Anna Bachmann

and in bogs in *Fagus* forest at medium to high altitude in the Amanos Dağları (Mountains) while streams and pools in *Pinus nigra* forest in Turkey support a variety of wetland species (Kargıoğlu 2003). Where there is a build-up of peat at medium to high altitude, wetlands may support a very wide range of wetland-dependent plants, such as in the Sabalan Mountains of north-west Iran (Sharifi *et al*. 2014) and Akdağ in Turkey. Wherever there are streams or areas of open water in valley bottoms marshes and inundated habitats become more frequent. Extensive peatlands occur in the upper forest zone in the extensive Karadeniz area in north-eastern Turkey (Doğu Karadeniz Dağları) and support a highly diverse range of wetland-dependent species (Byfield, Atay, and Özhatay 2010).

Lakes at medium and low altitude may support beds of submerged and floating vegetation in open water. Most lowland lakes support species-poor associations dominated by *C. demersum* and *M. spicatum*, with few other species (Akhani *et al*. 2010, Naqinezhad 2012). Marginal vegetation is often dominated by tall monocots, with a range of smaller species in gaps (Scott 1995). Where the topography allows, marginal vegetation grades through marshes into wet meadows which support a wide range of species. In the richest areas, such as at Yukarı Gerede Vadisi in Turkey, a combination of topography and geology allows development of a wide range of habitats which support a similarly wide range of vegetation associations, including springhead communities, marshes, rich sedge flushes, tussock fen, short sedge fen, and swamp (Byfield, Atay, and Özhatay 2010). The drawdown zones of such lakes may also support diverse wetland-dependent vegetation, such as at Yeniçağa Gölü in Turkey. Lowland marshes support a range of restricted range species including *Iris xanthospuria* which is endemic to Turkey and has only been confirmed from the marshes of Dalaman Ovası, although there are unconfirmed reports from Hatay Province. The most abundant plant in wetlands throughout the region is *Phragmites australis* which may occur as a narrow fringe along streams and rivers, or can form immense beds in places such as Aammiq Wetlands in Lebanon and parts of the restored Mesopotamian marshes. At a smaller scale, marshes occur throughout the region, associated with rivers, streams, lakes, and ponds or simply with impeded drainage resulting from natural topography or human activities.

As slopes become more gentle, river valley sides become less steep and the channels support more vascular plants. Large lowland river systems often include a wide range of habitats for wetland plants, including major marshlands, marginal and floodplain wetlands, oxbow lakes, seasonal peripheral habitats such as pools created by scour during seasonal high flows, as well as riparian and gallery woodland. Lowland rivers also support a wide range of vegetation along their margins. Seasonally flooded sand and gravel banks, such as in

Mountain riverine habitat in Gali Balnda, Iraq. Photo © S. Abdulrahman

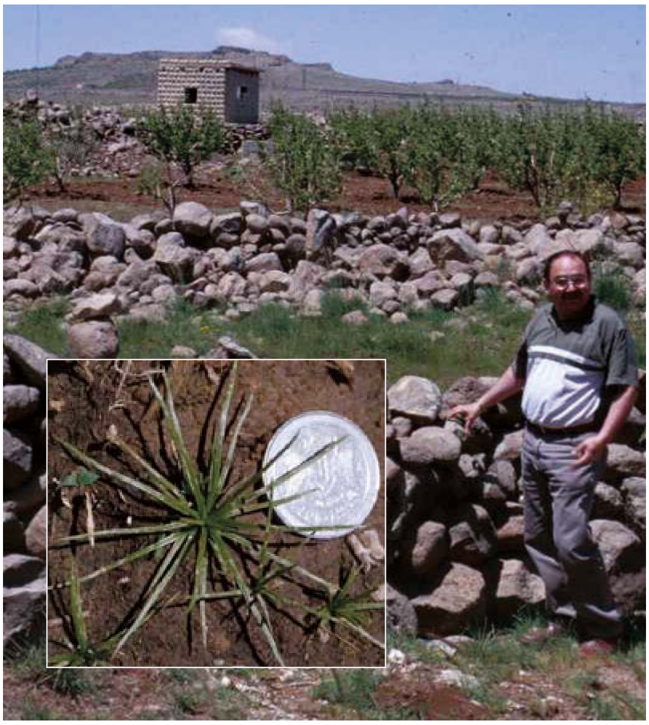
Wad Qana, a permanent stream with rich vegetation, Palestine. Photo © B. Al-Sheikh

the Yeşılırmak Delta in Turkey, may support a wide range of species, particularly Cyperaceae.

Ephemeral pools are a vital habitat for wetland plants throughout the region, from the Mediterranean coast where they may occur in dune slacks, in the upper reaches of deltaic systems, and in depressions over less permeable rocks, to upland desertic or steppic habitats. Some originate as stock watering ponds, whilst others are a consequence of impeded drainage or perched water tables. Throughout the region, although they may share some species with the drawdown zones of permanent lakes and ponds, such as *Baldellia ranunculoides* (NT) and *Elatine alsinastrum*, (NT) they also support a range of species which are restricted to this habitat, including annual *Lythrum* species, *Ranunculus lateriflorus,* and *Myosurus minimus*. A complex of pools near Homs in Syria and a second site near Biqaa in Lebanon have both been identified as Important Areas for Ponds (IAPs) (Ewald *et al*. 2010). Two particularly threatened taxa which are dependent upon ephemeral wetlands are *Isoetes olympica* (CR) and *Pilularia minuta* (EN). The area supporting *Isoetes olympica* in Lebanon is Jabal al Arab (also known as Jebel Druze) which is listed as an Important Plant Area (IPA) (Radford, Catullo, and de Montmollin 2011). The IPA is a convex volcanic massif reaching 1800 m and includes a number of permanent and seasonal pools. The site is threatened by over-exploitation of natural resources, tourism development, and urbanization (Radford, Catullo, and de Montmollin 2011). In contrast to ephemeral pools, most wadis typically only support wetland-dependent plants where they contain pools or lakes. In most cases, they do not hold water frequently enough or for long enough to be important for wetland plants.

Deltas generally represent complex wetland habitats, showing gradation from saline or brackish habitats nearest to the coast, to freshwater marshes inland. However, these systems are often further complicated by braided channels of large rivers which cut through the associated wetlands, providing even greater habitat diversity. Important deltaic systems in the region include those on the Kızılırmak, Yeşılırmak, Büyük Menderes, Göksu, Ceyhan, and Seyhan rivers in Turkey (Byfield, Atay, and Özhatay 2010) and the Shadegan Marshes and tidal mud-flats of Khor-al Amaya and Khor Musa in Iran (Carp 1980).

Habitat of *Isoetes olympica* in a vineyard near Kfar Noun, northern Lebanon, Inset. *I. olympica*. Photo © L.J. Musselman



Aammiq Wetlands, Lebanon. Photo © Ahmad Houri & Nisrine Machaka-Houri

Pilularia minuta (EN) which is threatened throughout its range by destruction of ephemeral wetlands. Photo © R.V. Lansdown

It is impossible to draw a clear line between freshwater and saline habitats in the region. Rivers lying in enclosed drainage basins terminate in saline wetlands which are subject to wide fluctuations in water level, often drying out completely. Extensive fresh to brackish marshes occur where rivers and spring-fed streams enter these salt lakes, such as the wetlands of the Sabkat al Jabboul in Syria and the Dead Sea in Palestine, Israel, and Jordan.

As is the case with freshwater lakes, both inland and coastal saline and brackish lakes are often associated with fringing beds of *Phragmites australis* and other tall monocots. *Ruppia maritima* and *Ceratophyllum demersum* are characteristic components of aquatic plant associations in the marshes along inland salt lakes (Al-Jaboul) in Syria, while *R. maritima* is associated with *Arundo donax* and *Scirpus littoralis* in Al-Jaboul Lake (Al-Oudat and Qadir 2011).

Given the long history of human influence in the region, it is not surprising that many artificial wetlands support important plant diversity. In fact in areas such as the Mesopotamian marshes, before the drainage of large areas, human activity was an integral part of the ecology of the wetlands. In other areas, reservoirs and 'artificialized' wetlands (e.g. where water levels have been stabilized by damming) mimic the ecology of natural

Stuckenia pectinata, widespread and abundant in fresh, brackish, and saline wetlands throughout the region. Photo © R.V. Lansdown

lakes, supporting similar vegetation, with extensive associated seasonally flooded pools, marshes, and seepages such as at Omerli Havzası in Turkey, which supports important populations of *Amsonia orientalis* and *Eleocharis carniolica* (Byfield, Atay, and Özhatay 2010). Many reservoirs support very little aquatic or wetland-dependent vegetation because they typically involve drowned steep-sided valleys and are consequently both deep and with very little gradation from adjacent terrestrial habitats to deep water. Occasionally, particularly around the tail of the reservoir, there may be marshy or seasonally inundated habitats supporting wetland plants, or where seepages occurred before flooding, these may survive and support diverse wetland-dependent plant associations.

Throughout the Mediterranean region and east through Asia, rice field systems and their associated irrigation and drainage canals and ditches can also represent important habitats for wetland plants, supporting a wide range of native species as well as non-native species such as *Eclipta prostrata*, *Heteranthera limosa,* and *H. reniformis*. However the weed flora of rice fields is typically dominated by members of the Poaceae and Cyperaceae (Marnotte *et al*. 2006). Rice field systems can occasionally also support plants of conservation importance such as *Baldellia ranunculoides* (NT).

Many wetland-dependent plant species are able to survive in wet hollows and other seasonally wet habitats associated with human settlements and agricultural systems. Most of these species are very tolerant and consequently tend to be widespread and abundant; however in some cases where such habitats are associated with long-standing traditional agricultural practices, they may include rare species such as *Isoetes olympica* (Musselman 2002).

6.4 Conservation status

Through this project 364 wetland dependent plants occurring in the Eastern Mediterranean region have been assessed. However, as discussed above (section 6.2) this is a significant under-representation of the region's true diversity. Of the extant species where there is sufficient information to identify an extinction risk, only 2.5% (nine species) are classed as threatened (Figure 6.1). There are an additional five species that are classed as Near Threatened, but no species are classed as Extinct or Extinct in the Wild. For the full list of species assessed, along with their Red List Category see Appendix 2.

The vast majority of the wetland dependent plants assessed (96.1% / 342 species) are not thought to be close to meeting the criteria for a threatened category and they were therefore assessed as Least Concern. Eight species did not have enough information to be able to identify their level of threat, and were assessed as Data Deficient. It is important to note that the DD species should not be considered as not threatened; the Data Deficient status indicates that more information is needed before their conservation status can be assessed. The likelihood is that some and possibly all may be threatened, which makes the need for more information urgent, for example *Lythrum anatolicum* which is endemic to Turkey was collected from a single site, Bolu in Düzce Province, south of Efteni (Melen) Lake by E. Leblebici in 1985 and has not been recorded since (Seçmen and Leblebici 1997). There is an urgent need for more information on its population size, the habitat where it was recorded and any threats to the species or the site. If the species still occurs at the site then there is a need for site protection.

Of the species assessed, 20 (5.5%) are strictly endemic to the region, and if only these species are used, the overall level of threat rises to 31.2% (five species) (Figure 6.2). However, while *Amsonia orientalis* is not endemic to the region, the species is possibly extirpated from its only location outside of the Eastern Mediterranean in Greece (Kavak 2014a). Of the endemics exactly half of the species (eight) are assessed as LC, compared to 96.1% of all species. Four of the eight DD species, and three of the five NT species, are also endemic to the region.

Figure 6.1 Number of species of Eastern Mediterranean wetland dependent plant species in each IUCN Red List Category.

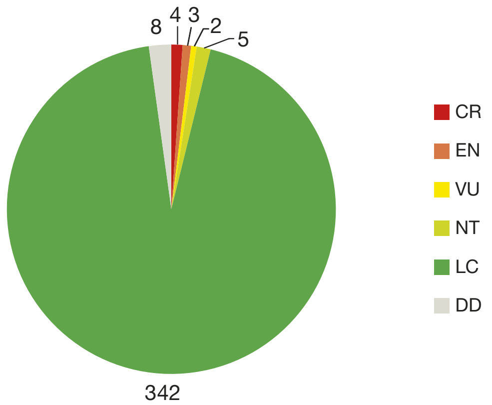
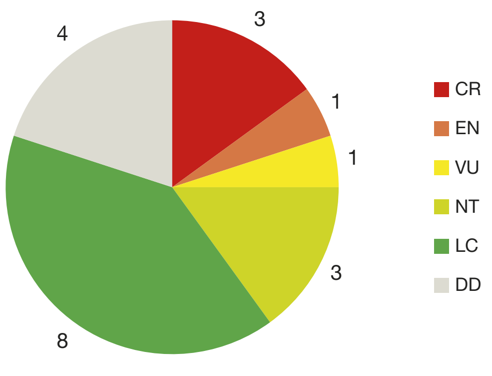


Figure 6.2 Number of species of Eastern Mediterranean endemic wetland dependent plant species in each IUCN Red List Category.



The range of taxa assessed was strongly biased by the dominance of Turkey, both in terms of the proportion of the region that it occupies and because of the availability of information on Turkish plants. Turkey supports most of the threatened and NT species (13 of 14), with four of them being endemic to Turkey and one additional species which is possibly endemic (Table 6.1). Lebanon is the only other country in the region to contain an endemic threatened wetland dependent species. Syria supports one threatened species (*Isoetes olympica*) and Iraq, Armenia, Azerbaijan, and Georgia all support one NT species. Iran also supports one threatened species (*Calamagrostis parsana*, also found in Turkey), though its Iranian location is outside the assessment region (Figure 2.1).

6.5 Patterns of species richness

Due to the lack of readily available information on the distribution of wetland dependent plant species within the region, the majority of species could not be mapped to sub-basins and have been mapped to countries of occurrence. Only the threatened and Near Threatened species could be linked to more precise localities allowing them to be mapped to sub-basins. In addition these results need to be viewed in light of the limitations of the assessment (see section 6.2), meaning that all figures presented in this section are an under-representation of true species diversity.

6.5.1 All freshwater plant species

Turkey has by far the highest proportion of the wetland dependent plant species assessed within the region, with 306 species. However it is important to note that only parts of Iran and Georgia, with 156 and 150 species (second and third highest), were included in the assessment so these countries (particularly Iran) will have a much higher number of species than is reported here. All the countries of the Levant possess a similar level of richness, all having between 57 (Jordan) and 114 (Lebanon). Iraq supports 105 wetland dependent plant species, and Azerbaijan and Armenia support 73 and 76 species respectively.

Table 6.1 The Threatened and Near Threatened wetland dependent plant species of the Eastern Mediterranean region.

Family	Species	RL Cat.	Distribution	Key Threats
Apocynaceae	*Amsonia orientalis*	CR	Turkey and Greece (possibly extinct)	Over-harvesting Urban development
Compositae	*Sonchus erzincanicus*	CR	Turkey	Droughts Grazing Urban development and pollution
Isoetaceae	*Isoetes olympica*	CR	Syria and Turkey (possibly extinct)	Agricultural expansion Grazing Tourism development
Leguminosae	*Thermopsis turcica*	CR	Turkey	Agricultural expansion Grazing Water abstraction
Gramineae	*Calamagrostis parsana*	EN	Iran and Turkey	Grazing
Marsileaceae	*Pilularia minuta*	EN	Mediterranean wide (incl. Turkey)	Agricultural expansion Grazing Urban development
Polygonaceae	*Rumex bithynicus*	EN	Turkey	Dams Fire management (reeds) Pollution (agriculture and urban)
Ranunculaceae	*Ranunculus schweinfurthii*	VU	Lebanon	Tourism development and activities
Ranunculaceae	*Ranunculus thracicus*	VU*	Greece and Turkey	Forestry Urban development and pollution Tourism development
Alismataceae	*Baldellia ranunculoides*	NT	Europe, North Africa, and Turkey	Agricultural expansion and pollution Urban development
Cyperaceae	*Carex iraqensis*	NT	Iraq and Turkey	Grazing (possible threat)
Elatinaceae	*Elatine alsinastrum*	NT	Europe to Asia (incl. Israel and Turkey)	Agricultural expansion Ecosystem modifications
Orchidaceae	*Dactylorhiza euxina*	NT	Armenia, Azerbaijan, Georgia, and Turkey	Overharvesting
Rosaceae	*Alchemilla bursensis*	NT	Turkey	Deforestation Climate change

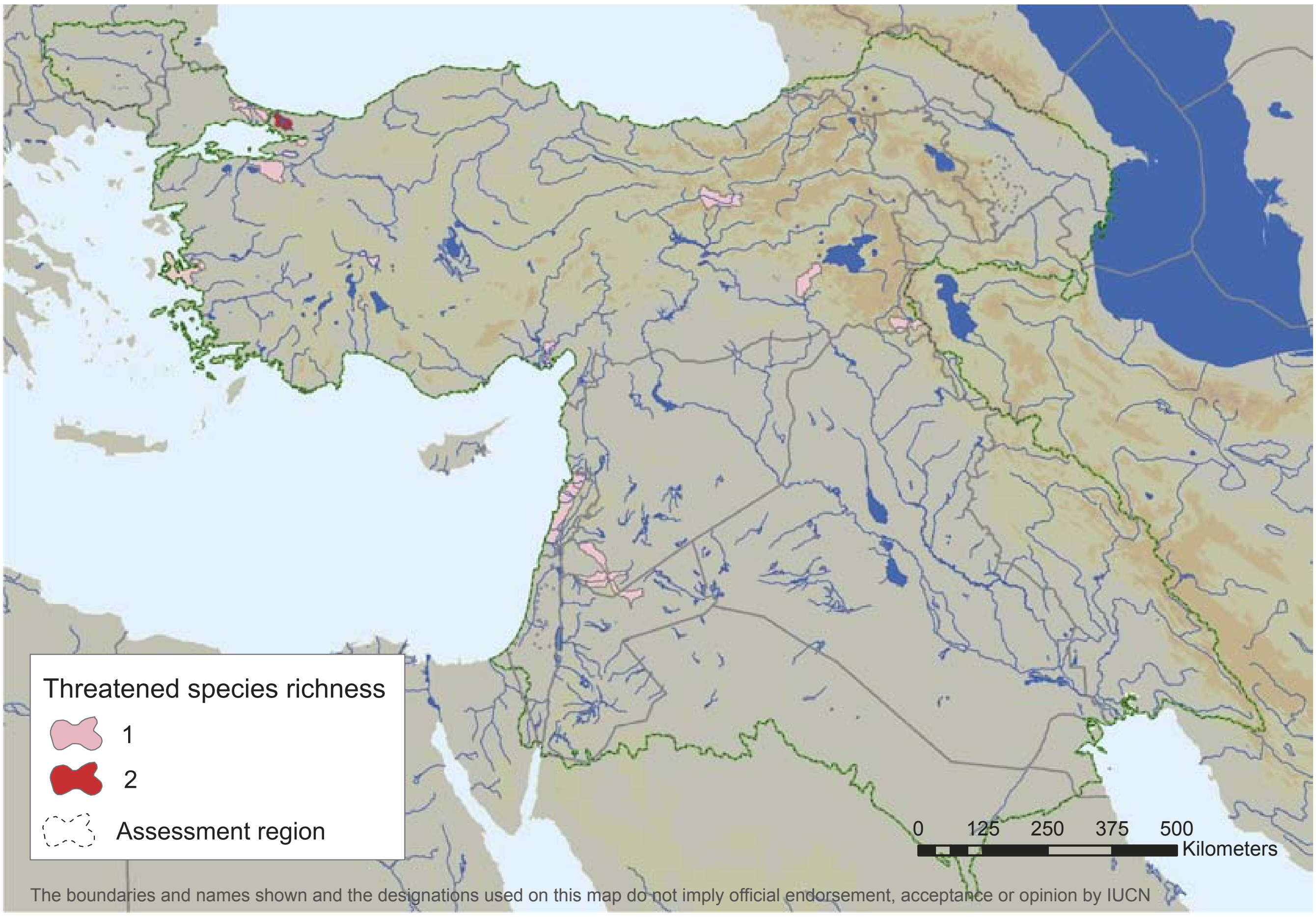
* Indicates that the Red List category assigned to the species is based on a draft assessment and may change before it is published.

6.5.2 Threatened freshwater plant species

Of the nine threatened wetland dependent plant species assessed, four occur in areas surrounding the Sea of Marmara in north-western Turkey and the Ömerli Basin, east of Istanbul is the only sub-basin in the region to contain more than one threatened species (Figure 6.3). *Amsonia orientalis* (Blue star) (CR) has been recorded from one locality in Greece, and a number of locations in Turkey, however its status in Greece is now uncertain and it has been extirpated through over-harvesting for ornamental use combined with habitat loss and degradation from all but one location in the Ömerli Basin (Kavak 2014a). The other threatened species found in the Ömerli Basin is *Ranunculus thracicus* (VU *draft* Red List assessment) which is only known from four localities around Istanbul, and a restricted number of locations in Greece. It is threatened in Turkey by afforestation of its seasonally flooded habitats and by urban development (Kavak in prep.). The two other species found around the Sea of Marmara are *Rumex bithynicus* (EN), endemic to Turkey, with three records in north-western Turkey including Lake Iznik but also a record from the Ceyhan Delta in southern Turkey, and *Isoetes olympica* (CR) which is known only from Mount Olympus where it is possibly extinct, and another distant location in the Jabal Al-Arab (Jebel Druze) in southern Syria. *Rumex bithynicus* is threatened by agricultural and urban pollution and possibly also by the Hersek Dam, and impacts of reed bed burning (Kavak 2014b). *Isoetes olympica* is likely to have been lost from Mount Olympia due to ski resort developments, and is affected by grazing at Jabal Al-Arab (Jebel Druze) in Syria (Daoud-Bouattour *et al.* 2010).

Two threatened species occur in eastern Anatolia, Turkey: *Calamagrostis parsana* (EN) is only known from two sites in the south-eastern Taurus Mountains of Turkey and four sites in the Alborz Mountains in northern Iran (outside the assessment region). Although this species is affected by intensive grazing pressure it is likely to be more widespread and under-recorded (Akhani 2014). *Sonchus erzincanicus* (CR) is endemic to a single marsh site at Erzincan where it is affected by a number of threats including urban and agricultural pollution, as well as droughts (Kavak 2014c). *Thermopsis turcica* (CR) is endemic to marshy habitats on the shores of two close lakes in western Central Anatolia, Eber, and Akşehir, where it is threatened by water abstraction and the conversion of wetland habitats for agriculture (Kavak 2014d). *Pilularia minuta* (EN) is widespread across the Mediterranean, with its only population within the Eastern Mediterranean being close to Izmir in the Aegean Region of Turkey. It has a very localized and fragmented distribution and is declining due to the vulnerability of its low elevation temporary pools habitats which are often drained for agriculture or urban development. The western slopes of the Lebanese mountains

Figure 6.3 Eastern Mediterranean threatened freshwater plant species richness. Species richness = number of species per sub-basin (defined by HydroBASINS 'Level 8', Lehner and Grill 2013).



are the only other area in the region to support a threatened wetland dependent plant species, *Ranunculus schweinfurthii* (VU). This species is endemic to Lebanon and known from only four locations/sub-populations, which are thought to be in a good and stable condition but are highly susceptible to tourist developments in the area (Rhazi *et al.* 2010).

6.6 Major threats to wetland-dependent plants

6.6.1 Factors affecting threatened species

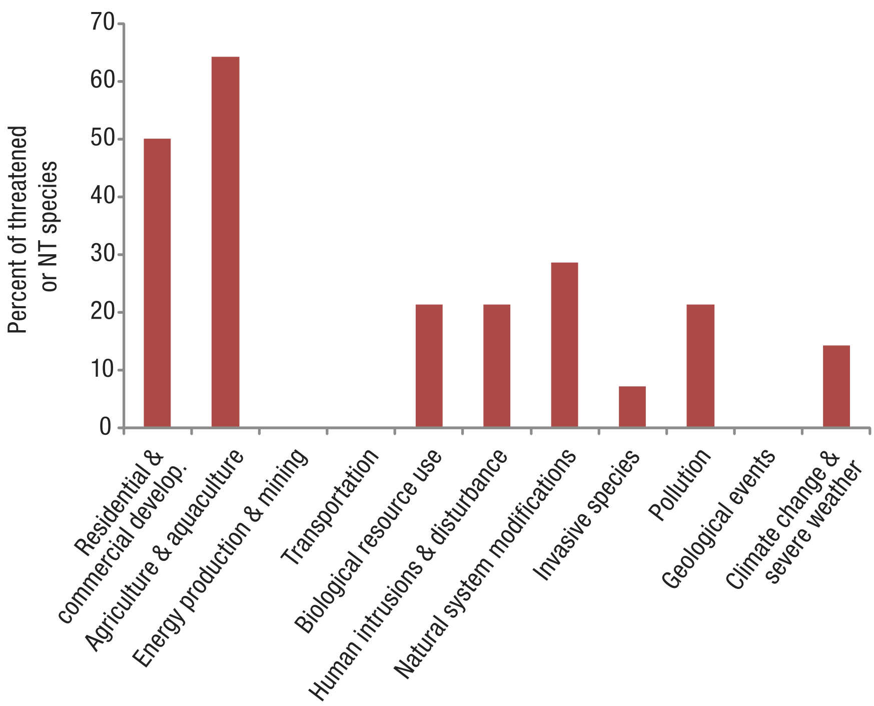
The IUCN Red List uses a standardized classification of threats (for more information see http://www.iucnredlist.org/technical-documents/classification-schemes, and Salafsky *et al.* 2008), based on these results, the main threats affecting the most threatened and Near Threatened wetland-dependent plant species are urban development (50% of species) and agricultural expansion (64% of species) (Figure 6.4). Biological resource use (over-harvesting), disturbance from humans (e.g. tourist activities), natural system modifications (fire regimes, or dams and water abstraction), and pollution all affect between 20% and 30% of threatened and NT species. Whilst it is certain that agricultural expansion is a significant threat to wetlands throughout the region, the reason for the high importance of urban development is because a high proportion of the threatened species occur around the Sea of Marmara which is undergoing significant urban expansion.

The main threats to wetland-dependent plants species are described below. In addition to these, parts of the region have suffered internal or international conflict for decades and there is no prospect of an end to this in the foreseeable future. Such conflict has dramatic and far-reaching impacts on wildlife, over and above the human impacts (Dudley *et al.* 2002). Not only does conflict risk weakening or negating any site management and protection, but pressure on human populations forces people to prioritize survival over conservation considerations. Movement of armaments and bombardment can eliminate important sites for conservation and much of the infrastructure controlling pollution breaks down. At the time of writing, there are refugee camps in many areas providing some shelter for refugees from conflict in Syria, those in the Biqaa region are very likely to be destroying the complexes of ponds identified as an IAP (Ewald *et al.* 2010). Obviously, human needs should and do take priority, but the impact on wildlife must be recognized and if possible mitigated.

