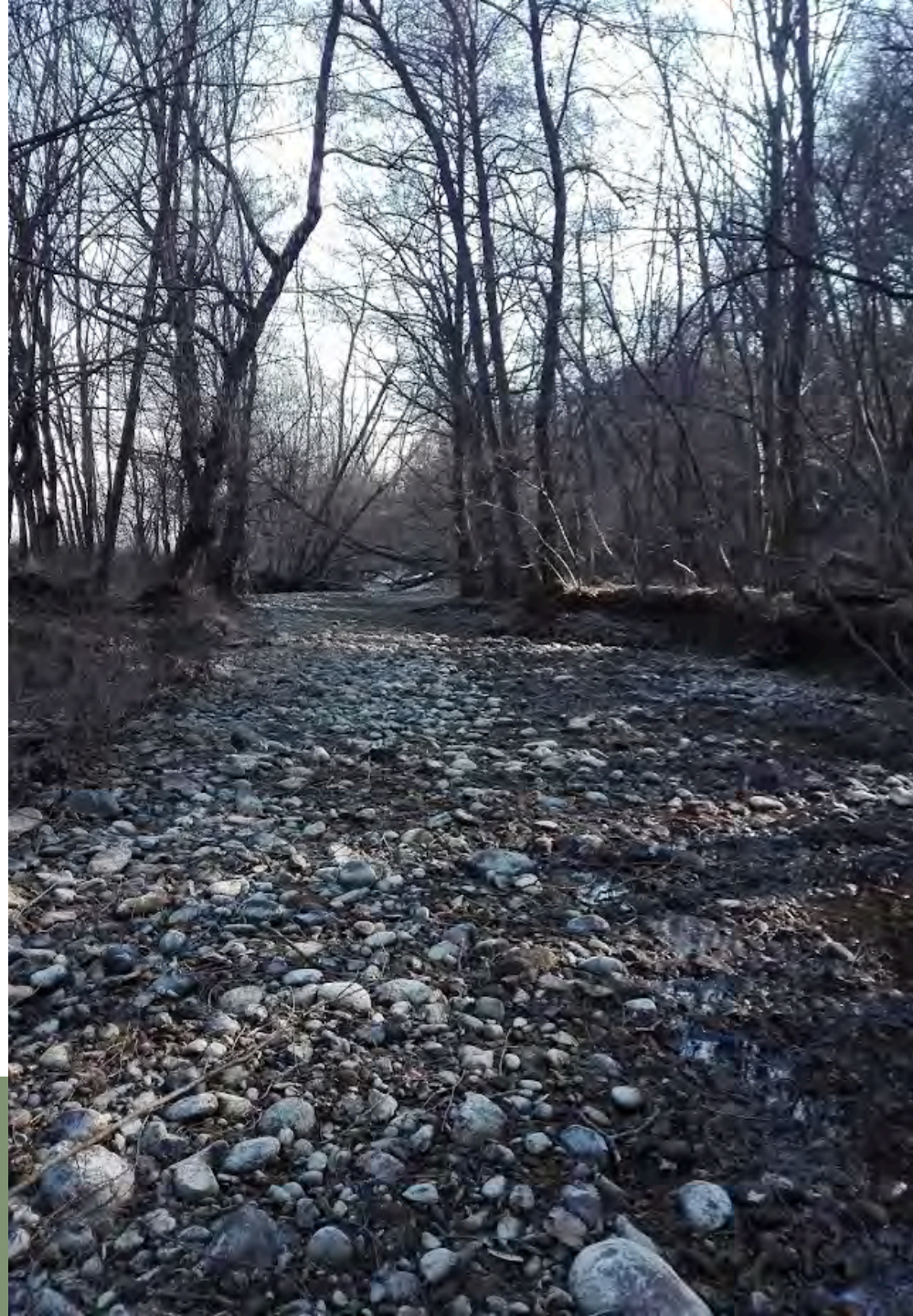
Dead Fish Walking

Origine e declino dei pesci del Po



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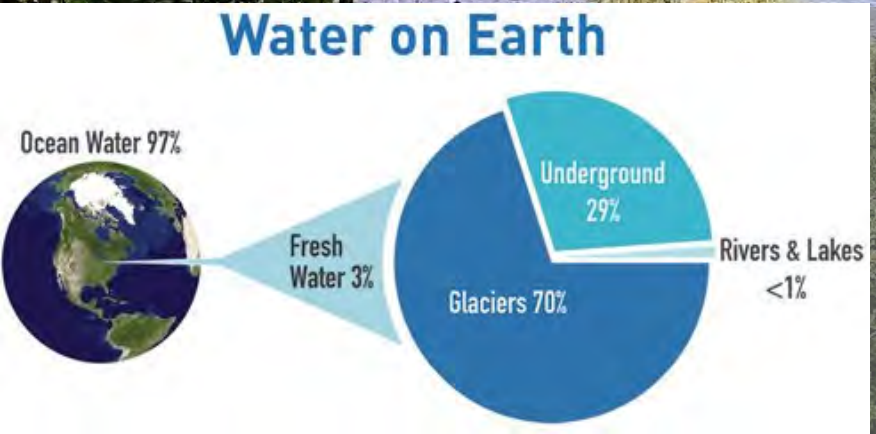


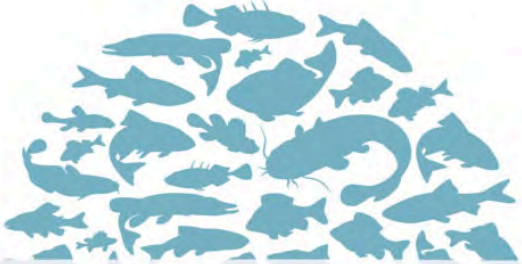
Freshwater, as a whole i.e. glaciers, groundwater, lakes and rivers, accounts for less than 3 % of the hydrosphere.

Lakes and rivers, which account for less than 0,01 % of the hydrosphere, are home to more than 10 % of known species

Balian et al., 2008

1%

OF AQUATIC HABITAT IS FRESHWATER



51%

OF KNOWN FISH SPECIES ARE FOUND IN FRESHWATER

Why?

I bacini idrografici sono separati tra loro da diverse migliaia di anni, alcuni anche da più di 1 mya. Per questo motivo ogni bacino ha comunità ittiche esclusive (eccetto le specie migratrici)

La situazione Italiana

- In Italia sono attualmente riconosciute 101 diverse specie, di cui il 50% alloctone (Bianco, 2013)

- La fauna ittica italiana è ricchissima di specie endemiche in gran parte differenziatesi per isolamento geografico durante le dinamiche glaciali pleistoceniche.

- Sono riconosciuti in Italia almeno tre diversi distretti ittio-geografici (Bianco 2013) caratterizzati da particolari specie endemiche: Padano – Veneto; Tosco –Laziale e Apulo –Campano