6.6.2 Drainage and conversion to urban or agricultural use

Historically, this region has possibly seen the longest relationship between settled human communities and wetlands. Whilst this has led to the development of unintensive traditional exploitation of wetland resources, it has also seen a very long history of their modification and exploitation. Since the start of the 20th century, there has been an increase in both the level and the rate of destruction of semi-natural habitats throughout the region (e.g. see Davidson 2014). The massive destruction and degradation of the Mesopotamian marshes during the regime of Saddam Hussein is well known, however, recent work monitoring the recovery of vegetation (Alwan 2006, Hamdan *et al.* 2010) suggests that whilst reasonably diverse, the marshes supported no threatened plant species before drainage, and also that more than half of the species recorded prior to the draining have either survived or re-colonized.

Figure 6.4 Drivers of threats affecting threatened and Near Threatened freshwater plant species of the Eastern Mediterranean region.



Drainage of massive wetland systems in the region has not been limited to the Mesopotamian marshes. The northern end of the rift valley runs from East Africa up the eastern coast of the Mediterranean into Turkey, creating large, low-lying areas. Historically, these included some of the most important wetland complexes in the region. In Turkey the most significant of these was the Amik Lake and its related wetlands (see Kilic *et al.* 2006, Çalişkan 2008, Lansdown 2010, Ozelkan, Avci, and Karaman 2011) which covered an area of approximately 53 km^2 in 1972, which increased during flood periods and was surrounded by extensive marshland created by episodic floods and silting up of the outlet to the Orontes River. In the past, it provided food security and construction materials and supported livelihoods for local communities. A major drainage project, channelling the lake's tributary rivers directly to the Orontes was undertaken from 1966 by the State Hydraulic Works, with further works completed by the early 1970s. Draining and reclamation of areas around the lake commenced in 1940 and by the early 1970s most of the lake had been drained with only isolated fragments remaining, and by 2007 Hatay Airport had been constructed in the centre of the former lakebed. The drainage has had only limited success, with frequent flooding (including some leading to closure of the airport) and salinization of land converted to cotton production. The destruction of the Amik Lake and its related wetlands has led to the loss of vital ecosystem goods and services, and biodiversity (Kilic *et al.* 2006). While the remnant fragments of Amik Lake (known as Gölbaşı Lake) still support some wetland plant diversity and provide habitat for migrating birds, searches in recent years have failed to find any of the endemic taxa, all of which are thought to be extinct. The site now supports a wide range of non-native plants probably introduced by local people. In spite of the significant losses, restoration work

Mahzam and Al-Alam area of the Mesopotamian Marshes in Iraq. Photo © A. Haloob

Seasonal wetlands at Pano Teeb in the Mesopotamian Marshes in Iraq. Photo © M.A. Salim

Gölbaşı Lake, a small remnant of the former Amik Lake in Hatay Province, Turkey. Photo © M. Çenet

could re-create a complex of marshes and other wetland habitats which could both be of international conservation value and provide significant income from eco-tourism.

Further south along the rift valley in northern Israel, Lake Hula and its wetlands were also drained in the 1950s and 1960s. Massive wetland areas were lost with the extinction from Israel of a number of wetland plant species, including *Berula erecta*, *Marsilea minuta,* and *Nymphaea alba* (Radford, Catullo, and de Montmollin 2011). As is the case with the former Amik Lake, marginal springs still flow and retain some wetland plant diversity. In recent years, extensive wetlands have been restored in the Hula Valley which has led to the return of large numbers of common crane (*Grus grus*). However a number of wetland plants such as *Butomus umbellatus*, *Nymphaea alba,* and *Utricularia australis* have failed to recolonize, in particular, reintroduction attempts have so far failed to restore *Marsilea minuta* or *Utricularia australis* (Hamdan *et al*. 2010).

6.6.3 Habitat loss and degradation

Throughout the long history of human activity in the region there has always been some loss and modification of wetland habitats, but in general humans typically exploited wetlands and the species that they supported without destroying them. Since the start of the 20th century massive wetland drainage and destruction has occurred in a number of areas. There is still a significant level of wetland degradation and modification, such as construction of dams on rivers and the expansion of urban and agricultural land use. It is equally true that throughout much of the region, wetlands are perceived as wasted land and there is a greater tendency for efforts to focus on reducing these habitats to the smallest possible area, rather than their protection or even low-intensity exploitation. There is also a general lack of awareness of the importance of wetlands and the ecosystem services they provide. This lack of awareness is shown by the significant amounts of discharged untreated waste water and nutrient-rich run-off from agricultural land into water bodies across the region and the effects of uncontrolled tourism and associated development. For example, it is common for people to picnic along the edges of the Aammiq wetland in Lebanon, where they often use trees to shelter fires from the wind for cooking and in many cases, the fires have slowly but steadily eaten through the bark of the trees, weakening and sometimes killing them (see photo).

In Turkey the uncontrolled movement of people in areas supporting threatened plants has resulted in the over-exploitation of plants for sale for ornamental use or food, which has had a significant effect on some species, including *Amsonia orientalis*. In addition, around many wetlands such as Sultan Marshes, and lakes Eber and Akşehir, reeds have been seen as a constraint on the expansion of agriculture and they are often cut or burnt. Throughout the region there is still extensive use of tall wetland monocots such as *Phragmites australis* and *Typha* species for house construction and in places this can lead to the degradation of beds of tall monocots. Another aspect of this lack of awareness can be seen by the burning of reed beds to flush out birds for hunting. Massive bird hunting in Aammiq resulted in the proliferation of snakes in the wetland in unprecedented scale; the balance was fortunately restored when a strict hunting ban was enforced a few years ago, after the area was declared a

Tree burnt by fires, Aammiq Wetland, Lebanon. Photo © Ahmad Houri & Nisrine Machaka-Houri

reserve. This has not always been the case in other wetlands in the region where elimination of birds has had a direct impact on the insect population with consequent knock-on effects on plant pollination and propagation. A lack of, or poor implementation of, planning controls has also allowed the casual destruction and degradation of wetlands. In many areas, private landowners have been able to modify their land through construction, farming, grazing, and other activities with little or no state control.

Overgrazing is one of the most important threats to the wetland ecosystems since the abundance of water and the associated plants provide an extremely suitable habitat to an otherwise water-poor region. In fact historic and ongoing over-grazing has completely altered the character of much of the region, increasing desertification to the extent that vast areas are more or less bare. The lack of relevant protective laws and their enforcement, has contributed to this problem. Climate change has resulted in reduced levels of rainfall in the Eastern Mediterranean. This has applied additional pressure to already over-stretched water resources, with the needs of settlements, industry, and agriculture taking priority over conservation, even though conservation of natural wetlands can significantly improve water quality. Many wetlands throughout the region also support large populations of non-native aquatic plants. It is likely that humans have modified the vegetation of water bodies in the region for millennia, to the extent that it is impossible to establish the true native distribution of some taxa, such as *Acorus calamus* and some *Nymphaea* species. Most water bodies support some aliens and it is notable that non-native aquatic plants occurred in the Mesopotamian marshes both before drainage and after restoration. Some invasive species such as *Azolla filiculoides* are very widespread and cover entire water bodies excluding light to submerged plants, however this is generally a relatively short-lived phenomenon. In contrast the invasion of *Ludwigia grandiflora*, which is present in Gölbaşı Lake in Hatay Province in Turkey, can lead to a long-term modification of wetland vegetation and processes.

Non-native species in a remnant of Amik Lake in Hatay Province, Turkey, including *Hydrilla verticillata*, *Ludwigia grandiflora,* and a *Nymphaea* cultivar. Photo © M. Çenet

6.6.4 Modification of water courses and hydrological regimes

Apart from simple drainage or infilling of standing waters, the modification of wetland regimes falls into three classes:

- Construction of weirs and dams across rivers, resulting in conversion of parts of the flowing system to a standing system, eliminating or modifying the seasonal amplitude in variation of flows and levels, disrupting erosion-deposition processes and interrupting transport of propagules (potentially both downstream with flow and upstream in the digestive systems

Burning of wetland habitats to flush birds, Aammiq Wetland, Lebanon. Photo © Ahmad Houri & Nisrine Machaka-Houri

of fish). The Orontes, Jordan, Tigris, and Euphrates river basins have all been heavily dammed and the water diverted for agricultural needs (see AQUASTAT 2009).

- Stabilization of the hydrological regimes resulting in the conversion of seasonal or ephemeral pools to permanent ponds and reservoirs. This is one of the actions which has the most severe impacts on wetland-dependent plant species' diversity throughout the world, because it results in the replacement of diverse specialist associations which are driven by varying inundation duration and able to compete with more aggressive perennial plants due to extreme conditions, with a combination of true aquatics and perennial marginal plants.
- Channelization, diversion, and replacement of natural channels with artificial substrates. The most frequent effect of these actions is to reduce habitat diversity for wetland plants by destroying marginal wetlands, such as backwaters, oxbows, seasonally inundated habitats associated with river channels and floodplain wetlands. For example, flow diversion has drastically reduced the flow into Aammiq Wetland in Lebanon and directed the water directly into the main Litani River.

6.6.5 Over-abstraction

The Azraq Wetland in Jordan is another example of dramatic loss and degradation of a wetland in the region. This was an oasis with extensive marshland and natural water that formed 'glittering pools and streams'. Excessive pumping of water from the oasis to large urban areas and the illegal drilling of artesian wells for agricultural purposes has caused water levels to drop over the last 50 years, starting in the early 1980s. This over-abstraction has led to extreme depletion of the oasis, drying up massive areas of wetlands. With international support, the Royal Society for the Conservation of Nature (RSCN) began a rescue effort in 1994, managing to restore a significant portion of the wetland and aims to restore depleted water levels by 10%. So far, this target has not been achieved because of continued water pumping, and only 5.5% of the original wetland has been restored (Freyhof and Harrison 2014). Aammiq is probably the most important wetland area in Lebanon and its area has been greatly reduced by water abstraction to supply an ever increasing population and more intensive agricultural activities. This wetland used to spread over a large part of the Biqaa area but is now mostly dry for a large part of the year. A number of wells are pumping water from ground water sources and a major spring which supported the wetlands has been diverted for drinking water. In another area, slightly north of Aammiq, another wetland exists in Kfarzabad which is also under similar threats. Similarly, in Palestine, tributaries of the Jordan River and a number of springs have dried out as a result of over-abstraction; these springs and tributaries only flow when there is heavy continuous rain for days.

6.6.6 Water pollution

As a result of the high population density in the region, inadequate treatment, and the generally weak sewer networks, water bodies in general, and wetlands in particular, suffer from severe pollution from sewage, industrial wastewater discharge, and often diffuse run-off from agriculture involving fertilizer, pesticides, and sediment (Jurdi *et al* 2002, Houri and El Jeblawi 2007). Hyper-eutrophication of water courses is frequent throughout the region as pollution increases and fresh water replenishment decreases. Many wetlands also suffer from the disposal of solid waste resulting from uncontrolled tourism.

6.7 Conservation actions and recommendations

6.7.1 Conservation actions in place

Most countries in the region are signatories to international conventions, such as the Barcelona Agreement (1981), Paris Agreement (1983), Bern Agreement (1984), Ramsar Convention (1994), Convention on Biological Diversity (1992), and

Part of Wadi Elmalih, Palestine which has been reduced to a trickle due to over-abstraction. Photo © B. Al-Sheikh

Dense growth of filamentous green algae, caused by hyper-eutrophication, Oustouan River, Lebanon. Photo © Ahmad Houri & Nisrine Machaka-Houri

Small artificial pool in Wadi Rum where livestock grazing is precluded. Photo © R.V. Lansdown

European Landscape Convention (2003) (Karadeniz, Tiril, and Bayland 2009). In addition, a wide range of initiatives documenting natural habitats, including wetlands, are under way in the region, for example a collaboration between the Ministry of Environment and Nature Iraq is in the process of publishing an account of Key Biodiversity Areas of Iraq (Iraq Ministry of Environment and Nature Iraq In prep), Important Plant Areas have been identified for most countries in the region (Byfield, Atay, and Özhatay 2010, Radford, Catullo, and de Montmollin 2011) and Important Areas for Ponds have been identified in Israel, Lebanon, and Syria (Ewald *et al.* 2010). Also freshwater Key Biodiversity Areas have been identified for the whole Eastern Mediterranean region and wider Mediterranean Basin Hotspot through this project (Darwall *et al*. 2014). All of these combine to help inform conservation of wetland dependent plants and site protection, as well as often enabling or informing the infrastructure necessary to establish protected areas.

All countries in the region have protected wetland areas for conservation, for example in Turkey the Regulation for Protection of the Wetlands was published in 2002 and revised in 2005, defining different zones of protection (Karadeniz, Tiril, and Baylan 2009), and most other countries have similar structures in place.

There are also a large number of NGOs and many governmental bodies actively working for conservation in the region. For example, Nature Iraq has been active in the preparation of the KBA report and in restoration of the Mesopotamian marshes, in collaboration with many other organizations. Similarly, in Lebanon, A Rocha has been working on introducing improved management techniques which helped reduce the threats of agricultural expansion and water extraction and stop habitat reduction of the wetland (Yazbek *et al*. 2010), and the Society for the Protection of Nature in Lebanon (SPNL), has been involved in habitat restoration of the Kfarzabad wetlands. In Turkey, the Nezahat Gökyiğit Botanical Garden in İstanbul has established *ex-situ* conservation for *Thermopsis turcica*, whilst *in-situ* conservation is being implemented by the General Directorate of Nature Conservation and National Parks and a new conservation action plan for the species will be implemented between 2014 and 2024 by the Republic of Turkey Ministry of Water Affairs and Forestry. In Jordan, work undertaken at Wadi Rum has shown that reduction of grazing pressure can lead to dramatic development of vegetation over otherwise bare areas, leading to increased humidity and the development of wetlands. This work is now being expanded by raising awareness among nomadic herders and has potential to dramatically alter the current distribution and character of wetlands.

6.7.2 Recommendations

The most important steps to address the conservation needs of wetland-dependent plants in the region are to complete the Red List assessments for wetland-dependent plants in the region, by preparing assessments for all the taxa not included in this project and then to use those data to produce a conservation action plan for wetland-dependent plants in the region. Without these two actions, the information provided by IUCN Red List assessments to inform conservation of wetland plants in the region will be limited.

Other actions in the region which are clearly needed include increasing the network of wetland sites which are protected for conservation of wetland plants using sources such as the KBA for Iraq (Iraqi Ministry of Environment and Nature Iraq In prep), the IPAs for the south and east Mediterranean region (Radford, Catullo, and de Montmollin 2010), Turkey (Byfield, Atay, and Özhatay 2010) and Lebanon (Yazbek *et al*. 2010), the IAP for the Mediterranean and Alpine Arc (Ewald *et al*. 2010), and the freshwater KBAs for the Mediterranean Basin Hotspot (Darwall *et al*. 2014). This protection needs to be backed by national legislation, it needs to involve local communities with re-allocation of land rights if necessary, and needs to include the creation of protected buffer zones to provide physical and chemical protection to the areas of greatest importance and vulnerability.

There is also a need for further work on habitat restoration. In particular, restoration of parts of the former Amik Lake could still enable recovery of important wetland plant associations, whilst the potential diversity of many other sites in the region could probably still be restored. One of the major problems with wetland conservation in the region is lack of awareness of the values of wetlands across stakeholder groups, who often see wetlands as wasted ground, the potential source of problems such as mosquitoes, and as a suitable repository for waste water and other waste products. This attitude can only be changed through increasing the awareness of the benefits of clean, healthy wetland systems, in particular emphasis on the health benefits of access to clean water without the need for expensive treatment. This awareness raising needs to engage with all groups, including women and children, for example through educational visits to wetlands such as those that happen at Azraq Wetland Reserve in Jordan.

It is widely accepted that ecotourism, when well-managed, can provide benefits to local communities at the sites involved, as opposed to the small number of affluent individuals who tend to benefit from the destruction of wetlands. However, there is a need to inform ecotourism through the publication of identification guides and other interpretation materials, such as the guides to the wild flowers of the Lebanon (Houri and Machaka-Houri 2001, Houri and Machaka-Houri 2008).

Any initiatives to conserve wetland-dependent plants in the region will need funding and would benefit from access to the best available knowledge and experience in the subject. Support for capacity building by international funding organizations will be fundamental if these actions are to have any real impact.

6.7.3 Field research, monitoring, and taxonomic studies needed

Wetlands in the region suffer from a lack of thorough and systematic research into their flora and fauna and there are still many taxonomic questions to be answered. Field research should be the basis for determining the conservation status of wetlands and the species which they support as well as potential to improve this status. The number of unconfirmed records of wetland dependent plants across the region shows that there is a need for long term surveys by competent specialists. These

Part of the Azraq Wetland Reserve, showing access facilities for tourists and environmental education, Jordan. Photo © R.V. Lansdown

studies should also focus on the ecological linkages between water availability, plant, and animal population in a quantitative and qualitative way.

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Chapter 7. Synthesis for all taxa

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The upper Tarsus River in southern Turkey is one of the most species-rich rivers in the Eastern Mediterranean region. Photo © Manuel Lopes-Lima

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7.1 Introduction and inclusion of additional taxa

In this synthesis chapter we combine all the data sets from Chapters 3 to 6 (freshwater fishes, molluscs, odonates, and plants) with existing data on freshwater species of birds, mammals, amphibians, and decapods, and consider the status of freshwater biodiversity across the Eastern Mediterranean region. Here, we present combined species richness, and threatened species richness across the region. The types of factors driving threats to the freshwater species are quantified and discussed along with the identification of human use of species. The objective of this analysis (and the accompanying data) is to provide outputs to help inform conservation and development planning for wetland ecosystems and species at the national, state, catchment, and site scales.

As all birds, amphibians, mammals, and freshwater decapods (crabs, crayfish, and shrimps) have been globally assessed on the IUCN Red List, the freshwater/wetland species from these groups that are present within the region (referred to as the 'additional taxa') can be included in the analysis. To identify the species within the region a GIS overlay selection using the Eastern Mediterranean region was undertaken on the additional taxa distribution maps, and then filtered to only include those species coded as found within the 'freshwater' system on the IUCN Red List. The species and their Red List categories are shown in Appendix 2 along with the freshwater taxa from this report.

7.2 Red List status

While the Eastern Mediterranean region covers just less than 1.5% (< 2 million km^2) of the Earth's land surface, and large parts are classed as arid and semi-arid, it supports a higher proportion (1.9%) of species dependent upon freshwater habitats (Table 7.1). The region contains over 2% of the world's freshwater fishes and odonates, 3% of the world's freshwater mollusc species, and over 5% of the mammals and almost 10% of the birds that are dependent upon freshwater systems. However, it is important to note that the number of species in the region, especially for the molluscs and plants, are likely to be significant underestimates and true diversity is likely to be much higher (see individual taxa chapters).

When the Red List assessments for the freshwater groups assessed in this report (fishes, molluscs, odonates, and plants) are combined with the additional comprehensively assessed groups (freshwater species of birds, mammals, amphibians, and decapods) 19.2% (224 species) of extant species for which sufficient data are available are threatened with extinction (Table 7.2 and Figure 7.1). Six species, all fishes, are considered to have become Extinct (EX) and 18 species (seven fishes and 11 molluscs) are assessed as Critically Endangered Possibly Extinct, which means that urgent surveys are required to confirm whether the species are still extant or have become extinct (see Chapters 3 and 5 for details). When compared to the globally assessed animal groups, such as the amphibians with 41.2% threatened species, mammals with 25.9%, and birds with 13.4% threatened (IUCN 2014), the level of threat may seem relatively low. However, when compared to the other regional freshwater multi-taxa studies undertaken so far by IUCN, the level of threat to freshwater biodiversity in the Eastern Mediterranean is high, with only Africa containing a (slightly) higher proportion of threatened species (Eastern Himalaya 7.2% threatened (Allen, Molur, and Daniel, 2011), Indo-Burma 13.2% threatened (Allen, Smith, and Darwall 2012), Western Ghats of India 17.8% threatened (Molur *et al.* 2011), and Africa 21% threatened (Darwall *et al.* 2011)).

Of the freshwater groups in the Eastern Mediterranean, three groups have exceptionally high levels of threat, the molluscs (45.8%), decapods (44.4 %), and fishes (41.0%), reflecting their limited dispersal ability and high proportion of restricted range species (Table 7.2; Figure 7.1). The mammals and amphibians both have around one third of their species assessed as threatened, and then the remaining groups (plants, odonates, and birds) all have between 2.5–6.7% of their species assessed as threatened.

Almost one third (29.8%) of the Eastern Mediterranean freshwater species are endemic to the region (Table 7.3). These endemic species do not have populations outside the region to influence their Red List conservation status. When only these species are used, the level of threat (of extant species for which sufficient data are available that are threatened with extinction) increases to 58.2% (Table 7.3 and Figure 7.2). The fishes have the highest number of endemic threatened species at 108, but

Table 7.1 Estimated numbers of extant inland water-dependent species by major taxonomic groups.

Taxon	Global number of described species	Number of species in Eastern Mediterranean assessment region	% of species found in Eastern Mediterranean assessment region
Fishes	>15,000[1]	3,22[4]	2.15%
Molluscs	>5,000[1]	1,50[4]	3.00%
Odonates	5,680[1]	1,24[4]	2.18%
Plants	30,000[2]	3,64[4]	1.21%
Birds	2,283[3]	2,25[5]	9.86%
Mammals	1,45[3]	8[5]	5.52%
Amphibians	4,330[3]	31[5]	0.72%
Decapods	2,628[3]	12[5]	0.46%
All groups	65,066	1,236	1.90%

Data sources: [1]Balian *et al.* 2008; [2]Estimate by R. Lansdown, chair of the IUCN Freshwater Plant Specialist Group; 32014. [2]IUCN Red List, filtered by 'system = freshwater'; [4]Species lists generated by experts for this project; [5] Based on GIS analysis using the Red List species distributions.

the group (with more than one endemic species in the region) with the highest level of threat is the molluscs, at 76.8% (53 species) threatened, followed by the decapods (75% or three species), fishes (55.1% or 108 species), amphibians (50% or 10 species), odonates (44.4% or four species), and then plants (31.2% or five species).

7.3 Patterns of species richness

7.3.1 Species numbers by country

The IUCN Red List species assessments are coded to countries of occurrence, it is therefore possible to identify the number of

Table 7.2 Number of Eastern Mediterranean freshwater species within each IUCN Red List Category for each taxonomic group.

	IUCN Red List Category										
Freshwater group	EX	EW	CR	EN	VU	NT	LC	DD	NA	Total species	% Threatened
Fishes	6	0	39	53	31	20	157	16	0	322	41.0
Molluscs	0	0	19	19	17	9	57	24	5	150	45.5
Odonata	0	0	0	2	6	6	106	4	0	124	6.7
Plants	0	0	4	3	2	5	342	8	0	364	2.5
Birds	0	0	1	6	5	7	206	0	0	225	5.3
Mammals	0	0	0	2	1	1	4	0	0	8	37.5
Amphibians	0	0	5	1	4	5	15	1	0	31	33.3
Decapods	0	0	1	2	1	0	5	3	0	12	44.4
All groups	6	0	69	88	67	53	892	56	5	1,236	19.2

Those Categories shown in colour are known as the 'Threatened' Categories IUCN Red List Categories:
EX – Extinct, EW – Extinct in the Wild, CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, LC – Least Concern, DD – Data Deficient, NA – Not Assessed.

Almost a half of all decapod species in the region, such as this freshwater crab (*Potamon* spp.) from Turkey, are assessed as threatened. Photo © Jean-Pierre Boudot

Table 7.3 Number of Eastern Mediterranean endemic freshwater species within each IUCN Red List Category for each taxonomic group.

	IUCN Red List Category										
Freshwater group	EX	EW	CR	EN	VU	NT	LC	DD	NA	Total species	% Threatened
Fishes	6	0	32	49	27	16	72	13	0	215	55.1
Molluscs	0	0	19	17	17	7	9	21	4	94	76.8
Odonata	0	0	0	2	2	2	3	2	0	11	44.4
Plants	0	0	3	1	1	3	8	4	0	20	31.2
Birds	0	0	0	0	0	0	1	0	0	1	0
Mammals	0	0	0	1	0	0	0	0	0	1	100
Amphibians	0	0	5	1	4	5	5	0	0	20	50
Decapods	0	0	1	2	0	0	1	2	0	6	75
All groups	6	0	60	73	51	33	99	42	4	368	58.2

Those Categories shown in colour are known as the 'Threatened' Categories IUCN Red List Categories: EX – Extinct, EW – Extinct in the Wild, CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, LC – Least Concern, DD – Data Deficient, NA – Not Assessed.

Figure 7.1 Proportion of Eastern Mediterranean freshwater species within each IUCN Red List Category for each taxonomic group. IUCN Red List Categories: EX – Extinct, EW – Extinct in the Wild, CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, LC – Least Concern, DD – Data Deficient, NA – Not Assessed.

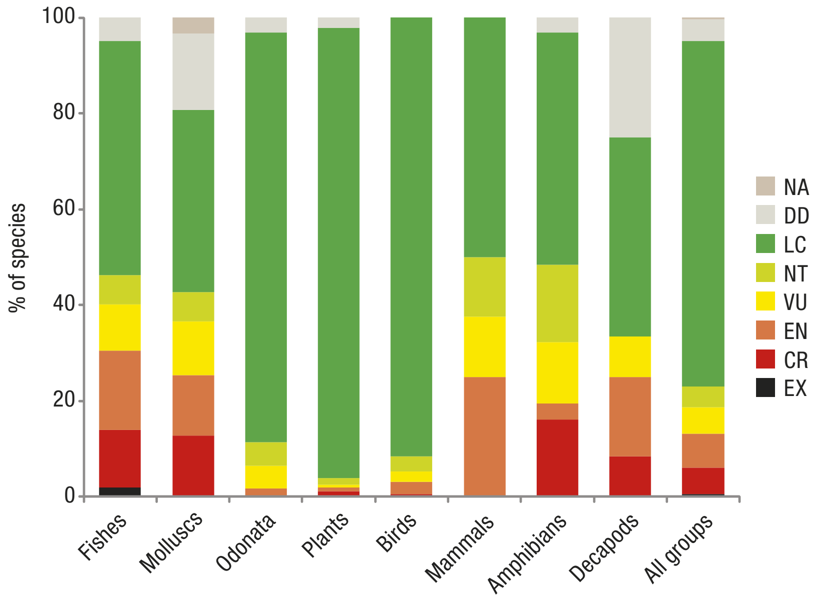
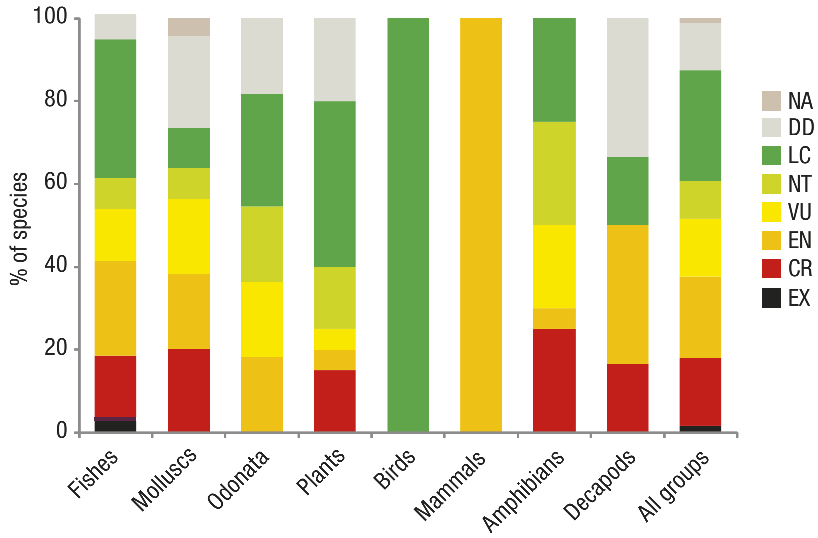


Figure 7.2 Proportion of Eastern Mediterranean endemic freshwater species within each IUCN Red List Category for each taxonomic group. IUCN Red List Categories: EX – Extinct, EW – Extinct in the Wild, CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened, LC – Least Concern, DD – Data Deficient, NA – Not Assessed.



freshwater species that are found within each country of the Eastern Mediterranean region. Figure 7.3 shows that Turkey, which is the largest country in the Eastern Mediterranean region, supports the highest diversity of freshwater species with almost 1,000, however it also contains the highest proportion of threatened species (18% of extant species for which sufficient data are available are threatened with extinction) and also the highest number (four) of Extinct or Extinct in the Wild species, all of which are fishes (see Chapter 3). Iran contains the second highest number of freshwater species with 562, (7.0% threatened), even though this only relates to a small portion of the territory of Iran, therefore the figure for Iran as a whole will be much higher. Syria is notable in terms of the proportion of its freshwater species that are threatened, being the second highest in the region with 11.8%; this is also likely to be an underestimate due to the lack of recent information available for this country. See Appendix 3 for a species breakdown for each country by taxonomic group. The country with the highest number (and proportion) of DD species is Turkey with 37 (3.7%), followed by Iran with 15 species (2.7%), Iraq with 10 species (2.5%), and Syria with 10 species (2.3%).