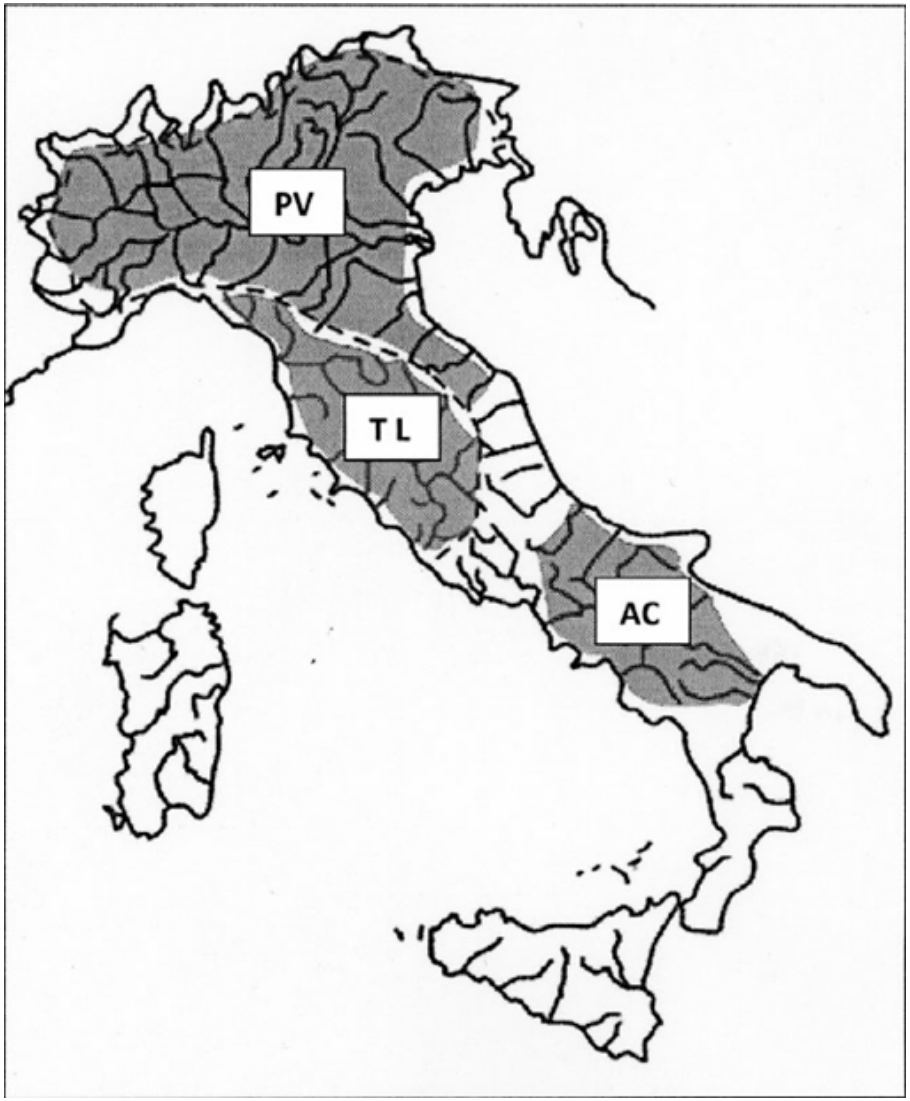


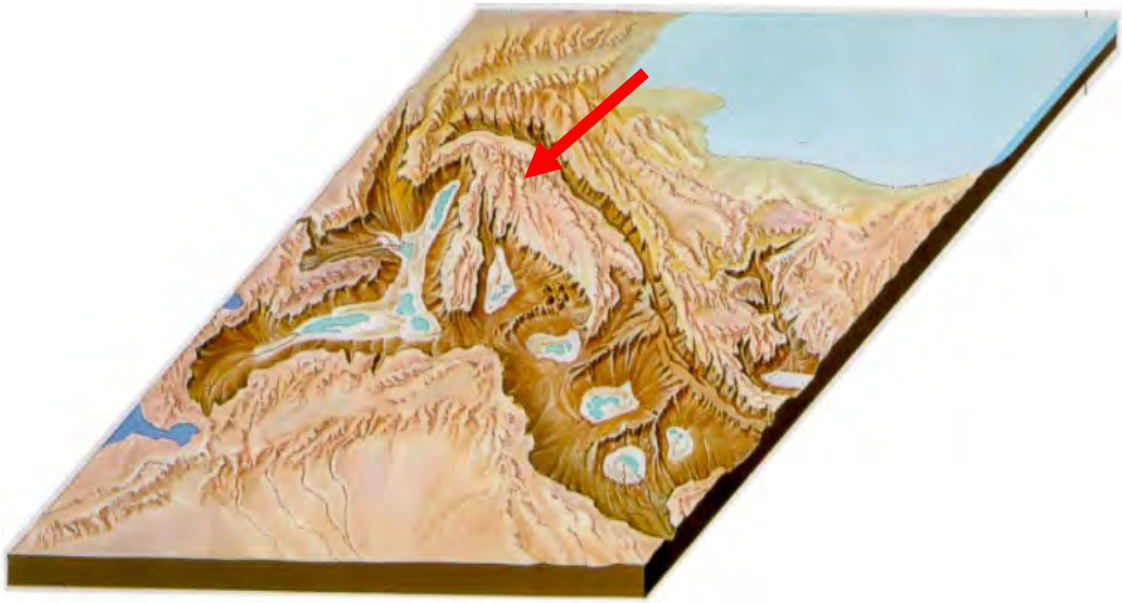
Fig. 3. Approximate delimitation of Italian ichthyogeographic districts: PV: Padany-Venetian; TA; Tuscany-Latium; AC; Apulia-Campania

Il paleo bacino del fiume Po nel periodo glaciale pleistocenico (18.000 anni fa).

Il distretto Padano - Veneto comprende l'intera Italia Settentrionale, la gran parte delle Marche, il versante adriatico della Slovenia e la maggior parte di quello adriatico della Croazia; quest'area corrisponde al bacino del Fiume Po durante l'ultimo periodo glaciale pleistocenico

Origine dell'ittiofauna indigena delle acque interne italiane - 1

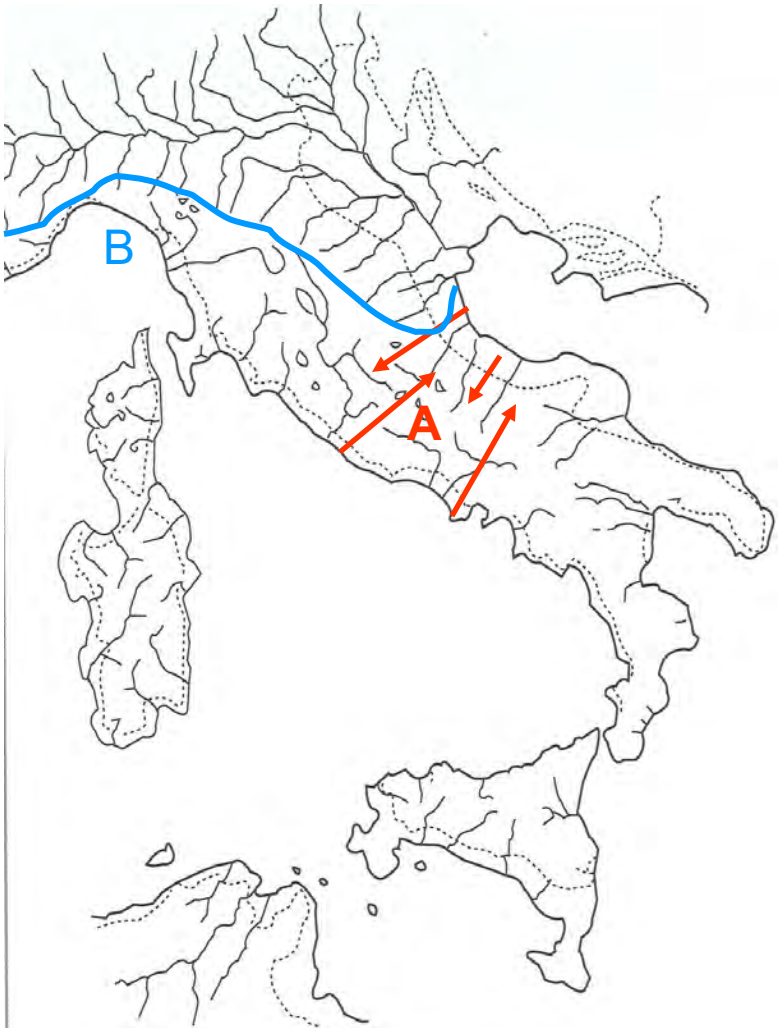
I primi processi di speciazione avvennero, probabilmente, durante la "crisi di salinità del Mediterraneo" del Messiniano, Miocene (5 Mya), a partire da *taxa* stenoalini di origine danubiana. Questi *taxa* sono noti come "elementi primari". In questo periodo il bacino del Mediterraneo "disseccato" venne invaso da acque dolci o oligosaline provenienti dalla Paratetide (Mare Sarmatico)