Table 7.4 shows the number of species that have become extirpated from each country (note this does not necessarily mean the species is extinct, just no longer found within the country). It shows that while Turkey has the greatest number of extirpated species with 17 (1.7% of all freshwater species assessed), it is Israel which has the highest proportion of extirpated species at 3.8% (15 species), followed by Syria with 2.9% (13 species) (compared to Turkey 1.7%).

7.3.2 Species numbers by Hotspot within the Eastern Mediterranean

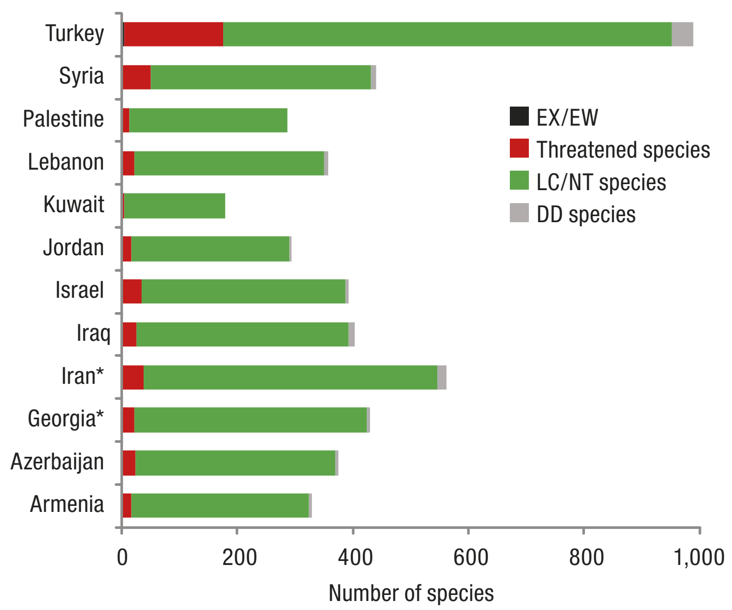
Using the species distribution maps, the number of freshwater animal species and threatened species mapped to the sub-basins that overlap the three biodiversity Hotspots that are found in the Eastern Mediterranean region (see Figure 1.1) can be identified. Note that plants were not included as only the threatened species were mapped to sub-basins. Also, these figures represent the number of species for each Hotspot within the region only, and not for the entire Hotspots which all extend beyond the Eastern Mediterranean region.

The Mediterranean Basin hotspot supports the greatest number of freshwater species with 641 species, 159 of which are threatened. One third of its freshwater animal species are fishes, and it is the only Hotspot where fish species outnumber birds (Figure 7.4 and Table 7.5). The Mediterranean Basin Hotspot also has a significantly higher proportion of molluscs than

Table 7.4 Number of freshwater species that are recorded as being extirpated/possibly extirpated from a country of the Eastern Mediterranean region. *denotes those countries where only a part of their territory is included in the analysis (see Figure 2.1).

	Armenia	Azerbaijan	Georgia*	Iran*	Iraq	Israel	Jordan	Kuwait	Lebanon	Palestine	Syria	Turkey
Number of species extirpated/possibly extirpated	1	1	0	2	3	15	4	0	2	3	13	17
% of all freshwater species that are extirpated/ possibly extirpated	0.3	0.3	0.0	0.4	0.7	3.8	1.4	0.0	0.6	1.0	2.9	1.7

Figure 7.3 Total number of freshwater species (fishes, molluscs, odonates, plants, birds, mammals, amphibians, decapods) by country of the Eastern Mediterranean region.
* denotes those countries where only a part of their territory is included in the analysis (see Figure 2.1)



the other Hotspots, with 15.6% (100 species), compared to 9% (47 species) for the Irano-Anatolian and 4.7% (18 species) for the Caucasus Hotspot. It is not surprising that the Caucasus Hotspot supports the fewest number of freshwater species, as it covers only a small part of the region (north-eastern Turkey, Georgia, and Azerbaijan), but it has a higher proportion of its freshwater animal species being birds (44.3%) than the other Hotspots (Mediterranean Basin 31%; Irano-Anatolian 38%).

Just over one quarter of all freshwater animal species (25.9% or 159 species) in the Mediterranean Basin Hotspot are threatened, which is the highest level of threat for the three Hotspots (Irano-Anatolian 17.2% or 87 species; Caucasus 8.9% or 33 species), and significantly higher than the Eastern Mediterranean region as a whole (19.2%) indicating that the freshwater systems of this Hotspot may be under greater pressure than the others within the region (Figure 7.4 and Table 7.5). In terms of threatened freshwater species composition for each Hotspot, the fishes make up the largest proportion for each, with 48.4% for the Caucasus, 62.1% for the Irano-Anatolian, and 55.3% for the Mediterranean Basin. The taxa making up the second largest proportion of threatened species differs for each Hotspot, for the Caucasus 30.3% of all threatened freshwater species are birds, for the Irano-Anatolian both the birds and molluscs each represent around 12% (12.6% and 11.5% respectively), and for the Mediterranean basin it is the molluscs at 29.6%.

For species that are extirpated from each region (note this does not mean globally Extinct), the Irano-Anatolian and the Mediterranean Hotspots contain the highest numbers with 14 and 17 respectively, representing 2.7% of all freshwater species in each Hotspot.

7.3.3 Centres of species richness by sub-basins

Species richness is presented here as the number of native species contained within river sub-basins, derived from the HydroBASINS hydrographic data (Lehner and Grill 2013) and has been mapped to include all the species groups assessed through this project. As only the threatened and NT plant species have been mapped to river sub-basins (the remainder are mapped to countries, see Chapter 6 for more details), the plants are not included in the species richness analysis (Figures 7.5, 7.7, and 7.8) but are included in the threatened species richness analysis (Figure 7.6).

As with many species richness maps, they have the potential to be biased by sampling intensity and mapping methodology. Some parts of the region may have benefited from much more intense survey and taxonomic study either historically or by more recent workers, or because they happen to be close to research centres. Conversely, some areas are likely to have higher species richness than is shown in this report as they have been historically under-surveyed, often because of political instability or actual difficulty of access.

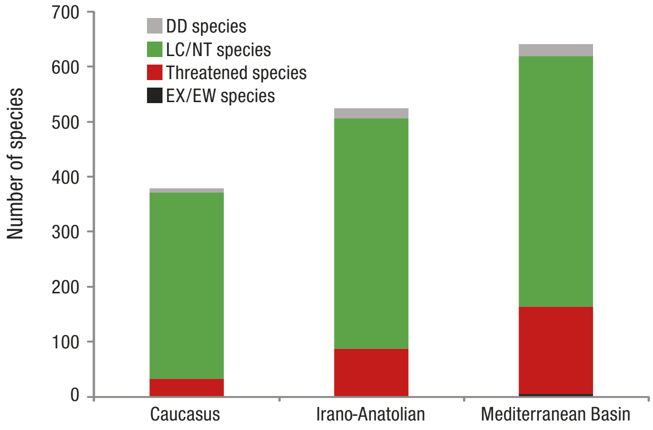


Figure 7.4 Number of freshwater animal species and threatened species found within each biodiversity Hotspot within the Eastern Mediterranean region.

The groups assessed through this project (fishes, molluscs, odonates, threatened plant species) and the freshwater shrimps have all been mapped directly to the HydroBASINS sub-basin layer. However the birds, mammals, amphibians, and remaining decapods originally were mapped to polygons representing the species extent of range which have then been translated across to the HydroBASINS sub-basin layer. This means that there is likely to be some commissioning errors for the additional groups (i.e. where a species is recorded as being present within a sub-basin when it should be recorded as absent), and is particularly the case for the widespread bird species. The results of this can be seen in the Arabian Desert in the south of the region, which shows species and threatened species presence (Figures 7.5 and 7.6). The original bird distribution polygons were provided by BirdLife International (BirdLife International and NatureServe 2012).

Figure 7.5 shows that the highest levels of species richness (between 177–217 species per sub-basin) are found along the Mediterranean coasts of the Levant (Jordan River, coastal Israel, Litani River) and Turkey (Gulf of İskenderun rivers, Köprü River, Köyceğiz Lake catchment, lower Büyük Menderes), Sea of Marmara catchments, Black Sea coast of Turkey (Çoruh River), and also within the Aras/Kura catchment in Georgia, Azerbaijan, and Armenia. The Jordan River is a good example, supporting an amazing array of freshwater biodiversity (185 freshwater animal species are mapped to the sub-basin) including: the Palestine loach (*Oxynoemacheilus insignis*) a NT fish species endemic to the Levant; the Jordan barbel (*Luciobarbus longiceps*) an EN fish species endemic to the Jordan watershed; *Unio terminalis*, a VU species of bivalve endemic to the Levant; the Syrian demoiselle (*Calopteryx syriaca*) an EN species of damselfly only found along the river systems in the Levant; the Levant waterfrog (*Pelophylax bedriagae*) a LC species found across the eastern Mediterranean; the Black stork (*Ciconia nigra*) a LC bird species that migrates along the Jordan Valley, with some spending the winter; and *Atyaephyra orientalis* a LC freshwater shrimp species endemic to the Middle East.

Table 7.5 The number of freshwater species and threatened species by each taxonomic group found within each biodiversity Hotspot within the Eastern Mediterranean region. *Note that plant total species richness could not be included as only the threatened plant species were mapped to sub-basin.

		Caucasus	Irano-Anatolian	Mediterranean Basin
All animal groups	Total richness	379	524	641
	Threatened species	33	87	159
	DD species	7	18	22
	EX/EW species	0	1	5
	LC/NT species	339	418	455
	Extirpated	0	1	5
	% Threatened	8.9	17.2	25.9
	% Extirpated	0.5	2.7	2.7
Fishes	All species	104	160	217
	Threatened species	16	54	88
	DD species	5	9	4
	EX/EW species	0	1	5
	Extirpated from Hotspot	2	10	14
Odonata	All species	69	87	100
	Threatened species	2	4	6
	DD species	1	3	1
	EX/EW species	0	0	0
	Extirpated from Hotspot	0	0	2
Molluscs	All species	18	47	100
	Threatened species	3	10	47
	DD species	0	4	14
	EX/EW species	0	0	0
	Extirpated from Hotspot	0	3	0
Decapods	All species	1	6	8
	Threatened species	0	1	3
	DD species	0	1	2
	EX/EW species	0	0	0
	Extirpated from Hotspot	0	0	0
Birds	All species	168	193	192
	Threatened species	10	11	10
	DD species	0	0	0
	EX/EW species	0	0	0
	Extirpated from Hotspot	0	1	0
Mammals	All species	3	5	3
	Threatened species	0	1	0
	DD species	0	0	0
	EX/EW species	0	0	0
	Extirpated from Hotspot	0	0	0
Amphibians	All species	16	26	21
	Threatened species	2	6	5
	DD species	1	1	1
	EX/EW species	0	0	0
	Extirpated from Hotspot	0	0	1
Plants*	Threatened species	0	3	7

Areas of high species richness (136–176 species per sub-basin) are found in the Euphrates and Tigris plains in central and southern Iraq, many coastal rivers of the Levant, Turkey (Mediterranean, Marmara, and Black seas), and a number of inland lake catchments and rivers in Turkey (including the Akar River that drains into Lake Akşehir, the lakes Eğirdir and Burdur catchments, and Sultan Marshes). The areas of low species richness, is a reflection on the lack of availability of permanent water, with most water sources being intermittent or seasonal.

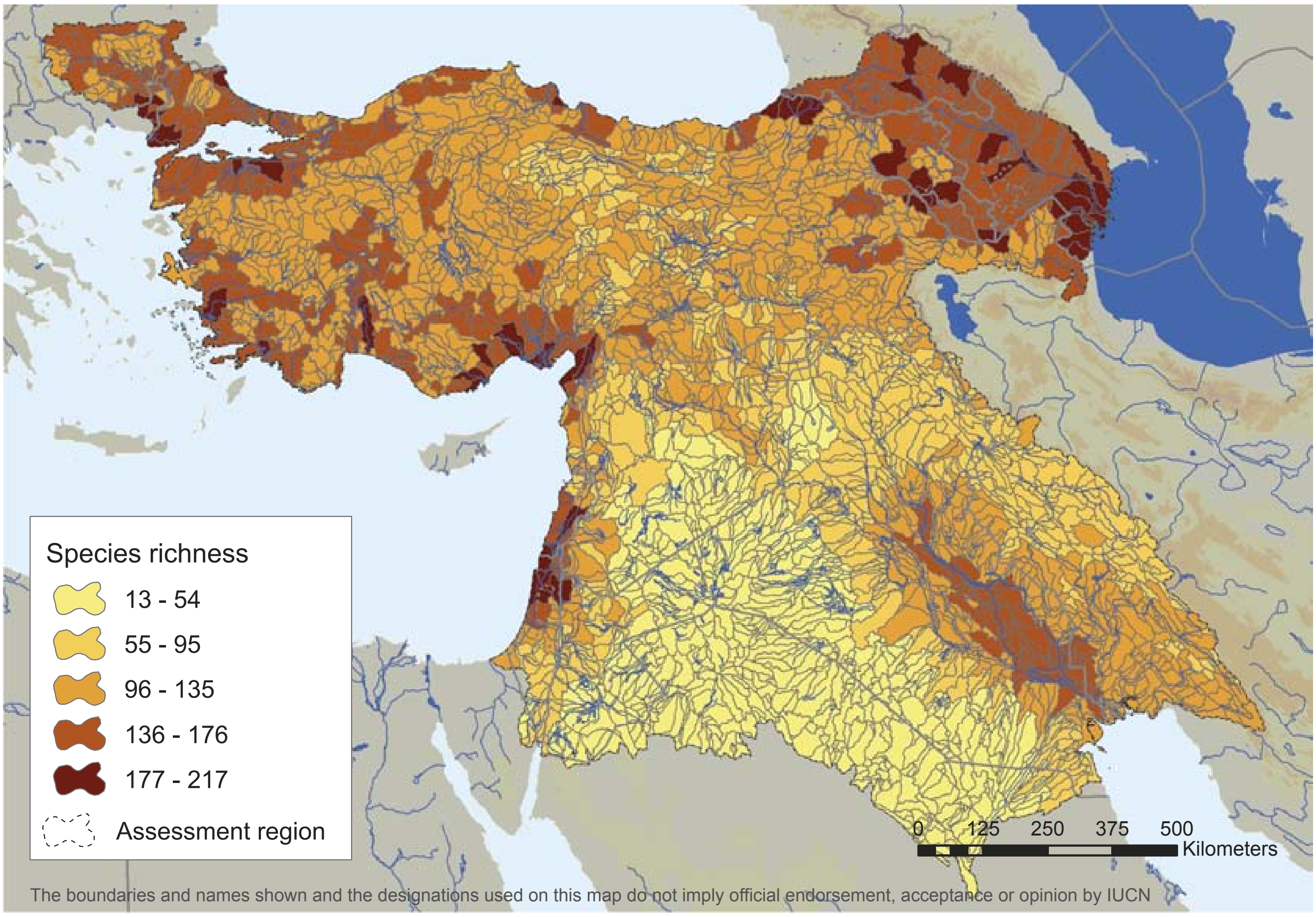
7.3.4 Distribution of threatened species

In general the pattern of threatened species richness (Figure 7.6) reflects that of species richness (Figure 7.5). The greatest numbers of globally threatened freshwater species (between 18–20 species per sub-basin) (Figure 7.6) are found in the lower Orontes/Asi catchment in Turkey, the lower and middle Tigris/Euphrates including the Hammar marshes, the Shatt al Arab River, Ras al-Ain spring area and outflowing Khabur/Khabour River (part of the Euphrates catchment) in northern Syria, and the lower Aras/Kura River in Azerbaijan.

The Ras al-Ain (Arabaic for 'head of the spring') spring complex and Khabur River in Syria typifies the situation of many springs (and spring-fed rivers and wetlands) across the region. Over-exploitation of groundwater resources (there are an estimated 6,000 wells in the aquifer) combined with periods of extreme drought have resulted in the intermittent drying out of the springs (which used to supply 87% of the total discharge from the aquifer) which has also caused the flows in Khabur River to be drastically reduced impacting downstream communities (UN-ESCWA and BGR 2013, Van Damme and Kebapçı 2014). The intermittent desiccation of the springs and outflowing river is disastrous for the species that survive there, one of which, the CR freshwater snail *Melanopsis khabourensis* is endemic to the Ras al-Ain spring complex. Other threatened species found in the Ras al-Ain and Khabur river system include a freshwater snail (*Melanopsis infracincta* CR) which is only found in one additional site, the Ayn al-'Arus spring at the head of the connected Balikh River (Van Damme, Seddon, and Kebapçı 2014), the Leopard barbel (*Luciobarbus subquincunciatus* CR) once common in the 1980s but is now thought to be extirpated from the Khabur River (Freyhof 2014a) and *Palaemonetes mesopotamicus* (CR) a species of freshwater shrimp known only from the Khabur River and the Orontes River, though its status in Syria is unknown and is suspected to be extirpated (De Grave 2013).

Areas that contain high levels of threatened freshwater species (between 14–17 species per sub-basin) are found within six distinct areas within the region: the coastal Levant and Gulf

Figure 7.5 Distribution of all freshwater species of fishes, molluscs, odonates, birds, mammals, amphibians, and decapods in the Eastern Mediterranean project area.



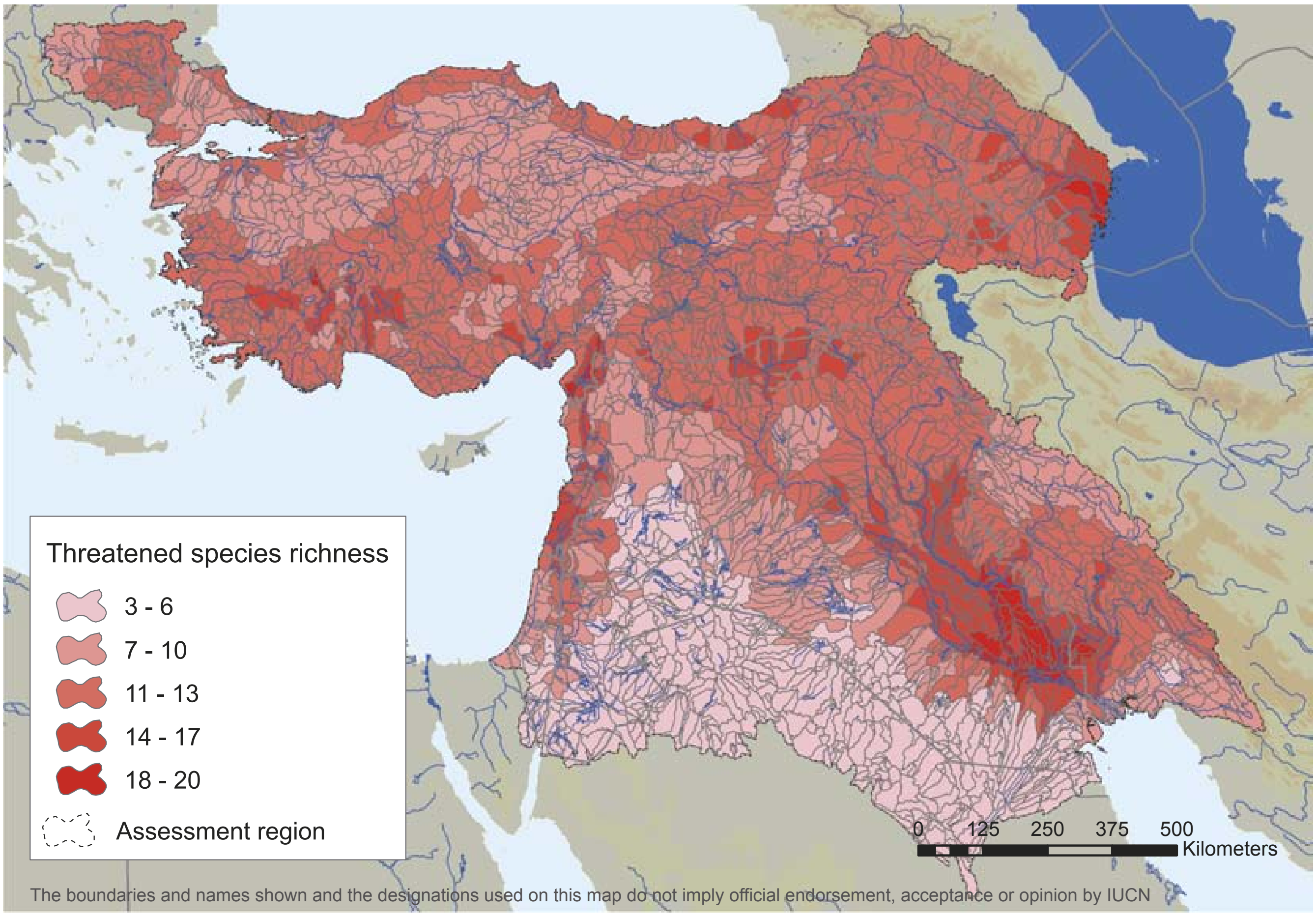


Figure 7.6 Distribution of all threatened (CR, EN, and VU) freshwater species of fishes, molluscs, odonates, plants, birds, mammals, amphibians, and decapods in the Eastern Mediterranean project area.

The Ras al-Ain springs in Syria, which are threatened by ground water extraction and now intermittently dry out, typify the status of springs across the region. Photo © Jörg Freyhof

of İskenderun catchments (Orontes/Asi catchment from the lower parts in Turkey all the way through Syria to Lake Homs, the Kebir/Nahr al Kabir on the Lebanon/Syria border, coastal catchments of Lebanon including the Litani River, Upper Hula basin, and Lake Kinneret/Sea of Galilee); the wider Tigris and Euphrates lower plains including the Hawizah marshes up to the Diyala River in Iraq and lower Karoun in Iran; the Khabur River (Euphrates catchment) in northern Syria; the Lakes Region of Turkey (the catchments of lakes Burdur, Işıklı, Eğirdir, and Beyşehir , and lakes Eğirdir and Beyşehir themselves; the upper Büyük Menderes, the Köprü River, and Kırkgöz Springs); the lower Çoruh River and other Black Sea catchments in north-eastern Turkey; and the lower Aras/Kura River in Azerbaijan and southern Armenia.

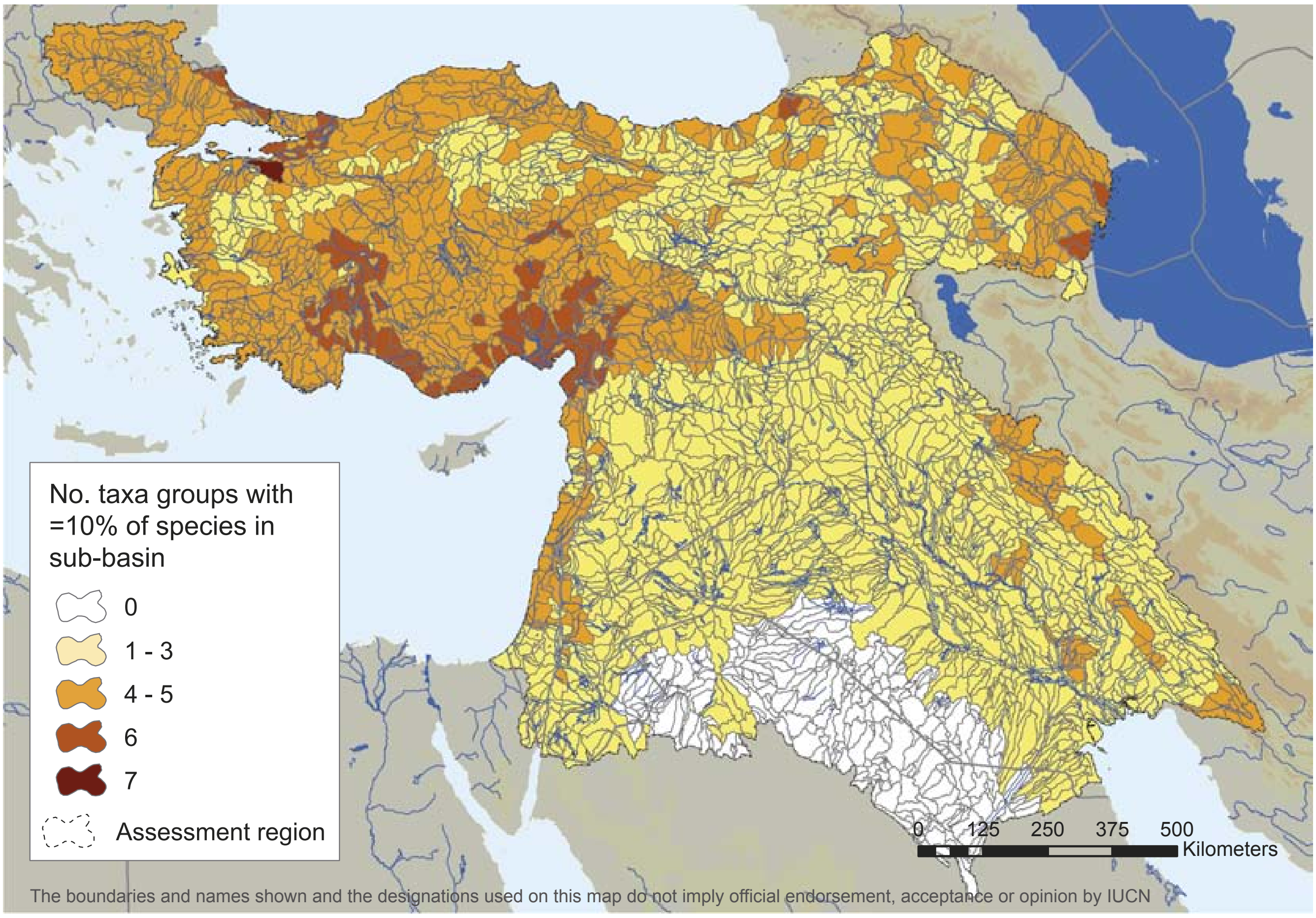
7.3.5 Sub-basins containing high proportions of species and threatened species for all taxonomic groups

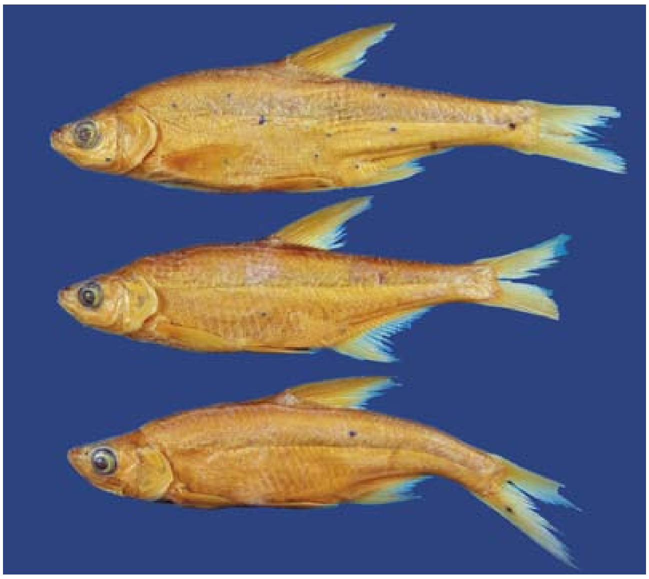
While the total species and threatened species richness figures above (7.5 and 7.6) present those areas containing the highest number of freshwater species and threatened species, they are biased towards the speciose groups of the fishes, molluscs, and birds. Therefore, to ensure each taxonomic group has an equal weighting, those sub-basins that contain high proportions (at least 10%) of the total known species numbers for each animal taxonomic group have been identified (Figure 7.7). Only one sub-basin contains 10% of species for all the seven groups, a tributary to the Simav/Susurluk River which flows into the Sea of Marmara in north-western Turkey.