Antichi fossili viventi

Lampetra zanandreai e *Acipenser naccarii* si sono probabilmente separati dai loro ancestori durante il Miocene Medio (15 – 13 Mya) attraverso la connessione adriatico – pannonica. Queste specie potrebberoessere tra le più antiche dell'ittiofauna italiana. In particolare la *L. zanandreai è* un relitto legato a un gruppo di specie ampiamente diffuso in passato e poi sostituito quasi ovunque in Europa da altri gruppi di lamprede

Origine dell'ittiofauna indigena delle acque interne italiane - 2



I maggiori eventi speciativi avvennero in massima parte durante le regressioni quaternarie (Pleistocene), in particolare durante quella würmiana (15.000 – 10.000 anni fa), che consentirono l'emersione del bacino del fiume Po fino al bordo della fossa meso-adriatica assieme ai fenomeni di tettonica nell'area appenninica. Tali fenomeni misero in contatto bacini dell'area adriatica con quelli dell'area tirrenica (A) e, parallelamente, isolarono i bacini dell'Italia peninsulare da queli dell'Italia continentale (settore padano) (B).

Origine dell'ittiofauna indigena delle acque interne italiane - 3

Durante la massima glaciazione würmiana avvennero scambi continentali di ittiofaune primari con l' area pannonica e danubiana.

Distretti ittiogeografici
(Gandolfi & Zerunian, 1987)

REGIONE PADANA con **8 endemismi**, **10 subendemismi**

- **Specie termofile fredde**, in comune con area danubiana
- **Taxa endemici di origine messiniana e** altri di origine **danubiana** (intr.epoca romana) adattate a acque temperate (es. *Perca fluviatils*)
- **Specie eurialine** o di origine marine di origine pannonica o messiniana (ad eccezione della trota marmorata e del carpione)

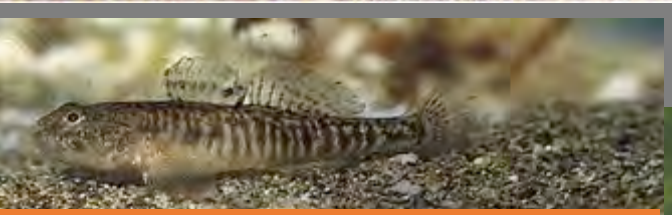
REGIONE ITALICO-PENINSULARE con 4 endemismi

- **Specie avventizie balcaniche**
- **Specie messiniane**
- **Specie introdotte dalla Regione Padana**

Specie endemiche della Regione Padana (Distretto PV)

Lampreda padana *Lampetra zanandreai*

Savetta *Chondrostoma soetta*


Panzarolo *Knipowitschia punctatissima*

Triotto
Rutilus herythrophtalmus

Cobite mascherato
Sabanejewia larvata

Ghiozzo padano *Padogobius martensi*

Carpione del Garda
Salmo carpio

Ghiozzetto cenerino
Pomatoschistus canestrini

Specie subendemiche della Regione Padana (Distretto PV)

Sono taxa cha hanno avuto origine evolutiva in questa regione ed hanno poi esteso il loro areale in distretti ittiogeografici vicini.

Storione cobice *Acipenser naccarii*

Trota marmorata *Salmo (trutta) marmoratus*

Lasca *Chhondrostoma genei*

Alborella *Alburnus a. alborella*

Cobite *Cobitis taenia*

Barbo canino *Barbus meridionalis*

Barbo italiano *Barbus plebejus*

Vairone *Leuciscus souffia muticellus*

Ghiozzetto di laguna *Knipowitschia panizzae*

Specie endemiche della Regione Italico-peninsulare (Distretto TL)

Barbo tiberino *Barbus tyberinus.*

Alborella meridionale *Alburnus albidus*

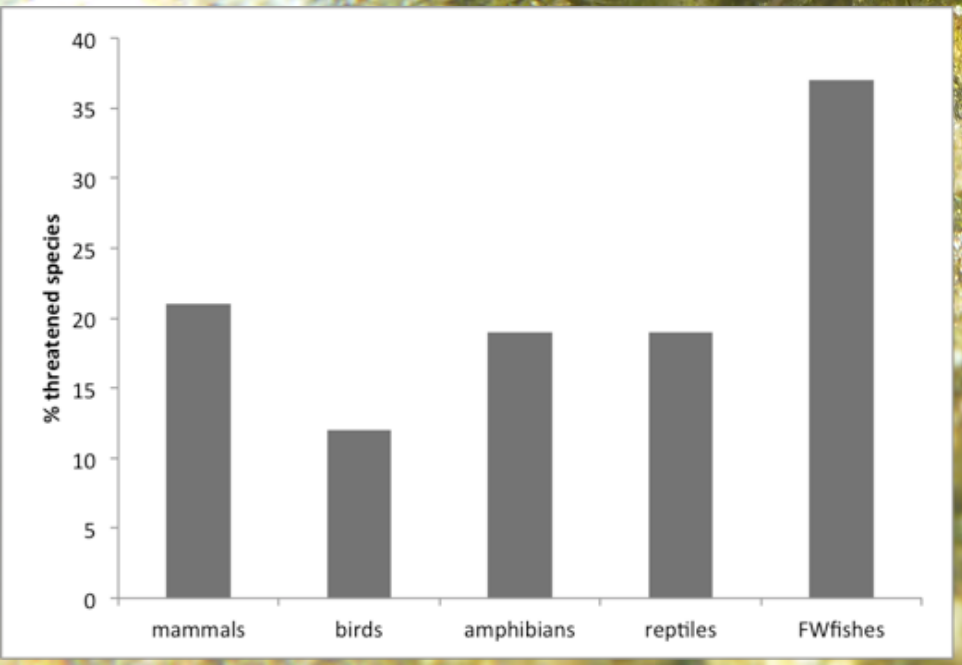
Rovella *Rutilus rubilo*

Cavedano do ruscello *Squalius lucumonis*

Carpione del Fibreno *Salmo fibreni*

Ghiozzo di ruscello *Gobius nigricans*

I pesci delle acque interne sono riconosciuti come il gruppo di animali maggiormente a rischio di estinzione di tutto il pianeta (IUCN, 2011)
Oltre il 37 % delle specie conosciute è a rischio



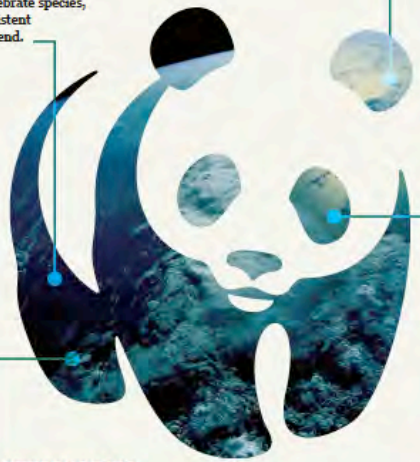
LIVING PLANET REPORT 2016

RISKS

Our use of natural resources has grown dramatically, particularly since the mid-20th century, so that we are endangering the key environmental systems that we rely upon.

BIODIVERSITY

The Living Planet Index, which measures biodiversity abundance levels based on 14,152 monitored populations of 3,706 vertebrate species, shows a persistent downward trend.



ANTHROPOCENE

Scientists propose that, as a result of human activity, we have transitioned from the Holocene into a new geological epoch: the "Anthropocene".

RESILIENCE

The 21st century presents humanity with a dual challenge to maintain nature in all of its many forms and functions and to create an equitable home for people on a finite planet.