There are many sub-basins that contain at least 10% of species for six of the groups, but they are found clustered together: primarily from the Central Anatolian Lakes Region (Akşehir, Burdur, and Eğirdir catchments, Lake Beyşehir, etc.) along the coastal Mediterranean rivers of Turkey (including the Ceyhan, Seyhan, Tarsus, Göksu, Köprü , Eşen, and Büyük Menderes) to the lower Orontes/Asi River. There are also sub-basins within this category (10% of species for six groups) in north-western Turkey including the catchment of Lake İznik, and lower Sakarya River, the lower Çoruh River in north-eastern Turkey, and the lower Aras/Kura River in Azerbaijan.

Figure 7.8 shows that there are no sub-basins that contain a high proportion (at least 5%) of threatened species for all seven, or even six of the taxonomic groups. Only one sub-basin, the lower Orontes/Asi in Turkey contains 5% of threatened species for five groups, it is also the sub-basin that contains the highest total number of threatened species in the entire region (20 species, Figure 7.6). Three sub-basins contain 5% of threatened species

Figure 7.7 Sub-basins containing high proportions of species from across all animal taxonomic groups (fishes, molluscs, odonates, birds, mammals, amphibians, and decapods). The map represents the number of taxonomic groups for which at least 10% of their total known species from the Eastern Mediterranean region are mapped to the sub-basin.



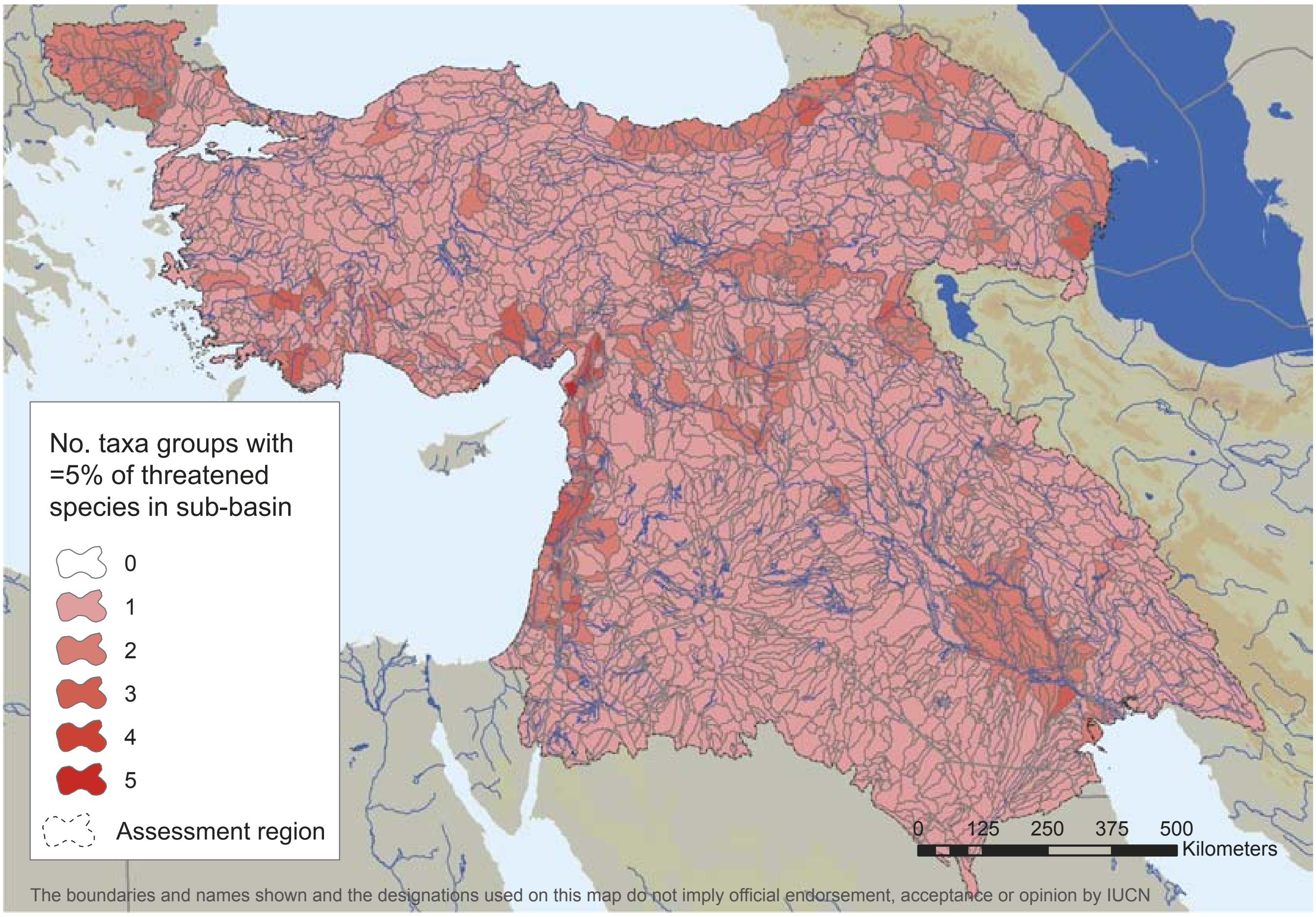


The CR Possibly Extinct *Acanthobrama centisquama* known only from former lakes Amik (Turkey) and al-Gab (Syria) both in the Orontes/Asi system. Photo © Jörg Freyhof

for four groups: Lake Kinneret/Sea of Galilee in Israel; Ras al-Ain springs/river in northern Syria; and the Karasu River (including Lake Gölbaşı) that flows into the now drained Amik Lake and lower Orontes/Asi River.

The lower Orontes/Asi system including former Amik Lake, and the Karasu and Afrin river catchments (Turkey and Syria border) are clearly a priority in terms of threatened freshwater biodiversity. The Afrin River is polluted and has almost dried out in its upper parts (J. Freyhof pers. comm. 2014), but the Karasu in general has good water quality, however this deteriorates in the middle and lower reaches due to urban, agricultural, and industrial pollution. In Syria the Asi/Orontes is considered one of the most disturbed hydrological ecosystems, and in Turkey the lower Orontes is affected by salinity and phosphates (UN-ESCWA and BGR 2013). While the main channel is often heavily polluted, the tributaries originating from springs in the mountains and the springs in the river bed itself (both in the upper and middle catchment) can be clean and are of conservation importance. There is also heavy exploitation of water resources across the catchment, the system is dammed and water flow is managed to provide water primarily for irrigation which has resulted in the lowering of the water table, and there are additional plans for irrigation and dam projects which will further threaten the basin's sustainability (UN-ESCWA and BGR 2013). These pressures have had significant impacts to freshwater biodiversity in this system, for example the Long-spined bream (*Acanthobrama centisquama*) is a CR fish species known only from former lakes Amik (Turkey) and al-Gab (Syria) both in the Orontes/Asi system, and is now classed as Possibly Extinct (Freyhof 2014b).

Figure 7.8 Sub-basins containing high proportions of threatened species from across all animal taxonomic groups (fishes, molluscs, odonates, birds, mammals, amphibians, and decapods). The map represents the number of taxonomic groups for which at least 5% of their total numbers of threatened species from the Eastern Mediterranean region are mapped to the sub-basin.



The River Afrin, a tributary to the lower Asi/Orontes River is one of the few rivers that support a large proportion of threatened freshwater species for a number of different taxonomic groups. Photo © Jörg Freyhof

Amik Lake was drained between the 1940s and 1970s, and the al-Gab lake was drained earlier, however the species may still be present in Lake Gölbaşı, just upstream of where Amik Lake used to be, but is itself impacted by pollution and water abstraction. The Orontes sportive loach (*Oxynoemacheilus hamwii*) and the Levantine Nase *(Chondrostoma kinzelbachi*) are both EN fishes, restricted to the lower Orontes system in Turkey having become extirpated from the Orontes in Syria (Freyhof 2014c, d). The Orontes scraper (*Capoeta barroisi*), also EN, was once widespread across the Orontes system (where it is endemic) but it is thought now to only exist in the lower Orontes and Afrin in Turkey, and in Lake Qattinah in southern Syria (Freyhof 2014e). *Leguminaia saulcyi* is a CR species of freshwater mussel now thought to be restricted to the Orontes, as it has become extirpated from Israel and from the coastal plain rivers of the Levant (Lopes-Lima and Seddon 2014a). *Anodonta pseudodopsis* is another threatened (EN) species of mussel, only known from the Orontes with recent records only from Lake Gölbaşı. It is possible that the species is still present in Lake Homs and other connected lakes in the Orontes, and also in the Nahr al-Kabir River in Lebanon and Syria (Lopes-Lima and Seddon 2014b). *Palaemonetes mesopotamicus* a CR species of freshwater shrimp is only known from one location in the lower Orontes despite widespread surveys across the Turkish part of the Orontes system, though old records for the species exist from Syria (the Khabur River) it is thought to be extirpated from there (De Grave 2013).

7.4 Important habitats supporting freshwater biodiversity in the Eastern Mediterranean

Using the IUCN Red List species assessments which code suitable habitats for the species, and also those which are of a major importance (meaning the habitat is required by the species to complete its life cycle, or is the primary habitat type), it is possible to identify which habitat types are the most important and threatened for freshwater biodiversity in the Eastern Mediterranean region. Figure 7.9 shows that *permanent rivers* is the most utilized habitat by freshwater biodiversity, supporting 64% (785 species) of the 1,230 species for which there are Red List assessments (Figure 7.6). This is followed by *permanent lakes (over 8 ha)* which provide a habitat for 44% of species (547 species), *permanent marshes and pools (under 8 ha)* (39% or 476 species), and *bogs, marshes, and swamps* (38% or 467 species). *Freshwater springs and oases*, and the *seasonal/intermittent* habitats (*rivers, lakes, and marshes/pools*) are also important habitat types, each supporting between 16–22% of all species.

In terms of threatened species, *permanent rivers* support the most with 61% (or 137) of all threatened species (a similar proportion to all species found in permanent rivers). This is followed by *freshwater springs and oases* (32% or 71 species) and *permanent freshwater lakes* (29% or 65 species). However, if the proportion of threatened species supported by each habitat is identified, *karst systems* are the most threatened habitat type with six of the eight species assessed as threatened. The second most threatened habitat type are the *freshwater springs and oases* which have 29% of its species assessed as threatened, which is followed by *permanent rivers* (17%).

Figure 7.10 presents the habitats coded as of *major importance* for threatened species. It shows that *permanent rivers* are of major importance for the survival of almost half of all threatened species in the region (111 species) more than any other habitat type. This is followed by *freshwater springs and oases* (25% or 56 species) and *permanent freshwater lakes* (22% or 49 species). However if this is looked at in terms of the proportion of all species supported by each habitat type, *karst systems* and *freshwater springs and oases* again come out on top. Fifty per cent of all species supported by karst systems (four species) are threatened and have coded karst as a 'major importance'. For *freshwater springs and oases*, this figure is 23% (56 species out of a total of 245), and for permanent rivers it is 14% (111 species out of a total of 785).

Permanent rivers, often fed by springs, are a key habitat for freshwater biodiversity in the region. However they are under great pressure (see individual taxa chapters) from a multitude of threats primarily from water abstraction, dams, increasing severity of droughts, and pollution. This is leading to many, once permanent, rivers becoming degraded, fragmented, and seasonal, with some becoming totally dry. One example of this is the Qweik River, a closed basin which rises in Turkey and flows into northern Syria where it was once the primary water source for the city of Aleppo. However, due to high levels of water abstraction the springs that fed the river are now dry and the river itself is intermittent and heavily polluted (UN-ESCWA and BGR 2013). The Halep loach (*Oxynoemacheilus tigris*) a CR fish

Figure 7.9 Habitats coded against all freshwater species (fishes, molluscs, odonates, plants, birds, mammals, amphibians, and decapods). Note species can have more than one habitat coded, and some habitat types (e.g. Tundra) are not found within the Eastern Mediterranean region but are coded in the species Red List assessment as the species will be found in these habitat types outside the region.

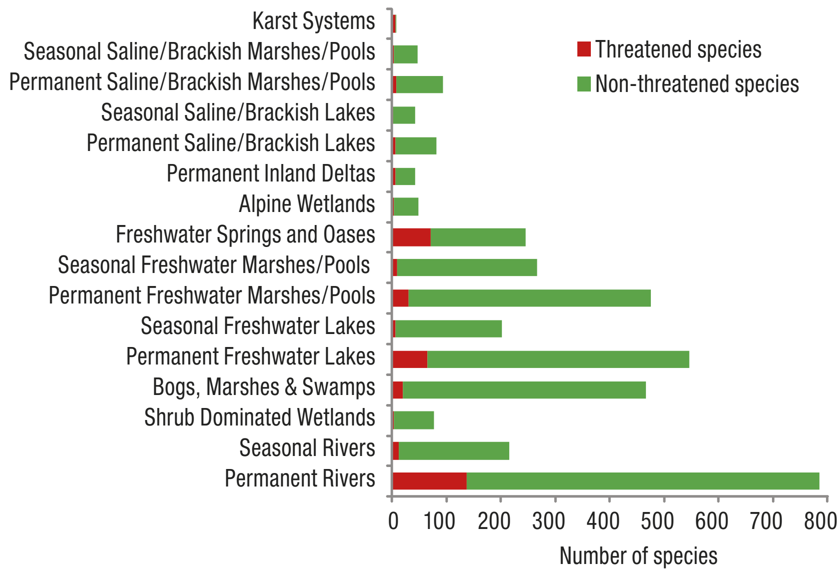
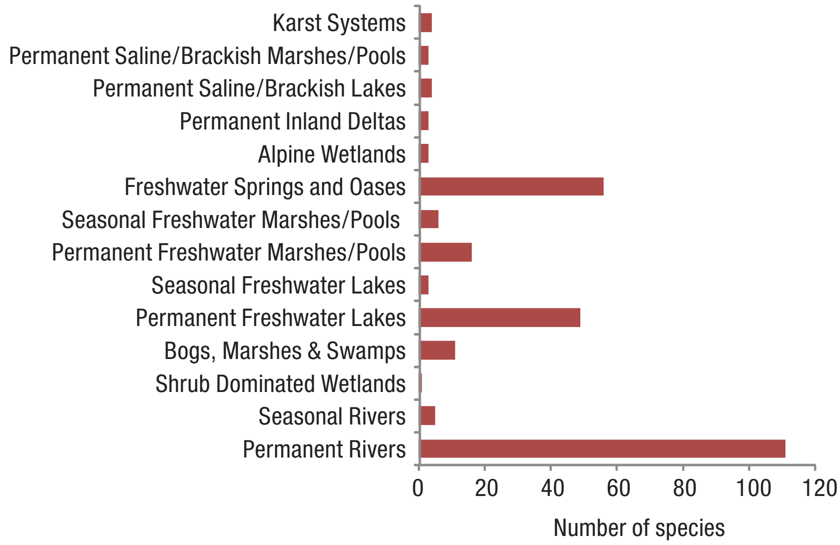


Figure 7.10 Habitats coded as 'major importance' for threatened freshwater species (fishes, molluscs, odonates, plants, birds, mammals, amphibians, and decapods).



The Qweik River was once the primary water source for the city of Aleppo, Syria, but like many over-abstracted rivers in the region, now only flows intermittently and is heavily polluted. Photo © Jörg Freyhof

species, was once widespread across the Qweik drainage, but now due to the loss of water in large parts of the river, the species is now known from just one stream in Turkey, which is only a few hundred metres long and flows into a reservoir (Freyhof 2014f).

The section above on Ras al-Ain springs (7.3.4) details the common plight of springs across the region, which are being threatened by water abstraction exacerbated by an increasing severity of droughts. Azraq Oasis, a Ramsar site in Jordan, is another similar situation, where the springs that fed a large permanent wetland (with extended seasonal flats) ran dry in 1992 due to excessive groundwater abstraction. Azraq Oasis is the only known site for the Azraq toothcarp (*Aphanius sirhani,* now CR), which was taken into captive breeding facilities. Since then, the wetlands have been partially restored (to 5.5% of their former size), however large scale water abstraction continues (much of it illegal), and the wetlands are wholly reliant upon artificial water supply provided by the government as the springs are still dry. The Azraq toothcarp has since been successfully re-introduced into the wetlands, though there is an additional threat from introduced invasive fish species (Freyhof and Harrison 2014).

Karst systems are widely found in the Mediterranean part of Anatolia and they occur in the majority of the Taurus Mountains Range, where limestone deposits originating from various geological ages are found together. The middle and western parts of the range, for example Teke Peninsula, Lakes Region, and Taseli Plateau, contain significant areas of complex karstic systems (Atalay 1997). However the fauna of Turkish karst systems is poorly known. The very recently discovered (2014), and therefore not yet assessed, cave loach species *Cobitis damlae* is the only known cave fish in Turkey. The species was discovered in the upper streams of the Dalaman River after a flood, where the Keloglan cave is found (Erk'akan, and Özdemir 2014). The Haditha karst system is found in western Iraq (within the Euphrates catchment), and supports two endemic CR cave fishes: the Haditha cave fish (*Caecocypris basimi*) and the Haditha cave garra (*Typhlogarra widdowsoni*). Falling groundwater levels are the major threat to the system, which is due to water abstraction and hydrological modifications of the water layers by the construction of a large dam close by on the Euphrates. The Haditha cave garra was once so abundant it was harvested and sold as an ornamental fish, though a survey in 2012 found that its two known cave sites were massively impacted by water abstraction, with one site totally dry (Freyhof 2014g). The Haditha cave fish was last recorded from a well in 1983, but the same 2012 survey failed to find the species (Freyhof 2014h). However, due to the nature of karst systems, their presence elsewhere within the karst cannot be ruled out.

The Haditha cave garra (*Typhlogarra widdowsoni*), a CR fish species endemic to the Haditha karst system in Iraq. Photo © Jörg Freyhof

7.5 Threats to freshwater biodiversity in the Eastern Mediterranean

For each species in the IUCN Red List assessment the direct threats that have impacted, are impacting, or may impact the species are coded against the IUCN-CMP Unified Classification of Direct Threats and Actions ver. 3.2 (for more information see http://www.iucnredlist.org/technical-documents/classification-schemes, and Salafsky *et al.* 2008). This allows for the major threatening processes to freshwater biodiversity to be identified. The previous chapters in this report discuss the threats to individual taxon groups in more detail, and in the context of each group's specific life histories. In summary, the taxon chapters show how unique and irreplaceable the freshwater biodiversity in the Eastern Mediterranean region is, and how it is being put under

The widespread abstraction of water is leading to the reduction of ground waters at an alarming rate. Azraq Oasis springs in Jordan are a classic example of how excessive levels of groundwater extraction can leave wetlands dry. Photo © Kevin Smith

Natural system modifications, such as by dams, represent one of the greatest threats to freshwater biodiversity in the Eastern Mediterranean. Oymapinar hydro-electric dam on the Manavgat River, Antalya, Turkey is one such example. Photo © Jörg Freyhof

severe pressure due to rapid economic development impacting the region's water resources. The widespread abstraction of water (primarily for agricultural irrigation), coupled with the damming of rivers (for hydropower and water storage), is compounded by increasing severity of droughts leading to reduced flows in rivers, in some cases leaving rivers and wetlands totally dry and a reduction of ground waters at an alarming rate (AQUASTAT 2009, Voss *et al.* 2013). Not only is this unsustainable level of extraction threatening freshwater biodiversity but it also threatens the long-term water security of the region (UNEP 2008). To make matters worse, freshwater habitats such as deltas and marshes are widely considered as vacant or worthless land often being converted for more 'productive' uses such as for agriculture, urban expansion, and industrial developments such

Table 7.6 Major ongoing threats to each taxon group in the Eastern Mediterranean. The percentage of threatened and NT freshwater species within each taxon group is shown for each of the IUCN threat categories (for both ongoing and/or future threats).

Threat Category	Plants	Fishes	Odonates	Molluscs	Birds	Amphibians	Decapods	Mammals
Residential & commercial development	50.0	2.1	50.0	20.3	26.3	33.3	0.0	50.0
Agriculture & aquaculture	64.3	1.4	28.6	14.1	78.9	66.7	0.0	75.0
Energy production & mining	0.0	3.6	21.4	0.0	31.6	0.0	0.0	25.0
Transportation	0.0	4.3	0.0	1.6	21.1	20.0	0.0	75.0
Biological resource use	21.4	11.4	7.1	0.0	78.9	73.3	25.0	75.0
Human disturbance	21.4	0.7	21.4	3.1	47.4	6.7	0.0	75.0
Natural system modifications	28.6	90.0	78.6	68.8	52.6	40.0	100.0	75.0
Invasive species, genes, & diseases	7.1	20.7	0.0	7.8	36.8	40.0	25.0	75.0
Pollution	21.4	47.1	71.4	56.3	36.8	66.7	25.0	75.0
Climate change & severe weather	14.3	69.3	50.0	29.7	47.4	20.0	0.0	25.0

as power plants and oil refineries. Freshwater habitats are also heavily degraded by pollution, particularly adjacent to urban areas and intensive agriculture.

The proportions of threatened and NT species within each taxon group that are impacted by the various categories of threat are presented in Table 7.6. The major threat to freshwater plants is *agriculture and aquaculture* (impacting 64.3% of threatened and NT species), followed by *residential and commercial development* (50% of species impacted). The greatest threat to threatened and NT fishes is *natural system modifications* (90% of species impacted), followed by *climate change and severe weather* (69% of species impacted). The odonates and molluscs are both most heavily impacted by *natural system modifications* (79%, 69% of species impacted, respectively), followed by *pollution* (71%, 56% of species impacted, respectively). Wetland birds are most impacted by *agriculture and aquaculture* and *biological resource use* equally (79% of species impacted), with *natural system modifications* also affecting just over a half of threatened and NT species (53% of species impacted). *Biological resource use* is also the major threat to amphibians (73% of species impacted), followed by *agriculture and aquaculture* and *pollution* (both impacting 67% of species). All species of threatened or NT freshwater decapod species (of which there are only four) are threatened by *natural system modifications*, with *biological resource use*, *invasive and other problematic species,* and *pollution* each affecting one species. Three of the four threatened or NT freshwater dependent mammal species are widely impacted by almost all threat categories.

The average proportion of threatened and NT species, for all the taxon groups combined, impacted by each category of threat is presented in Figure 7.11. *Natural system modifications*, *pollution,* and *agriculture and aquaculture* are the dominant threats to freshwater biodiversity in the Eastern Mediterranean region, affecting on average 67%, 50%, and 41% of the threatened and NT species, respectively.

The IUCN threat classification system is multi-levelled, in that more specific threat classifications are nested under each of the top level categories. A breakdown according to the second level threat classifications for the two greatest threats, *natural system modifications* and *pollution* is presented in figures 7.12 and 7.13, respectively. Figure 7.12 shows that *dams and water management and use* are a major pressure to freshwater biodiversity within the Eastern Mediterranean region, affecting a large proportion of threatened and NT species from each of the taxon groups, namely 90% of fishes, 71% of odonates, 66% of molluscs, 42% of birds, 40% of amphibians, 75% of mammals, and 100% of decapods. Under the major threat heading of *pollution, agricultural effluents* present the greatest source of pollution for plants (impacting 14% of threatened or NT species), odonates (64%), molluscs (42%), birds (31%), and amphibians (53%), whereas *domestic and urban waste water* is the major source of pollution impacting freshwater fishes (43%) (Figure 7.13).

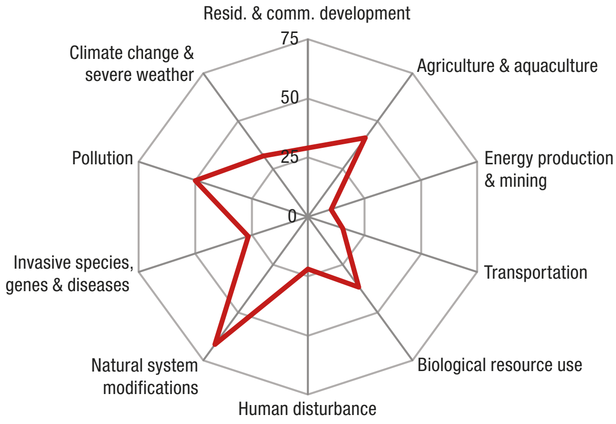


Figure 7.11 Major ongoing threats to freshwater biodiversity in the Eastern Mediterranean. The chart shows the average percentage of threatened and NT species for all taxon groups combined (fishes, molluscs, odonates, plants, birds, mammals, amphibians, and decapods) impacted by each of the main IUCN threat categories (for both ongoing and/or future threats).

Figure 7.12 Impact of sub-categories of threat within the threat category 'Natural System Modifications' for each of the taxon groups.

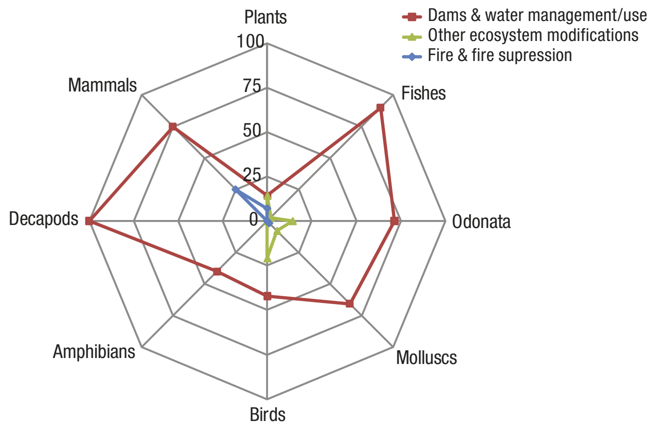
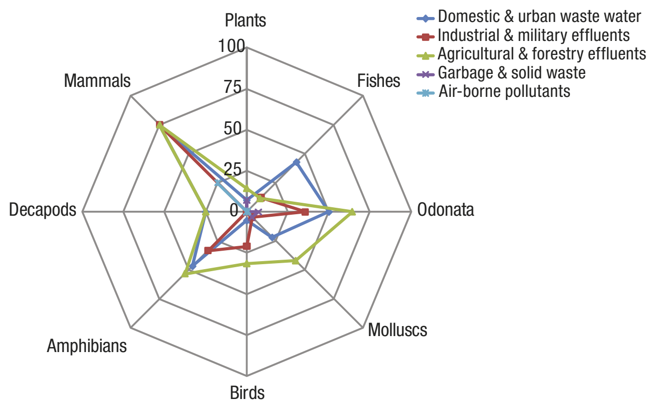


Figure 7.13 Impact of sub-categories of threat within the threat category 'Pollution' for each of the taxon groups.



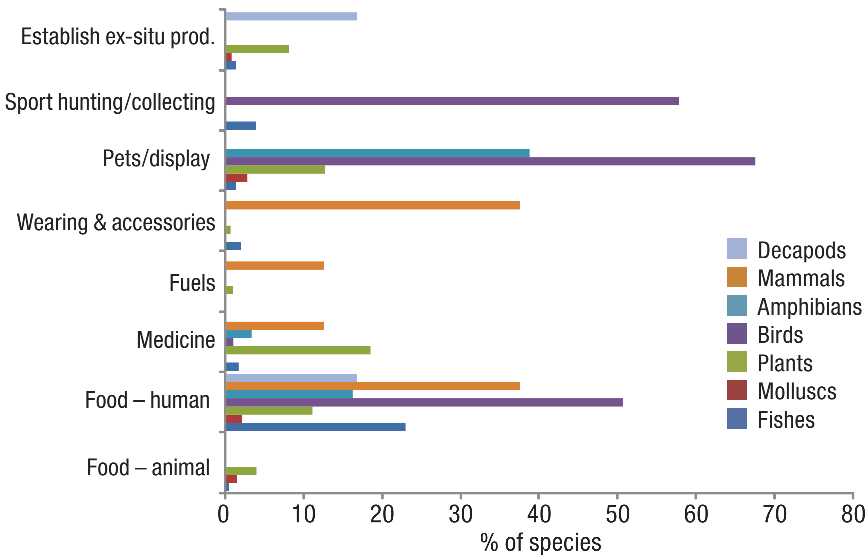
A number of frog species are harvested for food and export in the Eastern Mediterranean region. Eurasian Marsh Frogs in Sultan Marshes, Turkey. Photo © Jan Stefka. Online image/Flickr under CC licence 2.0 by-nc-sa

7.6 Provisioning ecosystem services and freshwater biodiversity of the Eastern Mediterranean

Within each species Red List assessment its human use and trade are recorded. Based on this information the freshwater species found in the Eastern Mediterranean that directly contribute to provisioning ecosystem services (e.g. food, medicine, fodder etc.) can be identified. It is important to note that if a species has been identified as providing some kind of provisioning service it does not mean that the harvesting of the species is a threat. If harvesting is a threat, it will be recorded under *biological resource use* in the threats classification scheme (section 7.5). Also, many of the species (in particular plants and birds) occur outside the Eastern Mediterranean region and their human use information in the Red List assessment may relate to harvesting activities not within the Eastern Mediterranean region.

The results show that the plants have by far the most diverse set of use purposes, with species being utilized in almost every category, though they are predominantly used as *medicine*, *food and for humans* and in *horticulture* (Figure 7.14). Almost a fifth of all freshwater plants (18.4%, 67 species) are harvested for medicinal use, whereas 11% (40 species) and 12.6% (46 species) are used as food for humans and in horticulture respectively. An example is the plant *Amsonia orientalis* (CR), known as 'blue star', which has cardioactive and anticancer characteristics and shows broad antimicrobial activity, and is also found in horticulture due to its purple star-shaped flowers. The species, only known from seasonal wetlands in Greece and northwest Turkey, was previously thought likely to be extirpated from Turkey, but it has been found within a very narrow area in the Ömerli Basin (Kavak 2014).

Figure 7.14 Proportion of freshwater species for each taxonomic group (fishes, molluscs, plants, birds, amphibians, mammals, and decapods) utilized for different purposes (this data excludes those species that are sourced from captive bred or horticulture). Note that no species of odonates were utilized for any purpose.



Almost one quarter of freshwater fishes assessed in this study (22.9% or 73 species) are harvested for *human food*, and 3.8% (12 species) are utilized in *sport hunting*. An example is the Shabout (*Barbus grypus*), a Vulnerable species which is of high commercial importance and a major target species in all larger rivers, marshes, and reservoirs within its range (Euphrates and Tigris catchments from southern Anatolia south to Shatt Al-Arab, it is also in rivers of the Persian Gulf of Iran) and is heavily overfished (Freyhof 2014i).

Large numbers of wetland birds, for example the Eurasian Wigeon (*Mareca penelope*) and Common coot (*Fulica atra*), are harvested from the wild either for *human food* (50.7% or 144 species), *pets/display animals* (67.6% or 152 species), or for *sport hunting* (57.8% or 130 species). The region has a long history of bird hunting, and hundreds of thousands of people are still involved in the activity today. Many of the waterfowl and songbirds that are hunted in the region are migrants, and it is an important socio-economic activity across the region, involving large numbers of people particularly in rural areas (e.g. in Syria there are an estimated 400,000 sport hunters, 200–300 falcon trappers and 20,000 people who hunt for a living) (BirdLife International 2010). This harvesting (in the Middle East and North Africa) is often excessive and indiscriminate and is a threat to many migratory bird species in the region (BirdLife International 2008).

The major human uses for the few amphibian species found in the Eastern Mediterranean region is for *human food* (16.1% or five species) and for *pets/display animals* (38.7% or 12 species). An example is the Near Threatened *Pelophylax caralitanus*, the largest edible frog from Turkey (where it is endemic to the Lakes District in southwestern Anatolia) and is harvested to export for food in France, Italy, and Switzerland (Öz *et al.* 2009).

The freshwater dependent mammals are primarily utilized for *human food* (37.5% or three species), and *wearing apparel, accessories* (37.5% or three species). An example is the Smooth-coated Otter (*Lutrogale perspicillata*) a VU species found across South and Southeast Asia, with an isolated population in Iraq (the sub-species *L. p. maxwelli)*. This sub-species, which is endemic to Iraq, and the Eurasian otter (*Lutra lutra*) are both hunted in large numbers for their pelts, and the level of harvest alongside persecution due to conflict with fishermen is thought to be a significant threat to the species (Al-Sheikhly and Nader 2013).

The decapods are only harvested (16.7% or two species) from the wild for *human food* (or *establishing ex-situ* populations for food). For example the long-clawed crayfish (*Astacus leptodactylus*), which is a LC species widespread across Europe, Middle East, and Russia, is commercially harvested for food. However, in Turkey there have been fluctuations in the harvest of this species over the years, showing an increasing trend since 1995, with a significant decline since 2005 (the trend is unknown after 2007). The reason for this apparent decline is not clear and there is no indication that it is related to crayfish plague, though

Integrated River Basin Management is especially important for transboundary rivers such as the Tigris, pictured here at Hasankeyf in Turkey.
Photo © Travel Aficionado. Online image/Flickr under CC licence 2.0 by-nc

over-harvesting is thought to be a contributing factor (Gherardi and Souty-Grosset 2010).

7.7 Freshwater Key Biodiversity Areas

Freshwater Key Biodiversity Areas (KBAs) are globally significant areas for the persistence of biodiversity (Eken *et al.* 2004, Langhammer *et al.* 2007, Holland, Darwall, and Smith 2011), and can guide the selection of new protected areas or the expansion of existing site networks. Building on the IUCN Red List assessment information collated through this project, the freshwater KBAs for the Mediterranean Basin have been identified through a regional stakeholder consultation process. The results of this are presented in an associated report '*Freshwater Key Biodiversity Areas in the Mediterranean Basin Hotspot*' (Darwall *et al.* 2014) which can be accessed on the IUCN website.

Field surveys and monitoring are a priority for many of the threatened species in the region in order to build a better understanding of the species requirements and to identify suitable cases for ex-situ conservation. Photo © Jörg Freyhof

In addition the Iraqi Ministry of Environment and Nature Iraq has recently identified a total of 82 KBAs. Thirty-nine of these KBAs are triggered by non-avian vertebrates, 67 by birds (IBAs), and 73 by plants (IPAs), covering 4.3%, 6.3%, and 5.6% of Iraq respectively. The non-avian vertebrate KBAs include a number of freshwater trigger species: the Smooth-coated otter *Lutrogale perspicillata* (VU); two newt species *Neurergus derjugini* [*N. microspilotus* in this assessment] (CR) and *Neurergus crocatus* (VU); and four fish species, the Orontes Scraper *Capoeta barroisi* (EN), the Leopard Barbel *Luciobarbus subquincunciatus* (CR), and the Haditha Karst system endemics Haditha Cave garra *Typhlogarra widdowsoni* (CR), and Haditha Cave fish *Caecocypris basimi* (CR). The results of this work are presented in the 'Key Biodiversity Areas of Iraq: Priority Sites for Conservation and Protection' report (Iraqi Ministry of Environment & Nature Iraq in prep).

7.8 Recommendations

This section builds on and summarizes the conservation recommendations presented in each of the preceding chapters, and incorporates an analysis of IUCN Red List species assessments (Table 7.7) for which 'conservation actions needed' for each species are coded against the IUCN-CMP Unified Classification of Direct Threats and Actions ver. 3.2 (see http://www.iucnredlist.org/technical-documents/classification-schemes, and Salafsky *et al.* 2008 for more information).

7.8.1 Integrated River Basin Management (IRBM)

The primary conservation action required for freshwater biodiversity in the region is *site/area management* which is recommended for 56.1% of all threatened freshwater species (Table 7.7). The recommended approach is for application of Integrated River Basin Management (IRBM). IRBM is the process of coordinating conservation, management, and development of water, land, and related resources across sectors within a given river basin, in order to maximize the economic and social benefits derived from water resources in an equitable manner while preserving and, where necessary, restoring freshwater ecosystems (WWF 2014, adapted from Global Water Partnership 2000). Catchment wide management plans are particularly recommended for those that contain freshwater Key Biodiversity Areas (see Section 7.7). Such plans will likely need to include the restoration of natural flow regimes working with stakeholders such as dam operators and those involved in water extraction (note: 32.6% of threatened species require *Habitat & natural process restoration)*, and the incorporation of biodiversity requirements within decisions for water allocation across sectors. In many cases it will be hard to achieve the recommended habitat restoration without a reduction in the levels of water abstraction, especially in the face of a changing climate which is likely to lead to even more severe and prolonged periods of drought across the region. In order to develop an effective IRBM plan the key threats to freshwater biodiversity (e.g. pollution, invasive species, and over-harvesting), and their drivers, will need to be identified and managed through a multi-stakeholder engagement process. The need for IRBM is particularly important for many of the regions' transboundary catchments (Voss *et al.* 2013). One international policy instrument that has recently (August 2014) come into force and which may provide useful guidance and support is the UN Watercourse Convention (UNWC). The UNWC is focused on the economic, social, and environmental uses of international watercourses including water provision, and fisheries. Of great significance is the convention text identifying a requirement to protect and maintain watercourses in their natural state, as part of securing equitable use of these resources, and that economic needs (e.g. power supply, water provision) may not, by default, be assumed to be more important than social or environmental needs (Loures and Harrison 2014). To date, 35 countries have ratified the convention, including Iraq, Jordan, Lebanon, and Syria. For more information on the UNWC, please see www.unwatercoursesconvention.org.

Table 7.7 'Conservation actions needed' as coded within the IUCN Red List assessments for all freshwater species (fishes, molluscs, odonates, plants, birds, mammals, amphibians, and decapods), showing the proportions of all freshwater species, and all threatened species for which each type of conservation action is recommended.

	Conservation action needed	% of all species	% of threatened species
1	Land/water protection	16.7	52.5
1.1	Site/area protection	14.3	45.7
1.2	Resource & habitat protection	11.6	35.3
2	Land/water management	18.1	61.1
2.1	Site/area management	16.4	56.1
2.2	Invasive/problematic species control	2.9	10.9
2.3	Habitat & natural process restoration	9.2	32.6
3	Species management	5.0	15.8
3.1	Species management	2.3	7.2
3.1.1	Harvest management	2.0	5.9
3.1.2	Trade management	1.3	3.6
3.1.3	Limiting population growth	0.3	0.5
3.2	Species recovery	0.7	2.3
3.2.1	Reintroduction	0.3	0.5
3.2.2	Benign introduction	0.5	2.3
3.3	Species re-introduction	0.8	2.7
3.4	Ex-situ conservation	2.8	11.3
3.4.1	Captive breeding/artificial propagation	2.1	10.9
3.4.2	Genome resource bank	0.9	1.4
4	Education & awareness	12.7	43.9
4.1	Formal education	1.6	4.1
4.2	Training	1.6	5.4
4.3	Awareness & communications	12.6	43.9
5	Law & policy	10.4	38.0
5.1	Legislation	9.2	36.7
5.1.1	International level	2.9	10.9
5.1.2	National level	7.5	24.4
5.1.3	Sub-national level	4.6	14.5
5.1.4	Scale unspecified	0.2	0.5
5.2	Policies and regulations	1.3	5.0
5.3	Private sector standards and codes	0.0	0.0
5.4	Compliance and enforcement	4.5	16.3
5.4.1	International level	2.0	8.1
5.4.2	National level	3.5	10.4
5.4.3	Sub-national level	0.7	0.0
5.4.4	Scale unspecified	0.2	0.9
6	Livelihood, economic, & other incentives	0.3	0.9
6.1	Linked enterprises & livelihood alternatives	0.3	1.4
6.2	Substitution	0.0	0.0
6.3	Market forces	0.0	0.0
6.4	Conservation payments	0.2	0.0
6.5	Non-monetary values	0.0	0.0

7.8.2 Site protection

A number of species require some degree of site protection below the spatial scale of the river basin (as recommended for 45.7% of threatened freshwater species). This is especially true for habitats that are essential for a species, for example spawning areas, or those species that are highly restricted to distinct habitats, such as springs and seepages, that could be quickly impacted by localized threats. It is important to note that for most freshwater species any site scale protection needs to be done in addition to a wider IRBM approach. For those few species that occur within existing protected areas, management actions are required to specifically target freshwater biodiversity as, in many cases, protected areas are not designated or managed for freshwater biodiversity. In cases where sites that require protection are not within existing protected areas, the freshwater Key Biodiversity Areas identified (see Section 7.7) may be used to inform new protected area establishment, delineation, and management.

7.8.3 Field surveys, research, and regional capacity building

A recommendation common to all taxon groups is the need for more field research particularly for the threatened species using modern standardized monitoring protocols. This will require an increase in collaborative research projects between regional and international scientists to help build capacity within the region. To make this achievable additional funding and ease of access to research licences are required. With many species on the brink of extinction within the region an immediate increase in field research and monitoring is critical to help identify if and when ex-situ conservation measures should be taken to ensure no more species are lost (11.3% of threatened species are recommended for ex-situ conservation). Capacity building within the region should also focus on inclusion of modern taxonomic research and species identification methods, and the publication of national field guides and checklists in the languages of the region.

7.8.4 Enforcement of existing legislation and government awareness

Capacity within many of the regions' national governments and their agencies is currently not sufficient to enforce compliance with existing legislation for the protection of freshwater biodiversity. More than 16% of threatened species are reported to potentially benefit from better compliance and enforcement of existing legislation, and this includes legislation for management of resource exploitation (e.g. fisheries), water extraction, pollution, and requirements for Environmental Impact Assessments (EIAs) for development projects, such as dam construction and management. Building capacity within government bodies (national to local) and raising awareness of the conservation needs of freshwater biodiversity and the benefits to people of healthy freshwater systems is an urgent need. Finally, and perhaps most important of all, legislation for the management of water resources across the region needs to ensure adequate water flows remain for maintaining ecological functions within all inland waters.

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Appendix 1. Example of a species Red List assessment

***Oxynoemacheilus hamwii* - (Krupp & Schneider, 1991)**

ANIMALIA - CHORDATA - ACTINOPTERYGII - CYPRINIFORMES - BALITORIDAE - Oxynoemacheilus - hamwii
Common Names: Orontes Sportive Loach (English)
Synonyms: Nemacheilus hamwii Krupp & Schneider, 1991

Red List Status
EN - Endangered, B2ab(i,ii,iii,iv,v) (IUCN version 3.1)

Red List Assessment

Assessment Information

Date of Assessment: 2013-01-10

Reviewed?	Date of Review:	Status:	Reasons for Rejection:	Improvements Needed:
true	2014-02-03	Passed	-	-

Assessor(s): Freyhof, J.
Reviewer(s): Ekmekçi, F., Özuluğ, M. & Smith, K.
Regions: Global

Assessment Rationale

This species was known from the headwaters in the Asi drainage in Turkey and northern Syria (it is now extirpated from Syria). It is now only left in the northern Asi drainage in three streams, the Yıldırım (2–5 km), Buyuk Karacay (3–5 km), and Kucuk Karacay (3–5 km) flowing to the lower Asi in Turkey, and the upper Afrin (10 km) which flows into Syria. Other records are misidentifications or thought to now be extirpated. The upper Afrin is already heavily impacted by human activities, especially by water abstraction. The species seems to be quite sensitive to pollution and has most likely vanished from the Syrian part of the Afrin. Water abstraction in the Afrin will increase in the near future due to population growth and climate change and this will lead to a continuous decline and possible extinction of this species. Due to the small distribution range of the species (area of occupancy estimated 50 km^2), only four sites (locations) remaining, and the ongoing and expected future decline in habitat area and quality, this species is assessed as Endangered.

Distribution

Geographic Range

The species was known from the headwaters in the Asi drainage in Turkey and northern Syria (it is now extirpated from Syria). It is now only left in the northern Asi drainage in three streams, the Yıldırım (2–5 km), Buyuk Karacay (3–5 km), and Kucuk Karacay (3–5 km) flowing to the lower Asi in Turkey, and the upper Afrin (10 km) which flows into Syria. Other records are misidentifications or are thought to now be extirpated.

Biogeographic Realms

Biogeographic Realm: Palearctic

Occurrence

Countries of Occurrence

Country	Presence	Origin	Formerly Bred	Seasonality
Syrian Arab Republic	Possibly Extinct	Native	Yes	Resident
Turkey	Extant	Native	-	Resident
Turkey -> Turkey-in-Asia	Extant	Native	-	Resident

Population

This species was widespread within its range in the late 20th century but seems to have lost most of its populations since.

Population Information

Current Population Trend: Decreasing

Continuing decline in mature individuals?	Qualifier	Justification
Yes	Observed	-

Habitats and Ecology

Moderately fast flowing waters of streams and rivers with mud or gravel substrate and low pollution level.

IUCN Habitats Classification Scheme

Habitat	Season	Suitability	Major Importance?
5.1. Wetlands (inland) -> Wetlands (inland) - Permanent Rivers/Streams/Creeks (includes waterfalls)	resident	Suitable	Yes

Continuing Decline in Habitat

Continuing decline in area, extent and/or quality of habitat?	Qualifier	Justification
Yes	Observed	-

Movement Patterns

Movement Patterns: Not a Migrant

Systems

System: Freshwater (=Inland waters)

Use and Trade

General Use and Trade Information

This species is not directly used by humans.

Threats

Large levels of water abstraction and pollution are the major threads within the Asi drainage and for this species. While the population in the Yıldırım is in a good shape, this stream is very small and depends on a spring coming from the mountains. Less rainfall due to climate change might lessen the amount of water in this stream in the future. In the upper Afrin, water abstraction and pollution is a major problem and water levels are already very low in late summer. Often dams in Syria stop all water flow into Turkey in the Asi. Less rainfall due to climate change as well as increased exploitation of the water resources in upper Afrin very seriously threaten this population.

Threats Classification Scheme

Threat	Timing	Scope	Severity	Impact Score
7.2.1. Natural system modifications -> Dams & water management/ use -> Abstraction of surface water (domestic use)	Ongoing	Majority (50-90%)	Slow, Significant Declines	Medium Impact: 6
7.2.3. Natural system modifications -> Dams & water management/ use -> Abstraction of surface water (agricultural use)	Ongoing	Majority (50-90%)	Slow, Significant Declines	Medium Impact: 6
7.2.5. Natural system modifications -> Dams & water management/ use -> Abstraction of ground water (domestic use)	Ongoing	Majority (50-90%)	Slow, Significant Declines	Medium Impact: 6
7.2.7. Natural system modifications -> Dams & water management/ use -> Abstraction of ground water (agricultural use)	Ongoing	Majority (50-90%)	Slow, Significant Declines	Medium Impact: 6
9.1.1. Pollution -> Domestic & urban waste water -> Sewage	Ongoing	Majority (50-90%)	Slow, Significant Declines	Medium Impact: 6

Conservation

There are no conservation actions in place for this species. A real action plan is recommended for this species and other freshwater biodiversity in Asi drainage and especially in Afrin subdrainage. The status of *O. hamwii* should be carefully monitored and even *ex situ* conservation should be taken into account.

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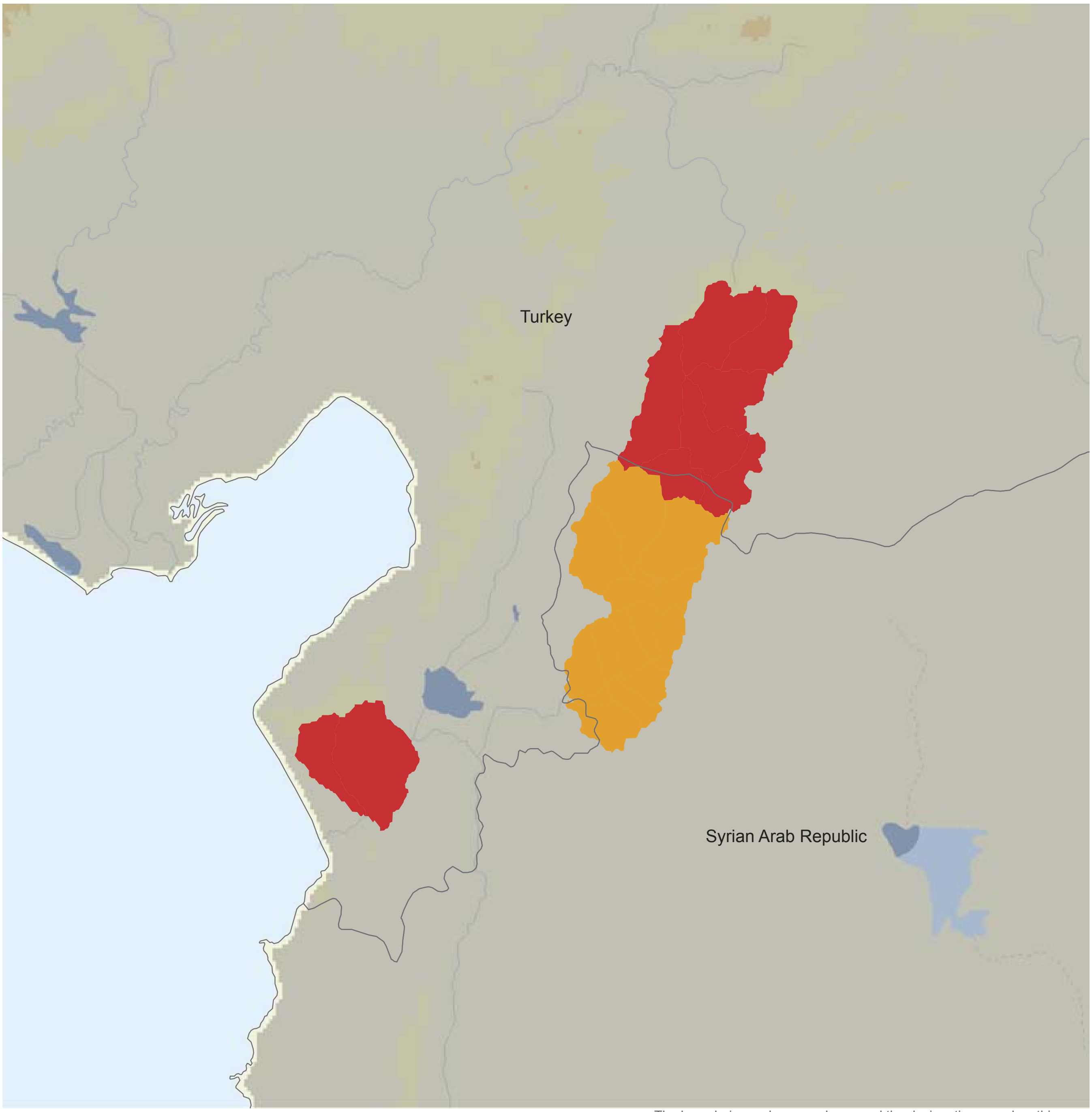

The boundaries and names shown and the designations used on this map do not imply any official endorsement, acceptance or opinion by IUCN.

Oxynoemacheilus hamwii

range type

Extant (resident)

Extinct

national boundaries

subnational boundaries

lakes, rivers, canals

salt pans, intermittent rivers

0 5 10 20 30 40 Kilometers

Map created 02/18/2013

gall stereographic central point: 0°, 0°

Appendix 2. Species lists

The species lists for each taxonomic group are listed below in order of the chapters in this report. Please see the IUCN Red List of Threatened Species website (www.iucnredlist.org) for more information on the species.

RL = The Red List Category for the species. These are: EX – Extinct, EW – Extinct in the Wild, CR – Critically Endangered (CR PE – Possibly Extinct), EN – Endangered, VU – Vulnerable, NT – Near Threatened, LC – Least Concern, DD – Data Deficient, NA – Not Assessed.
* = An asterisk next to the RL category indicates the species is endemic to the Eastern Mediterranean region.

2.1 Freshwater fishes

Class	Actinopterygii	
Order	Acipenseriformes	
Family	Species	RL
Acipenseridae	*Acipenser gueldenstaedtii*	CR
Acipenseridae	*Acipenser nudiventris*	CR
Acipenseridae	*Acipenser persicus*	CR
Acipenseridae	*Acipenser stellatus*	CR
Acipenseridae	*Acipenser sturio*	CR
Acipenseridae	*Huso huso*	CR

Order	Anguilliformes	
Family	Species	RL
Anguillidae	*Anguilla anguilla*	CR

Order	Atheriniformes	
Family	Species	RL
Atherinidae	*Atherina boyeri*	LC

Order	Clupeiformes	
Family	Species	RL
Clupeidae	*Alosa caspia*	LC
Clupeidae	*Alosa fallax*	LC
Clupeidae	*Alosa kessleri*	LC
Clupeidae	*Alosa maeotica*	LC
Clupeidae	*Alosa volgensis*	EN
Clupeidae	*Clupeonella caspia*	LC
Clupeidae	*Clupeonella cultriventris*	LC
Clupeidae	*Tenualosa ilisha*	LC

Order	Cypriniformes	
Family	Species	RL
Balitoridae	*Oxynoemacheilus anatolicus*	EN *
Balitoridae	*Oxynoemacheilus angorae*	LC *
Balitoridae	*Oxynoemacheilus araxensis*	DD *
Balitoridae	*Oxynoemacheilus argyrogramma*	LC *
Balitoridae	*Oxynoemacheilus atili*	NT *
Balitoridae	*Oxynoemacheilus banarescui*	NT *
Balitoridae	*Oxynoemacheilus bergianus*	LC
Balitoridae	*Oxynoemacheilus brandtii*	LC
Balitoridae	*Oxynoemacheilus ceyhanensis*	DD *
Balitoridae	*Oxynoemacheilus cinicus*	DD *
Balitoridae	*Oxynoemacheilus cyri*	LC *
Balitoridae	*Oxynoemacheilus ercisianus*	EN *
Balitoridae	*Oxynoemacheilus eregliensis*	VU *
Balitoridae	*Oxynoemacheilus evreni*	LC *
Balitoridae	*Oxynoemacheilus frenatus*	LC *
Balitoridae	*Oxynoemacheilus galilaeus*	CR *
Balitoridae	*Oxynoemacheilus germencicus*	VU *
Balitoridae	*Oxynoemacheilus hamwii*	EN *
Balitoridae	*Oxynoemacheilus insignis*	NT *
Balitoridae	*Oxynoemacheilus kaynaki*	LC *
Balitoridae	*Oxynoemacheilus kosswigi*	LC *
Balitoridae	*Oxynoemacheilus lenkoranensis*	DD *
Balitoridae	*Oxynoemacheilus leontinae*	LC *
Balitoridae	*Oxynoemacheilus mediterraneus*	LC *
Balitoridae	*Oxynoemacheilus mesudae*	EN *
Balitoridae	*Oxynoemacheilus namiri*	LC *
Balitoridae	*Oxynoemacheilus panthera*	EN *
Balitoridae	*Oxynoemacheilus paucilepis*	EN *
Balitoridae	*Oxynoemacheilus phoxinoides*	CR *
Balitoridae	*Oxynoemacheilus samanticus*	LC *
Balitoridae	*Oxynoemacheilus seyhanensis*	CR *
Balitoridae	*Oxynoemacheilus seyhanicola*	EN *
Balitoridae	*Oxynoemacheilus theophilii*	LC
Balitoridae	*Oxynoemacheilus tigris*	CR *
Balitoridae	*Paraschistura chrysicristinae*	CR PE *
Balitoridae	*Seminemacheilus ispartensis*	VU *
Balitoridae	*Seminemacheilus lendlii*	VU *
Balitoridae	*Turcinoemacheilus kosswigi*	LC *
Cobitidae	*Cobitis amphilekta*	DD *
Cobitidae	*Cobitis battalgili*	EN *
Cobitidae	*Cobitis bilseli*	EN *
Cobitidae	*Cobitis elazigensis*	LC *
Cobitidae	*Cobitis evreni*	EN *

Appendix 2.1 cont'd, Freshwater fishes

Cobitidae	*Cobitis fahireae*	LC *
Cobitidae	*Cobitis kellei*	CR PE *
Cobitidae	*Cobitis levantina*	EN *
Cobitidae	*Cobitis phrygica*	EN *
Cobitidae	*Cobitis pontica*	LC
Cobitidae	*Cobitis puncticulata*	EN
Cobitidae	*Cobitis satunini*	LC *
Cobitidae	*Cobitis simplicispina*	LC *
Cobitidae	*Cobitis splendens*	CR *
Cobitidae	*Cobitis strumicae*	LC
Cobitidae	*Cobitis turcica*	EN *
Cobitidae	*Sabanejewia aurata*	LC
Cobitidae	*Sabanejewia balcanica*	LC
Cyprinidae	*Abramis brama*	LC
Cyprinidae	*Acanthobrama centisquama*	CR PE *
Cyprinidae	*Acanthobrama lissneri*	NT *
Cyprinidae	*Acanthobrama marmid*	LC *
Cyprinidae	*Acanthobrama microlepis*	LC
Cyprinidae	*Acanthobrama telavivensis*	VU *
Cyprinidae	*Acanthobrama tricolor*	CR PE *
Cyprinidae	*Alburnoides eichwaldii*	LC
Cyprinidae	*Alburnoides fasciatus*	LC
Cyprinidae	*Alburnoides manyasensis*	LC *
Cyprinidae	*Alburnus akili*	EX *
Cyprinidae	*Alburnus alburnus*	LC
Cyprinidae	*Alburnus attalus*	EN *
Cyprinidae	*Alburnus baliki*	EN *
Cyprinidae	*Alburnus battalgilae*	VU *
Cyprinidae	*Alburnus caeruleus*	LC *
Cyprinidae	*Alburnus carinatus*	EN *
Cyprinidae	*Alburnus chalcoides*	LC
Cyprinidae	*Alburnus demiri*	VU *
Cyprinidae	*Alburnus derjugini*	LC
Cyprinidae	*Alburnus escherichii*	LC *
Cyprinidae	*Alburnus filippii*	LC
Cyprinidae	*Alburnus heckeli*	LC *
Cyprinidae	*Alburnus istanbulensis*	LC *
Cyprinidae	*Alburnus kotschyi*	LC *
Cyprinidae	*Alburnus nasreddini*	CR *
Cyprinidae	*Alburnus nicaeensis*	EX *
Cyprinidae	*Alburnus orontis*	VU *
Cyprinidae	*Alburnus qalilus*	EN *
Cyprinidae	*Alburnus schischkovi*	EN
Cyprinidae	*Alburnus sellal*	LC
Cyprinidae	*Alburnus tarichi*	NT *
Cyprinidae	*Alburnus timarensis*	CR *
Cyprinidae	*Aspius aspius*	LC
Cyprinidae	*Barbus cyclolepis*	LC
Cyprinidae	*Barbus ercisianus*	DD *
Cyprinidae	*Barbus escherichii*	LC *
Cyprinidae	*Barbus grypus*	VU
Cyprinidae	*Barbus lacerta*	LC *
Cyprinidae	*Barbus niluferensis*	NT *
Cyprinidae	*Barbus oligolepis*	LC *
Cyprinidae	*Barbus pergamonensis*	LC
Cyprinidae	*Barilius mesopotamicus*	LC
Cyprinidae	*Blicca bjoerkna*	LC
Cyprinidae	*Caecocypris basimi*	CR PE *
Cyprinidae	*Capoeta antalyensis*	VU *
Cyprinidae	*Capoeta baliki*	LC *
Cyprinidae	*Capoeta banarescui*	LC *
Cyprinidae	*Capoeta barroisi*	EN *
Cyprinidae	*Capoeta bergamae*	NT *
Cyprinidae	*Capoeta caelestis*	LC *
Cyprinidae	*Capoeta capoeta*	LC
Cyprinidae	*Capoeta damascina*	LC *
Cyprinidae	*Capoeta ekmekciae*	NT
Cyprinidae	*Capoeta erhani*	LC *
Cyprinidae	*Capoeta kosswigi*	DD *
Cyprinidae	*Capoeta mauricii*	EN *
Cyprinidae	*Capoeta pestai*	CR *
Cyprinidae	*Capoeta sieboldii*	LC *
Cyprinidae	*Capoeta tinca*	LC *
Cyprinidae	*Capoeta trutta*	LC *
Cyprinidae	*Capoeta turani*	NT *
Cyprinidae	*Capoeta umbla*	LC *
Cyprinidae	*Carasobarbus canis*	NT *
Cyprinidae	*Carasobarbus chantrei*	NT *
Cyprinidae	*Carasobarbus kosswigi*	VU *
Cyprinidae	*Carasobarbus luteus*	LC *
Cyprinidae	*Carassius carassius*	LC
Cyprinidae	*Chondrostoma angorense*	LC *
Cyprinidae	*Chondrostoma beysehirense*	EN *
Cyprinidae	*Chondrostoma colchicum*	LC
Cyprinidae	*Chondrostoma cyri*	LC *
Cyprinidae	*Chondrostoma fahirae*	EN *
Cyprinidae	*Chondrostoma holmwoodii*	VU *
Cyprinidae	*Chondrostoma kinzelbachi*	EN *
Cyprinidae	*Chondrostoma meandrense*	VU *
Cyprinidae	*Chondrostoma regium*	LC *
Cyprinidae	*Chondrostoma vardarense*	NT
Cyprinidae	*Crossocheilus klatti*	EN *
Cyprinidae	*Cyprinion kais*	LC *
Cyprinidae	*Cyprinion macrostomum*	LC *
Cyprinidae	*Cyprinus carpio*	VU
Cyprinidae	*Garra ghorensis*	EN *
Cyprinidae	*Garra rufa*	LC
Cyprinidae	*Garra variabilis*	LC *
Cyprinidae	*Gobio battalgilae*	DD *
Cyprinidae	*Gobio bulgaricus*	LC
Cyprinidae	*Gobio caucasicus*	LC
Cyprinidae	*Gobio gymnostethus*	CR *
Cyprinidae	*Gobio hettitorum*	CR *
Cyprinidae	*Gobio insuyanus*	CR *
Cyprinidae	*Gobio intermedius*	EN *
Cyprinidae	*Gobio maeandricus*	EN *
Cyprinidae	*Gobio microlepidotus*	VU *
Cyprinidae	*Gobio sakaryaensis*	LC *
Cyprinidae	*Hemigrammocapoeta caudomaculata*	LC *
Cyprinidae	*Hemigrammocapoeta culiciphaga*	LC *
Cyprinidae	*Hemigrammocapoeta elegans*	LC *
Cyprinidae	*Hemigrammocapoeta kemali*	EN *
Cyprinidae	*Hemigrammocapoeta nana*	NT *
Cyprinidae	*Ladigesocypris irideus*	NT *
Cyprinidae	*Leucalburnus satunini*	LC *
Cyprinidae	*Leucaspius delineatus*	LC
Cyprinidae	*Leuciscus vorax*	LC *
Cyprinidae	*Luciobarbus brachycephalus*	VU
Cyprinidae	*Luciobarbus capito*	VU
Cyprinidae	*Luciobarbus esocinus*	VU *
Cyprinidae	*Luciobarbus kersin*	DD *
Cyprinidae	*Luciobarbus kottelati*	VU *
Cyprinidae	*Luciobarbus longiceps*	EN *
Cyprinidae	*Luciobarbus lydianus*	LC *
Cyprinidae	*Luciobarbus mursa*	LC
Cyprinidae	*Luciobarbus pectoralis*	LC *
Cyprinidae	*Luciobarbus subquincunciatus*	CR *
Cyprinidae	*Luciobarbus xanthopterus*	VU *
Cyprinidae	*Mesopotamichthys sharpeyi*	VU *
Cyprinidae	*Mirogrex hulensis*	EX *

Appendix 2.1 cont'd, Freshwater fishes

Cyprinidae	*Mirogrex terraesanctae*	LC *
Cyprinidae	*Pelecus cultratus*	LC
Cyprinidae	*Petroleuciscus borysthenicus*	LC
Cyprinidae	*Petroleuciscus kurui*	DD *
Cyprinidae	*Petroleuciscus smyrnaeus*	LC
Cyprinidae	*Phoxinus colchicus*	LC
Cyprinidae	*Phoxinus strandjae*	EN
Cyprinidae	*Pseudophoxinus alii*	EN *
Cyprinidae	*Pseudophoxinus anatolicus*	EN *
Cyprinidae	*Pseudophoxinus antalyae*	VU *
Cyprinidae	*Pseudophoxinus atropatenus*	CR *
Cyprinidae	*Pseudophoxinus battalgili*	LC *
Cyprinidae	*Pseudophoxinus burduricus*	EN *
Cyprinidae	*Pseudophoxinus crassus*	EN *
Cyprinidae	*Pseudophoxinus drusensis*	EN *
Cyprinidae	*Pseudophoxinus egridiri*	EN *
Cyprinidae	*Pseudophoxinus elizavetae*	CR *
Cyprinidae	*Pseudophoxinus evliyae*	EN *
Cyprinidae	*Pseudophoxinus fahrettini*	EN *
Cyprinidae	*Pseudophoxinus firati*	EN *
Cyprinidae	*Pseudophoxinus handlirschi*	EX *
Cyprinidae	*Pseudophoxinus hasani*	CR *
Cyprinidae	*Pseudophoxinus hittitorum*	EN *
Cyprinidae	*Pseudophoxinus maeandri*	EN *
Cyprinidae	*Pseudophoxinus maeandricus*	CR *
Cyprinidae	*Pseudophoxinus ninae*	CR *
Cyprinidae	*Pseudophoxinus sojuchbulagi*	CR PE *
Cyprinidae	*Pseudophoxinus syriacus*	CR PE *
Cyprinidae	*Pseudophoxinus zekayi*	VU *
Cyprinidae	*Pseudophoxinus zeregi*	LC *
Cyprinidae	*Rhodeus amarus*	LC
Cyprinidae	*Romanogobio macropterus*	LC *
Cyprinidae	*Rutilus frisii*	LC
Cyprinidae	*Rutilus heckelii*	LC
Cyprinidae	*Rutilus rutilus*	LC
Cyprinidae	*Scardinius elmaliensis*	EN *
Cyprinidae	*Scardinius erythrophthalmus*	LC
Cyprinidae	*Squalius adanaensis*	NT *
Cyprinidae	*Squalius anatolicus*	LC *
Cyprinidae	*Squalius aristotelis*	LC *
Cyprinidae	*Squalius berak*	LC *
Cyprinidae	*Squalius cappadocicus*	CR *
Cyprinidae	*Squalius carinus*	EN *
Cyprinidae	*Squalius cephaloides*	VU *
Cyprinidae	*Squalius cephalus*	LC
Cyprinidae	*Squalius cii*	LC *
Cyprinidae	*Squalius fellowesii*	LC *
Cyprinidae	*Squalius kosswigi*	EN *
Cyprinidae	*Squalius kottelati*	NT *
Cyprinidae	*Squalius lepidus*	LC *
Cyprinidae	*Squalius orpheus*	LC
Cyprinidae	*Squalius pursakensis*	LC *
Cyprinidae	*Squalius recurvirostris*	VU *
Cyprinidae	*Squalius seyhanensis*	DD *
Cyprinidae	*Squalius turcicus*	LC *
Cyprinidae	*Tinca tinca*	LC
Cyprinidae	*Tylognathus festai*	CR *
Cyprinidae	*Typhlogarra widdowsoni*	CR *
Cyprinidae	*Vimba melanops*	DD
Cyprinidae	*Vimba mirabilis*	LC *
Cyprinidae	*Vimba vimba*	LC

Order	Cyprinodontiformes	
Family	Species	RL
Cyprinodontidae	*Aphanius anatoliae*	NT *
Cyprinodontidae	*Aphanius asquamatus*	LC *
Cyprinodontidae	*Aphanius danfordii*	CR *
Cyprinodontidae	*Aphanius dispar*	LC
Cyprinodontidae	*Aphanius dispar ssp. Richardsoni*	EN *
Cyprinodontidae	*Aphanius fasciatus*	LC
Cyprinodontidae	*Aphanius mento*	LC *
Cyprinodontidae	*Aphanius sirhani*	CR *
Cyprinodontidae	*Aphanius splendens*	EX *
Cyprinodontidae	*Aphanius sureyanus*	EN *
Cyprinodontidae	*Aphanius transgrediens*	CR *
Cyprinodontidae	*Aphanius villwocki*	LC *

Order	Esociformes	
Family	Species	RL
Esocidae	*Esox lucius*	LC

Order	*Gadiformes*	
Family	*Species*	RL
Lotidae	*Lota lota*	LC

Order	Gasterosteiformes	
Family	Species	RL
Gasterosteidae	*Gasterosteus aculeatus*	LC
Gasterosteidae	*Gasterosteus gymnurus*	LC
Gasterosteidae	*Pungitius platygaster*	LC

Order	Mugiliformes	
Family	Species	RL
Mugilidae	*Chelon labrosus*	LC
Mugilidae	*Ellochelon vaigiensis*	LC
Mugilidae	*Liza abu*	LC
Mugilidae	*Liza aurata*	LC
Mugilidae	*Liza ramada*	LC
Mugilidae	*Liza saliens*	LC
Mugilidae	*Mugil cephalus*	LC

Order	Perciformes	
Family	Species	RL
Cichlidae	*Coptodon zillii*	LC (draft)
Cichlidae	*Haplochromis flaviijosephi*	VU *
Cichlidae	*Oreochromis aureus*	LC (draft)
Cichlidae	*Oreochromis niloticus*	LC (draft)
Cichlidae	*Sarotherodon galilaeus*	LC (draft)
Cichlidae	*Tristramella sacra*	EX *
Cichlidae	*Tristramella simonis*	VU *
Gobiidae	*Babka gymnotrachelus*	LC
Gobiidae	*Knipowitschia byblisia*	LC *
Gobiidae	*Knipowitschia caucasica*	LC
Gobiidae	*Knipowitschia caunosi*	LC *
Gobiidae	*Knipowitschia ephesi*	CR *
Gobiidae	*Knipowitschia mermere*	VU *
Gobiidae	*Mesogobius batrachocephalus*	LC
Gobiidae	*Neogobius fluviatilis*	LC
Gobiidae	*Neogobius melanostomus*	LC
Gobiidae	*Neogobius pallasi*	LC
Gobiidae	*Ponticola cyrius*	LC
Gobiidae	*Ponticola gorlap*	LC
Gobiidae	*Ponticola rizensis*	EN *
Gobiidae	*Ponticola syrman*	LC
Gobiidae	*Ponticola turani*	VU *

Appendix 2.1 cont'd, Freshwater fishes

Gobiidae	*Proterorhinus nasalis*	LC
Gobiidae	*Proterorhinus semilunaris*	LC
Moronidae	*Dicentrarchus labrax*	LC
Percidae	*Perca fluviatilis*	LC
Percidae	*Sander lucioperca*	LC

Order	Pleuronectiformes	
Family	Species	RL
Pleuronectidae	*Platichthys flesus*	LC

Order	Salmoniformes	
Family	Species	RL
Salmonidae	*Salmo abanticus*	VU (draft) *
Salmonidae	*Salmo chilo*	VU (draft) *
Salmonidae	*Salmo coruhensis*	NT (draft) *
Salmonidae	*Salmo ischchan*	CR (draft) *
Salmonidae	*Salmo labecula*	EN (draft) *
Salmonidae	*Salmo opimus*	EN (draft) *
Salmonidae	*Salmo platycephalus*	EN (draft) *
Salmonidae	*Salmo rizeensis*	LC (draft) *
Salmonidae	*Salmo tigridis*	DD (draft) *
Salmonidae	*Stenodus leucichthys*	EW

Order	Siluriformes	
Family	Species	RL
Bagridae	*Mystus pelusius*	LC *
Clariidae	*Clarias gariepinus*	LC
Siluridae	*Silurus glanis*	LC
Siluridae	*Silurus triostegus*	LC *
Sisoridae	*Glyptothorax kurdistanicus*	DD *

Order	Synbranchiformes	
Family	Species	RL
Mastacembelidae	*Mastacembelus mastacembelus*	LC *

Order	Syngnathiformes	
Family	Species	RL
Syngnathidae	*Syngnathus abaster*	LC

Class	Cephalaspidomorphi	
Order	Petromyzontiformes	
Family	Species	RL
Petromyzontidae	*Caspiomyzon wagneri*	NT
Petromyzontidae	*Lampetra lanceolata*	EN *

Class	Chondrichthyes	
Order	Syngnathiformes	
Family	Species	RL
Carcharhinidae	*Carcharhinus leucas*	NT

2.2 Freshwater molluscs

Class	Bivalvia	
Order	Unionoida	
Family	Species	RL
Margaritiferidae	*Margaritifera homsensis*	EN *
Unionidae	*Anodonta anatina*	LC
Unionidae	*Anodonta cygnea*	LC
Unionidae	*Anodonta pseudodopsis*	EN *
Unionidae	*Anodonta vescoiana*	NT *
Unionidae	*Leguminaia saulcyi*	CR *
Unionidae	*Leguminaia wheatleyi*	NT *
Unionidae	*Potomida littoralis*	EN
Unionidae	*Pseudodontopsis euphratica*	NT (draft) *
Unionidae	*Unio crassus*	EN
Unionidae	*Unio mancus*	NT
Unionidae	*Unio terminalis*	VU *
Unionidae	*Unio tigridis*	LC *

Order	Veneroida	
Family	Species	RL
Cyrenidae	*Corbicula fluminalis*	LC
Dreissenidae	*Dreissena caputlacus*	EN (draft) *
Dreissenidae	*Dreissena iconica*	DD *
Dreissenidae	*Dreissena polymorpha*	LC
Sphaeriidae	*Musculium lacustre*	LC
Sphaeriidae	*Pisidium amnicum*	LC (draft)
Sphaeriidae	*Pisidium casertanum*	LC
Sphaeriidae	*Pisidium henslowanum*	LC
Sphaeriidae	*Pisidium milium*	LC (draft)
Sphaeriidae	*Pisidium moitessierianum*	LC (draft)
Sphaeriidae	*Pisidium personatum*	LC (draft)
Sphaeriidae	*Pisidium sogdianum*	NA ?
Sphaeriidae	*Pisidium subtruncatum*	LC (draft)
Sphaeriidae	*Pisidium tenuilineatum*	LC (draft)

Class	Gastropoda	
Order	Allogastropoda	
Family	Species	RL
Valvatidae	*Borysthenia naticina*	LC
Valvatidae	*Valvata cristata*	LC (draft)
Valvatidae	*Valvata macrostoma*	LC
Valvatidae	*Valvata piscinalis*	LC
Valvatidae	*Valvata saulcyi*	LC

Order	Architaenioglossa	
Family	Species	RL
Viviparidae	*Viviparus contectus*	LC
Viviparidae	*Viviparus viviparus*	LC

Order	Cycloneritimorpha	
Family	Species	RL
Neritidae	*Theodoxus altenai*	CR *
Neritidae	*Theodoxus anatolicus*	NT
Neritidae	*Theodoxus cinctellus*	DD *
Neritidae	*Theodoxus euphraticus*	DD *
Neritidae	*Theodoxus euxinus*	LC (draft)

Appendix 2.2 cont'd, Freshwater molluscs

Neritidae	*Theodoxus heldreichi*	LC *
Neritidae	*Theodoxus jordani*	LC *
Neritidae	*Theodoxus pallasi*	DD
Neritidae	*Theodoxus subthermalis*	LC
Neritidae	*Theodoxus syriacus*	DD *

Order	Hygrophila	
Family	Species	RL
Acroloxidae	*Acroloxus egirdirensis*	VU *
Acroloxidae	*Acroloxus lacustris*	LC
Lymnaeidae	*Galba truncatula*	LC
Lymnaeidae	*Lymnaea schirazensis*	LC
Lymnaeidae	*Lymnaea stagnalis*	LC
Lymnaeidae	*Radix auricularia*	LC
Lymnaeidae	*Radix balthica*	LC
Lymnaeidae	*Stagnicola kayseris*	EN (draft) *
Lymnaeidae	*Stagnicola tekecus*	DD (draft) *
Planorbidae	*Ancylus fluviatilis*	LC
Planorbidae	*Bathyomphalus contortus*	LC
Planorbidae	*Gyraulus albus*	LC
Planorbidae	*Gyraulus argaeicus*	VU *
Planorbidae	*Gyraulus bekaensis*	VU *
Planorbidae	*Gyraulus convexiusculus*	LC
Planorbidae	*Gyraulus crista*	LC
Planorbidae	*Gyraulus egirdirensis*	DD *
Planorbidae	*Gyraulus hebraicus*	LC *
Planorbidae	*Gyraulus huwaizahensis*	DD *
Planorbidae	*Gyraulus nedyalkovi*	VU *
Planorbidae	*Gyraulus pamphylicus*	VU *
Planorbidae	*Gyraulus taseviensis*	DD *
Planorbidae	*Planorbarius corneus*	LC
Planorbidae	*Planorbis carinatus*	LC (draft)
Planorbidae	*Planorbis planorbis*	LC
Planorbidae	*Segmentina nitida*	LC (draft)

Order	Littorinimorpha	
Family	Species	RL
Assimineidae	*Assiminea mesopotamica*	DD *
Assimineidae	*Paludinella littorina*	LC
Assimineidae	*Paludinella sicana*	LC
Bithyniidae	*Bithynia hareerensis*	DD *
Bithyniidae	*Bithynia pesicii*	EN *
Bithyniidae	*Bithynia phialensis*	LC *
Bithyniidae	*Bithynia pseudemmericia*	VU *
Bithyniidae	*Bithynia yildirimii sp. Nov.*	VU *
Bithyniidae	*Pseudobithynia hamicensis*	LC (draft) *
Bithyniidae	*Pseudobithynia kathrinae*	CR *
Bithyniidae	*Pseudobithynia levantica*	EN *
Bithyniidae	*Pseudobithynia pentheri*	NT *
Bithyniidae	*Pseudobithynia saulyci*	NA ?
Bithyniidae	*Pseudobithynia yildirimi*	NA ?
Cochliopidae	*Heleobia contempta*	DD (draft) *
Cochliopidae	*Heleobia galilaea*	VU *
Cochliopidae	*Heleobia longiscata*	DD *
Hydrobiidae	*Belgrandiella adsharica*	EN *
Hydrobiidae	*Belgrandiella cavernica*	CR PE *
Hydrobiidae	*Belgrandiella edessana*	VU *
Hydrobiidae	*Belgrandiella libanica*	NT *
Hydrobiidae	*Bythinella kazdaghensis*	VU *
Hydrobiidae	*Bythinella occasiuncula*	VU *
Hydrobiidae	*Bythinella turca*	CR *
Hydrobiidae	*Falsibelgrandiella bunarica*	DD *
Hydrobiidae	*Falsipyrgula barroisi*	EN *
Hydrobiidae	*Falsipyrgula beysehirana*	CR PE *
Hydrobiidae	*Falsipyrgula pfeiferi*	EN *
Hydrobiidae	*Globuliana gaillardotii*	LC
Hydrobiidae	*Graecoanatolica brevis*	CR PE *
Hydrobiidae	*Graecoanatolica conica*	CR PE *
Hydrobiidae	*Graecoanatolica dinarica*	EN *
Hydrobiidae	*Graecoanatolica kocapinarica*	VU *
Hydrobiidae	*Graecoanatolica lacustristurca*	EN *
Hydrobiidae	*Graecoanatolica pamphylica*	EN *
Hydrobiidae	*Graecoanatolica tenuis*	EN (draft) *
Hydrobiidae	*Horatia parvula*	DD *
Hydrobiidae	*Hydrobia acuta*	LC
Hydrobiidae	*Hydrobia anatolica*	CR PE *
Hydrobiidae	*Hydrobia soosi*	DD *
Hydrobiidae	*Hydrobia ventrosa*	LC
Hydrobiidae	*Islamia anatolica*	CR (draft) *
Hydrobiidae	*Islamia bunarbasa*	CR *
Hydrobiidae	*Islamia pseudorientalica*	CR PE *
Hydrobiidae	*Kirelia carinata*	CR PE *
Hydrobiidae	*Kirelia murtici*	CR *
Hydrobiidae	*Peringia ulvae*	LC (draft)
Hydrobiidae	*Pseudamnicola bilgini*	LC *
Hydrobiidae	*Pseudamnicola geldiayana*	EN *
Hydrobiidae	*Pseudamnicola intranodosa*	VU *
Hydrobiidae	*Pseudamnicola macrostoma*	DD
Hydrobiidae	*Pseudamnicola solitaria*	EN *
Hydrobiidae	*Pseudamnicola vinarskii*	DD *
Hydrobiidae	*Pseudorientalia natolica*	EN (draft) *
Hydrobiidae	*Pyrgorientalia zilchi*	NA ?
Hydrobiidae	*Radomaniola caputlacus*	NT *
Hydrobiidae	*Radomaniola gaillardoti*	DD
Hydrobiidae	*Sadleriana affinis*	DD *
Hydrobiidae	*Sadleriana byzanthina*	DD *
Hydrobiidae	*Sadleriana fluminensis*	LC
Hydrobiidae	*Sadleriana minuta*	NA ?
Hydrobiidae	*Sheitanok amidicus*	NT *
Hydrobiidae	*Tefennia tefennica*	VU *
Hydrobiidae	*Torosia proschwitzi*	DD *
Hydrobiidae	*Turcorientalia anatolica*	VU *

Order	Sorbeoconcha	
Family	Species	RL
Melanopsidae	*Esperiana sangarica*	VU *
Melanopsidae	*Melanopsis ammonis*	CR *
Melanopsidae	*Melanopsis buccinoidea*	LC
Melanopsidae	*Melanopsis denegabilis*	DD *
Melanopsidae	*Melanopsis dircaena*	EN *
Melanopsidae	*Melanopsis doriae*	LC
Melanopsidae	*Melanopsis germaini*	CR PE *
Melanopsidae	*Melanopsis infracincta*	CR PE *
Melanopsidae	*Melanopsis khabourensis*	CR PE *
Melanopsidae	*Melanopsis meiostoma*	DD *
Melanopsidae	*Melanopsis nodosa*	LC *
Melanopsidae	*Melanopsis pachya*	CR PE *
Melanopsidae	*Melanopsis saulcyi*	LC *
Thiaridae	*Melanoides tuberculata*	LC

Order	Stylommatophora	
Family	Species	RL
Succineidae	*Oxyloma elegans*	LC (draft) *

2.3 Odonata

Suborder	Anisoptera	
Family	Species	RL
Aeshnidae	*Aeshna affinis*	LC
Aeshnidae	*Aeshna cyanea*	LC
Aeshnidae	*Aeshna isoceles*	LC
Aeshnidae	*Aeshna juncea*	LC
Aeshnidae	*Aeshna mixta*	LC
Aeshnidae	*Aeshna serrata*	LC
Aeshnidae	*Anax ephippiger*	LC
Aeshnidae	*Anax immaculifrons*	LC
Aeshnidae	*Anax imperator*	LC
Aeshnidae	*Anax parthenope*	LC
Aeshnidae	*Brachytron pratense*	LC
Aeshnidae	*Caliaeschna microstigma*	LC
Cordulegastridae	*Cordulegaster bidentata*	NT
Cordulegastridae	*Cordulegaster heros*	NT
Cordulegastridae	*Cordulegaster insignis*	LC
Cordulegastridae	*Cordulegaster picta*	LC
Cordulegastridae	*Cordulegaster vanbrinkae*	DD
Corduliidae	*Cordulia aenea*	LC
Corduliidae	*Somatochlora borisi*	VU
Corduliidae	*Somatochlora flavomaculata*	LC
Corduliidae	*Somatochlora meridionalis*	LC
Corduliidae	*Somatochlora metallica*	LC
Gomphidae	*Anormogomphus kiritshenkoi*	NT
Gomphidae	*Gomphus davidi*	LC *
Gomphidae	*Gomphus flavipes*	LC
Gomphidae	*Gomphus kinzelbachi*	DD *
Gomphidae	*Gomphus schneiderii*	LC
Gomphidae	*Gomphus ubadschii*	DD
Gomphidae	*Gomphus vulgatissimus*	LC
Gomphidae	*Lindenia tetraphylla*	LC
Gomphidae	*Onychogomphus assimilis*	VU
Gomphidae	*Onychogomphus flexuosus*	VU
Gomphidae	*Onychogomphus forcipatus*	LC
Gomphidae	*Onychogomphus lefebvrii*	LC
Gomphidae	*Onychogomphus macrodon*	VU *
Gomphidae	*Ophiogomphus cecilia*	LC
Gomphidae	*Ophiogomphus reductus*	LC
Gomphidae	*Paragomphus genei*	LC
Gomphidae	*Paragomphus lineatus*	LC
Libellulidae	*Brachythemis fuscopalliata*	VU *
Libellulidae	*Brachythemis impartita*	LC
Libellulidae	*Crocothemis erythraea*	LC
Libellulidae	*Crocothemis sanguinolenta*	LC
Libellulidae	*Crocothemis servilia*	LC
Libellulidae	*Diplacodes lefebvrii*	LC
Libellulidae	*Leucorrhinia pectoralis*	LC
Libellulidae	*Libellula depressa*	LC
Libellulidae	*Libellula fulva*	LC
Libellulidae	*Libellula pontica*	NT *
Libellulidae	*Libellula quadrimaculata*	LC
Libellulidae	*Orthetrum abbotti*	LC
Libellulidae	*Orthetrum albistylum*	LC
Libellulidae	*Orthetrum brunneum*	LC
Libellulidae	*Orthetrum cancellatum*	LC
Libellulidae	*Orthetrum chrysostigma*	LC
Libellulidae	*Orthetrum coerulescens*	LC
Libellulidae	*Orthetrum ransonnetii*	LC
Libellulidae	*Orthetrum sabina*	LC
Libellulidae	*Orthetrum taeniolatum*	LC
Libellulidae	*Orthetrum trinacria*	LC
Libellulidae	*Pantala flavescens*	LC
Libellulidae	*Rhyothemis semihyalina*	LC
Libellulidae	*Selysiothemis nigra*	LC
Libellulidae	*Sympetrum arenicolor*	LC
Libellulidae	*Sympetrum danae*	LC (draft)
Libellulidae	*Sympetrum depressiusculum*	LC (draft)
Libellulidae	*Sympetrum flaveolum*	LC
Libellulidae	*Sympetrum fonscolombii*	LC
Libellulidae	*Sympetrum haritonovi*	LC
Libellulidae	*Sympetrum meridionale*	LC
Libellulidae	*Sympetrum pedemontanum*	LC
Libellulidae	*Sympetrum sanguineum*	LC
Libellulidae	*Sympetrum sinaiticum*	LC
Libellulidae	*Sympetrum striolatum*	LC
Libellulidae	*Sympetrum vulgatum*	LC
Libellulidae	*Trithemis annulata*	LC
Libellulidae	*Trithemis arteriosa*	LC
Libellulidae	*Trithemis festiva*	LC
Libellulidae	*Trithemis kirbyi*	LC
Libellulidae	*Urothemis edwardsii*	LC
Libellulidae	*Zygonyx torridus*	LC

Suborder	Zygoptera	
Family	Species	RL
Calopterygidae	*Calopteryx hyalina*	EN *
Calopterygidae	*Calopteryx splendens*	LC
Calopterygidae	*Calopteryx syriaca*	EN *
Calopterygidae	*Calopteryx virgo*	LC
Coenagrionidae	*Agriocnemis sania*	LC
Coenagrionidae	*Ceriagrion georgifreyi*	VU
Coenagrionidae	*Coenagrion armatum*	LC
Coenagrionidae	*Coenagrion hastulatum*	LC
Coenagrionidae	*Coenagrion lunulatum*	LC (draft)
Coenagrionidae	*Coenagrion ornatum*	LC
Coenagrionidae	*Coenagrion persicum*	DD *
Coenagrionidae	*Coenagrion ponticum*	LC
Coenagrionidae	*Coenagrion puella*	LC
Coenagrionidae	*Coenagrion pulchellum*	LC
Coenagrionidae	*Coenagrion scitulum*	LC
Coenagrionidae	*Coenagrion syriacum*	NT *
Coenagrionidae	*Enallagma cyathigerum*	LC
Coenagrionidae	*Erythromma lindenii*	LC
Coenagrionidae	*Erythromma najas*	LC (draft)
Coenagrionidae	*Erythromma viridulum*	LC
Coenagrionidae	*Ischnura elegans*	LC
Coenagrionidae	*Ischnura evansi*	LC
Coenagrionidae	*Ischnura fountaineae*	LC
Coenagrionidae	*Ischnura intermedia*	NT
Coenagrionidae	*Ischnura pumilio*	LC
Coenagrionidae	*Ischnura senegalensis*	LC
Coenagrionidae	*Pseudagrion sublacteum*	LC
Coenagrionidae	*Pseudagrion syriacum*	LC *
Coenagrionidae	*Pseudagrion torridum*	LC
Coenagrionidae	*Pyrrhosoma nymphula*	LC
Euphaeidae	*Epallage fatime*	LC
Lestidae	*Chalcolestes parvidens*	LC
Lestidae	*Chalcolestes viridis*	LC
Lestidae	*Lestes barbarus*	LC
Lestidae	*Lestes dryas*	LC
Lestidae	*Lestes macrostigma*	LC
Lestidae	*Lestes sponsa*	LC
Lestidae	*Lestes virens*	LC
Lestidae	*Sympecma fusca*	LC
Lestidae	*Sympecma paedisca*	LC
Platycnemididae	*Platycnemis dealbata*	LC
Platycnemididae	*Platycnemis kervillei*	LC *
Platycnemididae	*Platycnemis pennipes*	LC

2.4 Freshwater plants

Phylum	Tracheophyta	
Class	Equisetopsida	
Order	Equisetales	
Family	Species	RL
Equisetaceae	*Equisetum fluviatile*	LC
Equisetaceae	*Equisetum giganteum*	LC
Equisetaceae	*Equisetum hyemale*	LC
Equisetaceae	*Equisetum palustre*	LC
Equisetaceae	*Equisetum telmateia*	LC

Class	Isoetopsida	
Order	Isoetales	
Family	Species	RL
Isoetaceae	*Isoetes olympica*	CR *

Class	Liliopsida	
Order	Alismatales	
Family	Species	RL
Alismataceae	*Alisma gramineum*	DD
Alismataceae	*Alisma lanceolatum*	LC
Alismataceae	*Alisma plantago-aquatica*	LC
Alismataceae	*Baldellia ranunculoides*	NT
Alismataceae	*Damasonium bourgaei*	LC
Alismataceae	*Sagittaria sagittifolia*	LC
Butomaceae	*Butomus umbellatus*	LC

Order	Arales	
Family	Species	RL
Acoraceae	*Acorus calamus*	LC
Araceae	*Calla palustris*	LC
Lemnaceae	*Lemna gibba*	LC
Lemnaceae	*Lemna minor*	LC
Lemnaceae	*Lemna trisulca*	LC
Lemnaceae	*Lemna turionifera*	LC
Lemnaceae	*Spirodela polyrhiza*	LC

Order	Cyperales	
Family	Species	RL
Cyperaceae	*Blysmus compressus*	LC
Cyperaceae	*Bolboschoenus glaucus*	LC
Cyperaceae	*Bolboschoenus laticarpus*	LC
Cyperaceae	*Bolboschoenus maritimus*	LC
Cyperaceae	*Carex acuta*	LC
Cyperaceae	*Carex acutiformis*	LC
Cyperaceae	*Carex appropinquata*	LC
Cyperaceae	*Carex atherodes*	LC
Cyperaceae	*Carex caespitosa*	LC
Cyperaceae	*Carex canescens*	LC
Cyperaceae	*Carex cilicica*	LC *
Cyperaceae	*Carex davalliana*	LC
Cyperaceae	*Carex diandra*	LC
Cyperaceae	*Carex diluta*	LC
Cyperaceae	*Carex distans*	LC
Cyperaceae	*Carex divisa*	LC
Cyperaceae	*Carex elata*	LC
Cyperaceae	*Carex extensa*	LC
Cyperaceae	*Carex flava*	LC
Cyperaceae	*Carex iraqensis*	NT *
Cyperaceae	*Carex lasiocarpa*	LC
Cyperaceae	*Carex limosa*	LC
Cyperaceae	*Carex magellanica*	LC
Cyperaceae	*Carex melanorrhyncha*	DD *
Cyperaceae	*Carex microglochin*	LC
Cyperaceae	*Carex nigra*	LC
Cyperaceae	*Carex orbicularis*	LC
Cyperaceae	*Carex otrubae*	LC
Cyperaceae	*Carex paniculata*	LC
Cyperaceae	*Carex pseudocyperus*	LC
Cyperaceae	*Carex pseudofoetida*	LC
Cyperaceae	*Carex punctata*	LC
Cyperaceae	*Carex riparia*	LC
Cyperaceae	*Carex rostrata*	LC
Cyperaceae	*Carex songorica*	LC
Cyperaceae	*Carex umbrosa*	LC
Cyperaceae	*Carex vesicaria*	LC
Cyperaceae	*Cladium mariscus*	LC
Cyperaceae	*Cyperus difformis*	LC
Cyperaceae	*Cyperus fuscus*	LC
Cyperaceae	*Cyperus glaber*	LC
Cyperaceae	*Cyperus glomeratus*	LC
Cyperaceae	*Cyperus hamulosus*	LC
Cyperaceae	*Cyperus iria*	LC
Cyperaceae	*Cyperus laevigatus*	LC
Cyperaceae	*Cyperus longus*	LC
Cyperaceae	*Cyperus michelianus*	LC
Cyperaceae	*Cyperus rotundus*	LC
Cyperaceae	*Eleocharis acicularis*	LC
Cyperaceae	*Eleocharis argyrolepis*	LC
Cyperaceae	*Eleocharis atropurpurea*	LC
Cyperaceae	*Eleocharis carniolica*	LC
Cyperaceae	*Eleocharis macrantha*	LC *
Cyperaceae	*Eleocharis mitracarpa*	LC
Cyperaceae	*Eleocharis palustris*	LC
Cyperaceae	*Eleocharis quinqueflora*	LC
Cyperaceae	*Eleocharis uniglumis*	LC
Cyperaceae	*Eriophorum angustifolium*	LC
Cyperaceae	*Eriophorum latifolium*	LC
Cyperaceae	*Fimbristylis bisumbellata*	LC
Cyperaceae	*Fimbristylis dichotoma*	LC
Cyperaceae	*Fimbristylis ferruginea*	LC
Cyperaceae	*Fimbristylis littoralis*	LC
Cyperaceae	*Fimbristylis quinquangularis*	LC
Cyperaceae	*Fuirena pubescens*	LC
Cyperaceae	*Isolepis cernua*	LC
Cyperaceae	*Isolepis setacea*	LC
Cyperaceae	*Kobresia simpliciuscula*	LC
Cyperaceae	*Kyllinga brevifolia*	LC
Cyperaceae	*Pycreus flavescens*	LC
Cyperaceae	*Pycreus flavidus*	LC
Cyperaceae	*Pycreus sanguinolentus*	LC
Cyperaceae	*Rhynchospora alba*	LC
Cyperaceae	*Schoenoplectiella roylei*	LC
Cyperaceae	*Schoenoplectiella supina*	LC
Cyperaceae	*Schoenoplectus lacustris*	LC
Cyperaceae	*Schoenoplectus litoralis*	LC
Cyperaceae	*Schoenoplectus mucronatus*	LC
Cyperaceae	*Schoenoplectus tabernaemontani*	LC
Cyperaceae	*Schoenoplectus triqueter*	LC
Cyperaceae	*Schoenus nigricans*	LC
Cyperaceae	*Scirpoides holoschoenus*	LC
Cyperaceae	*Scirpus sylvaticus*	LC
Gramineae	*Agrostis canina*	LC
Gramineae	*Agrostis stolonifera*	LC
Gramineae	*Alopecurus aequalis*	LC
Gramineae	*Alopecurus arundinaceus*	LC
Gramineae	*Alopecurus creticus*	LC

Appendix 2.4 cont'd, Freshwater plants

Gramineae	*Alopecurus setarioides*	LC
Gramineae	*Beckmannia eruciformis*	LC
Gramineae	*Brachiaria eruciformis*	LC
Gramineae	*Calamagrostis parsana*	EN
Gramineae	*Calamagrostis pseudophragmites*	LC
Gramineae	*Catabrosa aquatica*	LC
Gramineae	*Crypsis alopecuroides*	LC
Gramineae	*Crypsis schoenoides*	LC
Gramineae	*Echinochloa crusgalli*	LC
Gramineae	*Eleusine indica*	LC
Gramineae	*Glyceria arundinacea*	LC
Gramineae	*Glyceria fluitans*	LC
Gramineae	*Glyceria maxima*	LC
Gramineae	*Glyceria nemoralis*	LC
Gramineae	*Glyceria notata*	LC
Gramineae	*Hemarthria altissima*	LC
Gramineae	*Panicum repens*	LC
Gramineae	*Phalaris arundinacea*	LC
Gramineae	*Phragmites australis*	LC
Gramineae	*Polypogon monspeliensis*	LC
Gramineae	*Polypogon viridis*	LC
Gramineae	*Scolochloa festucacea*	LC
Gramineae	*Zingeria biebersteiniana*	LC
Gramineae	*Zingeria pisidica*	LC

Order	Hydrocharitales	
Family	Species	RL
Hydrocharitaceae	*Hydrocharis morsus-ranae*	LC
Hydrocharitaceae	*Najas graminea*	LC
Hydrocharitaceae	*Najas marina*	LC
Hydrocharitaceae	*Najas minor*	LC
Hydrocharitaceae	*Stratiotes aloides*	LC
Hydrocharitaceae	*Vallisneria spiralis*	LC

Order	Juncales	
Family	Species	RL
Juncaceae	*Juncus acutus*	LC
Juncaceae	*Juncus alpinoarticulatus*	LC
Juncaceae	*Juncus articulatus*	LC
Juncaceae	*Juncus bufonius*	LC
Juncaceae	*Juncus bulbosus*	LC
Juncaceae	*Juncus compressus*	LC
Juncaceae	*Juncus conglomeratus*	LC
Juncaceae	*Juncus effusus*	LC
Juncaceae	*Juncus filiformis*	LC
Juncaceae	*Juncus fontanesii*	LC
Juncaceae	*Juncus heldreichianus*	LC
Juncaceae	*Juncus hybridus*	LC
Juncaceae	*Juncus inflexus*	LC
Juncaceae	*Juncus minutulus*	LC
Juncaceae	*Juncus rigidus*	LC
Juncaceae	*Juncus striatus*	LC
Juncaceae	*Juncus subnodulosus*	LC
Juncaceae	*Juncus subulatus*	LC
Juncaceae	*Juncus tenageia*	LC

Order	Liliales	
Family	Species	RL
Amaryllidaceae	*Leucojum aestivum*	LC
Iridaceae	*Iris pseudacorus*	LC
Iridaceae	*Iris spuria*	LC
Melanthiaceae	*Narthecium balansae*	DD

Order	Najadales	
Family	Species	RL
Juncaginaceae	*Triglochin bulbosa*	LC
Juncaginaceae	*Triglochin palustris*	LC
Potamogetonaceae	*Groenlandia densa*	LC
Potamogetonaceae	*Potamogeton alpinus*	LC
Potamogetonaceae	*Potamogeton berchtoldii*	LC
Potamogetonaceae	*Potamogeton coloratus*	LC
Potamogetonaceae	*Potamogeton crispus*	LC
Potamogetonaceae	*Potamogeton gramineus*	LC
Potamogetonaceae	*Potamogeton lucens*	LC
Potamogetonaceae	*Potamogeton natans*	LC
Potamogetonaceae	*Potamogeton nodosus*	LC
Potamogetonaceae	*Potamogeton perfoliatus*	LC
Potamogetonaceae	*Potamogeton praelongus*	LC
Potamogetonaceae	*Potamogeton pusillus*	LC
Potamogetonaceae	*Potamogeton trichoides*	LC
Potamogetonaceae	*Stuckenia amblyophyla*	LC
Potamogetonaceae	*Stuckenia pectinata*	LC
Potamogetonaceae	*Zannichellia palustris*	LC
Potamogetonaceae	*Zannichellia peltata*	LC

Order	Orchidales	
Family	Species	RL
Orchidaceae	*Anacamptis palustris*	LC
Orchidaceae	*Dactylorhiza euxina*	NT *
Orchidaceae	*Epipactis palustris*	LC
Orchidaceae	*Epipactis veratrifolia*	LC
Orchidaceae	*Spiranthes sinensis*	LC

Order	Typhales	
Family	Species	RL
Typhaceae	*Sparganium angustifolium*	LC
Typhaceae	*Sparganium emersum*	LC
Typhaceae	*Sparganium erectum*	LC
Typhaceae	*Sparganium natans*	LC
Typhaceae	*Typha angustifolia*	LC
Typhaceae	*Typha domingensis*	LC
Typhaceae	*Typha latifolia*	LC
Typhaceae	*Typha laxmannii*	LC
Typhaceae	*Typha minima*	LC

Class	Lycopodiopsida	
Order	Lycopodiales	
Family	Species	RL
Lycopodiaceae	*Lycopodiella inundata*	LC

Class	Magnoliopsida	
Order	Apiales	
Family	Species	RL
Umbelliferae	*Angelica sylvestris*	LC
Umbelliferae	*Apium graveolens*	LC
Umbelliferae	*Berula erecta*	LC
Umbelliferae	*Cicuta virosa*	LC
Umbelliferae	*Hydrocotyle vulgaris*	LC
Umbelliferae	*Oenanthe aquatica*	LC
Umbelliferae	*Oenanthe fistulosa*	LC
Umbelliferae	*Oenanthe silaifolia*	LC
Umbelliferae	*Sium sisaroideum*	LC

Appendix 2.4 cont'd, Freshwater plants

Order	Asterales	
Family	Species	RL
Compositae	*Bidens cernua*	LC
Compositae	*Bidens tripartita*	LC
Compositae	*Eclipta prostrata*	DD
Compositae	*Inula acaulis*	LC *
Compositae	*Pulicaria sicula*	LC
Compositae	*Pulicaria vulgaris*	LC
Compositae	*Senecio aquaticus*	LC
Compositae	*Sonchus erzincanicus*	CR *
Compositae	*Sonchus palustris*	LC

Order	Callitrichales	
Family	Species	RL
Callitrichaceae	*Callitriche brutia*	LC
Callitrichaceae	*Callitriche lenisulca*	LC
Callitrichaceae	*Callitriche mouterdei*	DD *
Callitrichaceae	*Callitriche stagnalis*	LC
Callitrichaceae	*Callitriche truncata*	LC
Hippuridaceae	*Hippuris vulgaris*	LC

Order	Campanulales	
Family	Species	RL
Campanulaceae	*Sphenoclea zeylanica*	LC

Order	Capparales	
Family	Species	RL
Cruciferae	*Barbarea integrifolia*	LC *
Cruciferae	*Barbarea plantaginea*	LC
Cruciferae	*Barbarea vulgaris*	LC
Cruciferae	*Cardamine uliginosa*	LC *
Cruciferae	*Nasturtium officinale*	LC
Cruciferae	*Rorippa amphibia*	LC
Cruciferae	*Rorippa aurea*	LC *
Cruciferae	*Rorippa austriaca*	LC
Cruciferae	*Rorippa islandica*	LC
Cruciferae	*Rorippa microphylla*	LC
Cruciferae	*Rorippa sylvestris*	LC

Order	Caryophyllales	
Family	Species	RL
Amaranthaceae	*Alternanthera sessilis*	LC
Caryophyllaceae	*Spergularia bocconei*	LC
Caryophyllaceae	*Spergularia marina*	LC
Caryophyllaceae	*Spergularia media*	LC
Portulacaceae	*Montia fontana*	LC

Order	Euphorbiales	
Family	Species	RL
Euphorbiaceae	*Euphorbia palustris*	LC

Order	Fabales	
Family	Species	RL
Leguminosae	*Lathyrus palustris*	LC
Leguminosae	*Lotus palustris*	LC
Leguminosae	*Tetragonolobus maritimus*	LC
Leguminosae	*Thermopsis turcica*	CR *

Order	Gentianales	
Family	Species	RL
Apocynaceae	*Amsonia orientalis*	CR
Asclepiadaceae	*Cynanchum acutum*	LC
Asclepiadaceae	*Oxystelma esculentum*	LC
Gentianaceae	*Swertia iberica*	LC
Gentianaceae	*Swertia longifolia*	LC

Order	Haloragales	
Family	Species	RL
Haloragaceae	*Myriophyllum spicatum*	LC
Haloragaceae	*Myriophyllum verticillatum*	LC

Order	Lamiales	
Family	Species	RL
Boraginaceae	*Myosotis laxa*	LC
Labiatae	*Lycopus europaeus*	LC
Labiatae	*Mentha aquatica*	LC
Labiatae	*Mentha longifolia*	LC
Labiatae	*Mentha pulegium*	LC
Labiatae	*Mentha spicata*	LC
Labiatae	*Mentha suaveolens*	LC
Labiatae	*Scutellaria galericulata*	LC
Labiatae	*Stachys palustris*	LC
Verbenaceae	*Phyla nodiflora*	LC

Order	Malvales	
Family	Species	RL
Malvaceae	*Kosteletzkya pentacarpos*	LC

Order	Myrtales	
Family	Species	RL
Lythraceae	*Ammannia baccifera*	LC
Lythraceae	*Ammannia multiflora*	LC
Lythraceae	*Ammannia verticillata*	LC
Lythraceae	*Lythrum anatolicum*	DD *
Lythraceae	*Lythrum borysthenicum*	LC
Lythraceae	*Lythrum hyssopifolia*	LC
Lythraceae	*Lythrum junceum*	LC
Lythraceae	*Lythrum portula*	LC
Lythraceae	*Lythrum salicaria*	LC
Lythraceae	*Lythrum thymifolia*	LC
Lythraceae	*Lythrum tribracteatum*	LC
Onagraceae	*Epilobium anatolicum*	LC *
Onagraceae	*Epilobium confusum*	LC
Onagraceae	*Epilobium hirsutum*	LC
Onagraceae	*Epilobium minutiflorum*	LC
Onagraceae	*Epilobium palustre*	LC
Onagraceae	*Epilobium parviflorum*	LC
Onagraceae	*Ludwigia palustris*	LC
Onagraceae	*Ludwigia stolonifera*	LC
Trapaceae	*Trapa natans*	LC

Order	Nymphaeales	
Family	Species	RL
Ceratophyllaceae	*Ceratophyllum demersum*	LC
Ceratophyllaceae	*Ceratophyllum muricatum*	LC
Ceratophyllaceae	*Ceratophyllum submersum*	LC
Nymphaeaceae	*Nuphar lutea*	LC
Nymphaeaceae	*Nymphaea alba*	LC

Order	Polygonales	
Family	Species	RL
Polygonaceae	*Persicaria amphibia*	LC
Polygonaceae	*Persicaria hydropiper*	LC
Polygonaceae	*Persicaria salicifolia*	LC
Polygonaceae	*Polygonum cappadocium*	DD *
Polygonaceae	*Rumex bithynicus*	EN *

Appendix 2.4 cont'd, Freshwater plants

Polygonaceae	*Rumex hydrolapathum*	LC
Polygonaceae	*Rumex palustris*	LC

Order	Primulales	
Family	Species	RL
Primulaceae	*Hottonia palustris*	LC
Primulaceae	*Lysimachia dubia*	LC
Primulaceae	*Lysimachia nummularia*	LC
Primulaceae	*Lysimachia punctata*	LC
Primulaceae	*Lysimachia vulgaris*	LC
Primulaceae	*Primula auriculata*	LC
Primulaceae	*Samolus valerandi*	LC

Order	Ranunculales	
Family	Species	RL
Ranunculaceae	*Caltha palustris*	LC
Ranunculaceae	*Ranunculus aquatilis*	LC
Ranunculaceae	*Ranunculus cornutus*	LC
Ranunculaceae	*Ranunculus flammula*	LC
Ranunculaceae	*Ranunculus lateriflorus*	LC
Ranunculaceae	*Ranunculus lingua*	LC
Ranunculaceae	*Ranunculus ophioglossifolius*	LC
Ranunculaceae	*Ranunculus peltatus*	LC
Ranunculaceae	*Ranunculus rionii*	LC
Ranunculaceae	*Ranunculus saniculifolius*	LC
Ranunculaceae	*Ranunculus schweinfurthii*	VU *
Ranunculaceae	*Ranunculus sphaerospermus*	LC
Ranunculaceae	*Ranunculus thracicus*	VU (draft)
Ranunculaceae	*Ranunculus trichophyllus*	LC

Order	Rosales	
Family	Species	RL
Parnassiaceae	*Parnassia palustris*	LC
Rosaceae	*Alchemilla bursensis*	NT *
Rosaceae	*Alchemilla stricta*	LC *
Rosaceae	*Filipendula ulmaria*	LC
Rosaceae	*Potentilla palustris*	LC
Rosaceae	*Potentilla supina*	LC

Order	Rubiales	
Family	Species	RL
Rubiaceae	*Galium debile*	LC
Rubiaceae	*Galium palustre*	LC
Rubiaceae	*Galium uliginosum*	LC
Rubiaceae	*Oldenlandia capensis*	LC

Order	Salicales	
Family	Species	RL
Salicaceae	*Salix alba*	LC
Salicaceae	*Salix amplexicaulis*	LC
Salicaceae	*Salix cinerea*	LC
Salicaceae	*Salix excelsa*	LC

Order	Sapindales	
Family	Species	RL
Zygophyllaceae	*Nitraria schoberi*	LC

Order	Scrophulariales	
Family	Species	RL
Lentibulariaceae	*Utricularia australis*	LC
Lentibulariaceae	*Utricularia gibba*	LC
Lentibulariaceae	*Utricularia minor*	LC
Lentibulariaceae	*Utricularia vulgaris*	LC
Scrophulariaceae	*Gratiola officinalis*	LC
Scrophulariaceae	*Limnophila indica*	LC
Scrophulariaceae	*Limosella aquatica*	LC
Scrophulariaceae	*Lindernia diffusa*	LC
Scrophulariaceae	*Lindernia procumbens*	LC
Scrophulariaceae	*Pedicularis palustris*	LC
Scrophulariaceae	*Rhamphicarpa medwedewii*	DD
Scrophulariaceae	*Scrophularia umbrosa*	LC
Scrophulariaceae	*Veronica anagallis-aquatica*	LC
Scrophulariaceae	*Veronica anagalloides*	LC
Scrophulariaceae	*Veronica beccabunga*	LC
Scrophulariaceae	*Veronica catenata*	LC
Scrophulariaceae	*Veronica scutellata*	LC

Order	Solanales	
Family	Species	RL
Menyanthaceae	*Menyanthes trifoliata*	LC
Menyanthaceae	*Nymphoides indica*	LC
Menyanthaceae	*Nymphoides peltata*	LC

Order	Theales	
Family	Species	RL
Elatinaceae	*Elatine alsinastrum*	NT
Elatinaceae	*Elatine ambigua*	LC
Elatinaceae	*Elatine macropoda*	LC

Order	Violales	
Family	Species	RL
Tamaricaceae	*Tamarix kotschyi*	LC
Tamaricaceae	*Tamarix mascatensis*	LC
Tamaricaceae	*Tamarix nilotica*	LC
Tamaricaceae	*Tamarix octandra*	LC
Tamaricaceae	*Tamarix parviflora*	LC
Tamaricaceae	*Tamarix ramosissima*	LC
Tamaricaceae	*Tamarix tetragyna*	LC
Tamaricaceae	*Tamarix tetrandra*	LC

Class	Polypodiopsida	
Order	Osmundales	
Family	Species	RL
Osmundaceae	*Osmunda regalis*	LC

Order	Polypodiales	
Family	Species	RL
Thelypteridaceae	*Thelypteris palustris*	LC

Order	Salviniales	
Family	Species	RL
Marsileaceae	*Marsilea quadrifolia*	LC
Marsileaceae	*Pilularia minuta*	EN
Salviniaceae	*Salvinia natans*	LC

2.5 Freshwater birds

Order	Accipitriformes	
Family	Species	RL
Accipitridae	*Accipiter brevipes*	LC
Accipitridae	*Accipiter nisus*	LC
Accipitridae	*Aquila fasciata*	LC
Accipitridae	*Aquila heliaca*	VU
Accipitridae	*Buteo buteo*	LC
Accipitridae	*Buteo lagopus*	LC
Accipitridae	*Circus aeruginosus*	LC
Accipitridae	*Circus cyaneus*	LC
Accipitridae	*Circus macrourus*	NT
Accipitridae	*Circus pygargus*	LC
Accipitridae	*Clanga clanga*	VU
Accipitridae	*Haliaeetus albicilla*	LC
Accipitridae	*Milvus migrans*	LC
Accipitridae	*Neophron percnopterus*	EN
Pandionidae	*Pandion haliaetus*	LC

Order	Anseriformes	
Family	Species	RL
Anatidae	*Anas crecca*	LC
Anatidae	*Anas platyrhynchos*	LC
Anatidae	*Anser anser*	LC
Anatidae	*Anser erythropus*	VU
Anatidae	*Anser fabalis*	LC
Anatidae	*Aythya ferina*	LC
Anatidae	*Aythya fuligula*	LC
Anatidae	*Aythya marila*	LC
Anatidae	*Aythya nyroca*	NT
Anatidae	*Branta ruficollis*	EN
Anatidae	*Bucephala clangula*	LC
Anatidae	*Cygnus columbianus*	LC
Anatidae	*Cygnus cygnus*	LC
Anatidae	*Cygnus olor*	LC
Anatidae	*Mareca penelope*	LC
Anatidae	*Mareca strepera*	LC
Anatidae	*Marmaronetta angustirostris*	VU
Anatidae	*Melanitta fusca*	EN
Anatidae	*Mergellus albellus*	LC
Anatidae	*Mergus merganser*	LC
Anatidae	*Mergus serrator*	LC
Anatidae	*Netta rufina*	LC
Anatidae	*Oxyura leucocephala*	EN
Anatidae	*Spatula querquedula*	LC
Anatidae	*Tadorna ferruginea*	LC
Anatidae	*Tadorna tadorna*	LC

Order	Caprimulgiformes	
Family	Species	RL
Apodidae	*Apus apus*	LC
Apodidae	*Tachymarptis melba*	LC
Caprimulgidae	*Caprimulgus nubicus*	LC

Order	Charadriiformes	
Family	Species	RL
Charadriidae	*Charadrius alexandrinus*	LC
Charadriidae	*Charadrius dubius*	LC
Charadriidae	*Charadrius hiaticula*	LC
Charadriidae	*Charadrius leschenaultii*	LC
Charadriidae	*Charadrius mongolus*	LC
Charadriidae	*Pluvialis apricaria*	LC
Charadriidae	*Pluvialis squatarola*	LC
Charadriidae	*Vanellus indicus*	LC
Charadriidae	*Vanellus leucurus*	LC
Charadriidae	*Vanellus spinosus*	LC
Glareolidae	*Glareola nordmanni*	NT
Glareolidae	*Glareola pratincola*	LC
Haematopodidae	*Haematopus ostralegus*	LC
Laridae	*Chlidonias hybrida*	LC
Laridae	*Chlidonias leucopterus*	LC
Laridae	*Chlidonias niger*	LC
Laridae	*Gelochelidon nilotica*	LC
Laridae	*Hydrocoloeus minutus*	LC
Laridae	*Hydroprogne caspia*	LC
Laridae	*Larus argentatus*	LC
Laridae	*Larus cachinnans*	LC
Laridae	*Larus canus*	LC
Laridae	*Larus genei*	LC
Laridae	*Larus ichthyaetus*	LC
Laridae	*Larus melanocephalus*	LC
Laridae	*Larus michahellis*	LC
Laridae	*Larus ridibundus*	LC
Laridae	*Sterna hirundo*	LC
Laridae	*Sternula albifrons*	LC
Recurvirostridae	*Himantopus himantopus*	LC
Recurvirostridae	*Recurvirostra avosetta*	LC
Rostratulidae	*Rostratula benghalensis*	LC
Scolopacidae	*Actitis hypoleucos*	LC
Scolopacidae	*Arenaria interpres*	LC
Scolopacidae	*Calidris alba*	LC
Scolopacidae	*Calidris alpina*	LC
Scolopacidae	*Calidris ferruginea*	LC
Scolopacidae	*Calidris minuta*	LC
Scolopacidae	*Calidris temminckii*	LC
Scolopacidae	*Gallinago media*	NT
Scolopacidae	*Limosa lapponica*	LC
Scolopacidae	*Limosa limosa*	NT
Scolopacidae	*Lymnocryptes minimus*	LC
Scolopacidae	*Numenius arquata*	NT
Scolopacidae	*Numenius phaeopus*	LC
Scolopacidae	*Numenius tenuirostris*	CR
Scolopacidae	*Steganopus tricolor*	LC
Scolopacidae	*Tringa erythropus*	LC
Scolopacidae	*Tringa nebularia*	LC
Scolopacidae	*Tringa ochropus*	LC
Scolopacidae	*Tringa stagnatilis*	LC
Scolopacidae	*Tringa totanus*	LC

Order	Ciconiiformes	
Family	Species	RL
Ciconiidae	*Ciconia ciconia*	LC
Ciconiidae	*Ciconia nigra*	LC

Order	Columbiformes	
Family	Species	RL
Columbidae	*Spilopelia senegalensis*	LC

Order	Coraciiformes	
Family	Species	RL
Alcedinidae	*Alcedo atthis*	LC
Alcedinidae	*Ceryle rudis*	LC
Alcedinidae	*Halcyon smyrnensis*	LC
Meropidae	*Merops apiaster*	LC
Meropidae	*Merops orientalis*	LC
Meropidae	*Merops persicus*	LC

Appendix 2.5 cont'd, Freshwater birds

Order	Cuculiformes	
Family	Species	RL
Cuculidae	*Clamator glandarius*	LC
Cuculidae	*Cuculus canorus*	LC

Order	Falconiformes	
Family	Species	RL
Falconidae	*Falco cherrug*	EN
Falconidae	*Falco peregrinus*	LC
Falconidae	*Falco subbuteo*	LC
Falconidae	*Falco vespertinus*	NT

Order	Gaviiformes	
Family	Species	RL
Gaviidae	*Gavia arctica*	LC
Gaviidae	*Gavia stellata*	LC

Order	Gruiformes	
Family	Species	RL
Gruidae	*Anthropoides virgo*	LC
Gruidae	*Grus grus*	LC
Rallidae	*Crex crex*	LC
Rallidae	*Fulica atra*	LC
Rallidae	*Gallinula chloropus*	LC
Rallidae	*Porphyrio porphyrio*	LC
Rallidae	*Porzana porzana*	LC
Rallidae	*Rallus aquaticus*	LC
Rallidae	*Zapornia parva*	LC
Rallidae	*Zapornia pusilla*	LC

Order	Passeriformes	
Family	Species	RL
Aegithalidae	*Aegithalos caudatus*	LC
Alaudidae	*Alauda arvensis*	LC
Alaudidae	*Alauda gulgula*	LC
Alaudidae	*Eremalauda dunni*	LC
Cinclidae	*Cinclus cinclus*	LC
Cisticolidae	*Cisticola juncidis*	LC
Cisticolidae	*Scotocerca inquieta*	LC
Corvidae	*Corvus corone*	LC
Corvidae	*Corvus rhipidurus*	LC
Corvidae	*Corvus ruficollis*	LC
Emberizidae	*Emberiza schoeniclus*	LC
Fringillidae	*Carduelis carduelis*	LC
Fringillidae	*Carpodacus erythrinus*	LC
Hirundinidae	*Delichon urbicum*	LC
Hirundinidae	*Hirundo daurica*	LC
Hirundinidae	*Hirundo obsoleta*	LC
Hirundinidae	*Hirundo rupestris*	LC
Hirundinidae	*Hirundo rustica*	LC
Hirundinidae	*Riparia riparia*	LC
Laniidae	*Lanius collurio*	LC
Laniidae	*Lanius excubitor*	LC
Laniidae	*Lanius isabellinus*	LC
Motacillidae	*Anthus cervinus*	LC
Motacillidae	*Anthus pratensis*	LC
Motacillidae	*Anthus spinoletta*	LC
Motacillidae	*Motacilla alba*	LC
Motacillidae	*Motacilla cinerea*	LC
Motacillidae	*Motacilla citreola*	LC
Motacillidae	*Motacilla flava*	LC
Muscicapidae	*Erythropygia galactotes*	LC
Muscicapidae	*Luscinia luscinia*	LC
Muscicapidae	*Luscinia svecica*	LC
Muscicapidae	*Oenanthe chrysopygia*	LC
Muscicapidae	*Oenanthe moesta*	LC
Muscicapidae	*Oenanthe monacha*	LC
Muscicapidae	*Oenanthe oenanthe*	LC
Muscicapidae	*Saxicola torquatus*	LC
Nectariniidae	*Nectarinia osea*	LC
Paridae	*Parus montanus*	LC
Paridae	*Parus palustris*	LC
Passeridae	*Passer moabiticus*	LC
Pycnonotidae	*Pycnonotus leucotis*	LC
Pycnonotidae	*Pycnonotus xanthopygos*	LC
Remizidae	*Remiz pendulinus*	LC
Sittidae	*Sitta tephronota*	LC
Sylviidae	*Acrocephalus agricola*	LC
Sylviidae	*Acrocephalus arundinaceus*	LC
Sylviidae	*Acrocephalus dumetorum*	LC
Sylviidae	*Acrocephalus griseldis*	EN
Sylviidae	*Acrocephalus melanopogon*	LC
Sylviidae	*Acrocephalus palustris*	LC
Sylviidae	*Acrocephalus schoenobaenus*	LC
Sylviidae	*Acrocephalus scirpaceus*	LC
Sylviidae	*Acrocephalus stentoreus*	LC
Sylviidae	*Cettia cetti*	LC
Sylviidae	*Hippolais rama*	LC
Sylviidae	*Locustella fluviatilis*	LC
Sylviidae	*Locustella luscinioides*	LC
Sylviidae	*Locustella naevia*	LC
Sylviidae	*Phylloscopus sindianus*	LC
Sylviidae	*Phylloscopus trochiloides*	LC
Sylviidae	*Phylloscopus trochilus*	LC
Sylviidae	*Sylvia conspicillata*	LC
Sylviidae	*Sylvia curruca*	LC
Timaliidae	*Panurus biarmicus*	LC
Timaliidae	*Turdoides altirostris*	LC *

Order	Pelecaniformes	
Family	Species	RL
Ardeidae	*Ardea alba*	LC
Ardeidae	*Ardea cinerea*	LC
Ardeidae	*Ardea goliath*	LC
Ardeidae	*Ardea purpurea*	LC
Ardeidae	*Ardeola ralloides*	LC
Ardeidae	*Botaurus stellaris*	LC
Ardeidae	*Bubulcus ibis*	LC
Ardeidae	*Egretta garzetta*	LC
Ardeidae	*Egretta gularis*	LC
Ardeidae	*Ixobrychus minutus*	LC
Ardeidae	*Nycticorax nycticorax*	LC
Pelecanidae	*Pelecanus crispus*	VU
Pelecanidae	*Pelecanus onocrotalus*	LC
Threskiornithidae	*Platalea leucorodia*	LC
Threskiornithidae	*Plegadis falcinellus*	LC
Threskiornithidae	*Threskiornis aethiopicus*	LC

Order	Phoenicopteriformes	
Family	Species	RL
Phoenicopteridae	*Phoenicopterus roseus*	LC

Order	Piciformes	
Family	Species	RL
Picidae	*Dendrocopos leucotos*	LC
Picidae	*Dryobates minor*	LC

Appendix 2.5 cont'd, Freshwater birds

Order	Podicipediformes	
Family	Species	RL
Podicipedidae	*Podiceps auritus*	LC
Podicipedidae	*Podiceps cristatus*	LC
Podicipedidae	*Podiceps grisegena*	LC
Podicipedidae	*Podiceps nigricollis*	LC
Podicipedidae	*Tachybaptus ruficollis*	LC

Order	Psittaciformes	
Family	Species	RL
Psittacidae	*Psittacula krameri*	LC

Order	Pterocliformes	
Family	Species	RL
Pteroclidae	*Pterocles lichtensteinii*	LC
Pteroclidae	*Pterocles senegallus*	LC

Order	Strigiformes	
Family	Species	RL
Strigidae	*Asio flammeus*	LC
Strigidae	*Bubo ascalaphus*	LC
Strigidae	*Glaucidium passerinum*	LC
Strigidae	*Ketupa zeylonensis*	LC
Tytonidae	*Tyto alba*	LC

Order	Suliformes	
Family	Species	RL
Anhingidae	*Anhinga rufa*	LC
Phalacrocoracidae	*Microcarbo pygmaeus*	LC
Phalacrocoracidae	*Phalacrocorax aristotelis*	LC
Phalacrocoracidae	*Phalacrocorax carbo*	LC

2.6 Freshwater amphibians

Order	Anura	
Family	Species	RL
Alytidae	*Latonia nigriventer*	CR *
Bombinatoridae	*Bombina bombina*	LC
Bufonidae	*Bufo bufo*	LC
Bufonidae	*Bufo eichwaldi*	VU *
Bufonidae	*Bufo verrucosissimus*	NT
Bufonidae	*Pseudepidalea luristanica*	LC
Bufonidae	*Pseudepidalea surda*	LC
Bufonidae	*Pseudepidalea variabilis*	DD
Hylidae	*Hyla arborea*	LC
Hylidae	*Hyla heinzsteinitzi*	CR *
Hylidae	*Hyla savignyi*	LC
Pelobatidae	*Pelobates syriacus*	LC
Pelodytidae	*Pelodytes caucasicus*	NT
Ranidae	*Pelophylax bedriagae*	LC
Ranidae	*Pelophylax caralitanus*	NT *
Ranidae	*Pelophylax ridibundus*	LC
Ranidae	*Rana dalmatina*	LC
Ranidae	*Rana holtzi*	CR *
Ranidae	*Rana macrocnemis*	LC
Ranidae	*Rana pseudodalmatina*	LC
Ranidae	*Rana tavasensis*	EN *

Order	Caudata	
Family	Species	RL
Salamandridae	*Lissotriton vulgaris*	LC
Salamandridae	*Mertensiella caucasica*	VU *
Salamandridae	*Neurergus crocatus*	VU *
Salamandridae	*Neurergus kaiseri*	CR *
Salamandridae	*Neurergus microspilotus*	CR *
Salamandridae	*Neurergus strauchii*	VU *
Salamandridae	*Ommatotriton ophryticus*	NT
Salamandridae	*Ommatotriton vittatus*	LC *
Salamandridae	*Salamandra infraimmaculata*	NT *
Salamandridae	*Triturus karelinii*	LC

2.7 Freshwater mammals

Order	Carnivora	
Family	Species	RL
Mustelidae	*Lutra lutra*	NT
Mustelidae	*Lutrogale perspicillata*	VU
Phocidae	*Pusa caspica*	EN

Order	Eulipotyphla	
Family	Species	RL
Soricidae	*Neomys anomalus*	LC
Soricidae	*Neomys fodiens*	LC
Soricidae	*Neomys teres*	LC

Order	Rodentia	
Family	Species	RL
Cricetidae	*Arvicola amphibius*	LC
Muridae	*Nesokia bunnii*	EN *

2.8 Freshwater decapods

Order	Decapoda	
Family	Species	RL
Astacidae	*Astacus astacus*	VU
Astacidae	*Astacus leptodactylus*	LC
Astacidae	*Austropotamobius torrentium*	DD
Atyidae	*Atyaephyra orientalis*	LC *
Atyidae	*Atyaephyra tuerkayi*	DD *
Atyidae	*Caridina babaulti*	LC
Atyidae	*Caridina fossarum*	LC
Palaemonidae	*Palaemonetes antennarius*	LC
Palaemonidae	*Palaemonetes mesopotamicus*	CR *
Palaemonidae	*Palaemonetes turcorum*	DD *
Typhlocarididae	*Typhlocaris ayyaloni*	EN *
Typhlocarididae	*Typhlocaris galilea*	EN *

Appendix 3. Number of freshwater species for each taxonomic group by country of the Eastern Mediterranean region

Note: The numbers excludes cases where a species is recorded as Origin Introduced or Vagrant. Also, these numbers are likely to be an underestimate of true diversity of freshwater species in each country, they are taken from the IUCN Red List assessment classification schemes included within each species Red List assessment (see www.iucnredlist.org).
* Denotes those countries where only a part of their territory is included in the analysis (see Figure 2.1).

		Armenia	Azerbaijan	Georgia*	Iran*	Iraq	Israel	Jordan	Kuwait	Lebanon	Palestine	Syria	Turkey
All species	All species	329	376	430	562	403	392	294	180	358	287	441	989
	Threatened species	18	24	22	38	26	33	17	5	23	13	51	171
	DD species	5	6	5	15	10	5	3	0	7	0	10	37
	EX/EW species	0	1	0	1	0	2	0	0	0	0	0	4
	LC/NT species	306	345	403	508	367	352	274	175	328	274	380	777
	EX/EW species	0	1	0	1	0	2	0	0	0	0	0	4
	% Threatened (of extant & suff. Info species)	5.6	6.5	5.2	7.0	6.6	8.6	5.8	2.8	6.6	4.5	11.8	18.0
	% DD (of all species)	1.5	1.6	1.2	2.7	2.5	1.3	1.0	0.0	2.0	0.0	2.3	3.7
	Extinct or Poss Extinct from the country	1	1	0	2	3	15	4	0	2	3	13	17
	% extirpated (of all species)	0.3	0.3	0.0	0.4	0.7	3.8	1.4	0.0	0.6	1.0	2.9	1.7
Fishes	All species	29	54	61	84	39	36	14	3	20	17	75	265
	Threatened species	4	10	7	15	8	9	4	0	3	0	24	98
	DD species	0	2	0	2	1	0	0	0	0	0	1	11
	EX/EW species	0	1	0	1	0	2	0	0	0	0	0	4
	Extinct or Poss Extinct from the country	1	1	0	1	1	4	0	0	0	0	7	8
Plants	All species	76	73	150	156	105	82	57	10	114	93	93	306
	Threatened species	0	0	0	1	0	0	0	0	1	0	1	7
	DD species	1	1	3	0	0	1	0	0	1	0	1	6
	EX/EW species	0	0	0	0	0	0	0	0	0	0	0	0
	Extinct or Poss Extinct from the country	0	0	0	0	0	0	0	0	0	0	0	2
Odonata	All species	50	49	53	66	38	56	41	10	41	28	55	96
	Threatened species	2	1	2	3	2	6	3	0	5	3	6	6
	DD species	2	1	1	4	3	0	0	0	1		1	3
	EX/EW species	0	0	0	0	0	0	0	0	0	0	0	0
	Extinct or Poss Extinct from the country	0	0	0	1	1	3	0	0	0	1	2	0

		Armenia	Azerbaijan	Georgia*	Iran*	Iraq	Israel	Jordan	Kuwait	Lebanon	Palestine	Syria	Turkey
Molluscs	All species	9	8	10	23	14	22	14	1	27	7	32	93
	Threatened species	2	1	2	1	1	6	5	0	8	3	10	42
	DD species	1	1	0	8	5	3	2	0	3	0	5	14
	EX/EW species	0	0	0	0	0	0	0	0	0	0	0	0
	Extinct or Poss Extinct from the country	0	0	0	0	0	5	0	0	1	1	2	6
Birds	All species	153	176	139	207	192	182	161	156	146	140	174	194
	Threatened species	10	10	9	12	11	8	5	5	6	6	9	11
	DD species	0	0	0	0	0	0	0	0	0	0	0	0
	EX/EW species	0	0	0	0	0	0	0	0	0	0	0	0
	Extinct or Poss Extinct from the country	0	0	0	0	1	2	3	0	1	0	2	1
Mammals	All species	3	4	3	6	4	2	1	0	1	0	2	5
	Threatened species	0	1	0	2	2	0	0	0	0	0	0	0
	DD species	0	0	0	0	0	0	0	0	0	0	0	0
	EX/EW species	0	0	0	0	0	0	0	0	0	0	0	0
	Extinct or Poss Extinct from the country	0	0	0	0	0	0	0	0	0	0	0	0
Amphibians	All species	9	11	12	16	9	8	5	0	7	2	7	24
	Threatened species	0	1	1	4	2	2	0	0	0	1	0	6
	DD species	1	1	1	1	1	1	1	0	1	0	1	1
	EX/EW species	0	0	0	0	0	0	0	0	0	0	0	0
	Extinct or Poss Extinct from the country	0	0	0	0	0	1	1	0	0	1	0	0
Decapods	All species	0	1	2	4	2	4	1	0	2	0	3	6
	Threatened species	0	0	1	0	0	2	0	0	0	0	1	1
	DD species	0	0	0	0	0	0	0	0	1	0	1	2
	EX/EW species	0	0	0	0	0	0	0	0	0	0	0	0
	Extinct or Poss Extinct from the country	0	0	0	0	0	0	0	0	0	0	0	0

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