100% RECYCLED

Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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ZSL LET'S WORK FOR WILDLIFE

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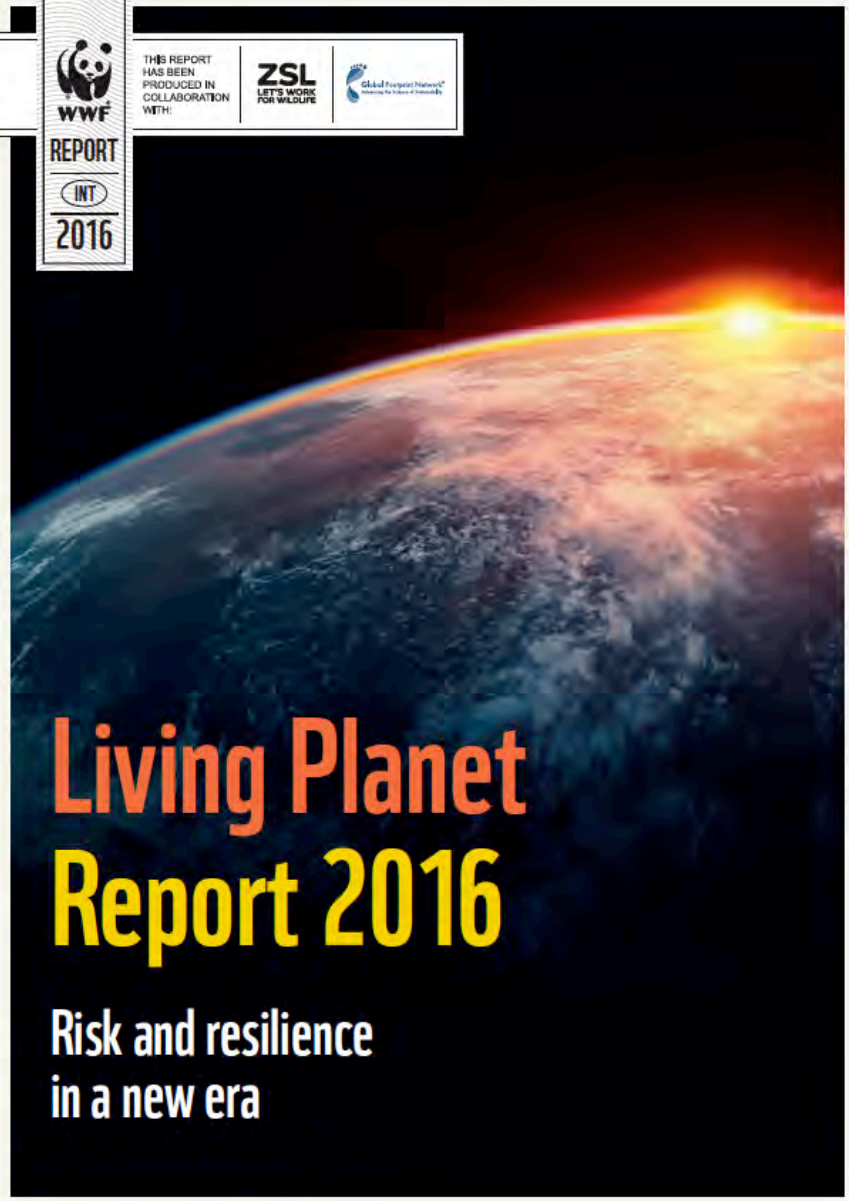


Living Planet Report 2016

Risk and resilience in a new era

CHAPTER 1: STATE OF THE NATURAL PLANET

MONITORING GLOBAL BIODIVERSITY

Biodiversity encompasses the genetic variation within species, the variety and population abundance of species in an ecosystem, and the habitats across a landscape. Monitoring of all these different aspects is imperative as it provides insight into trends in biodiversity and ecosystem health to make informed decisions on resource use and protection. Because biodiversity is so multifaceted, a variety of metrics are necessary; the use of any one in particular would depend upon the biodiversity component of interest and the ultimate use of the information. Contemporary examples of indices now in use include the Living Planet Index (LPI), the IUCN Red List of Threatened Species, and indicators that show us the state of specific habitats – such as forests – or the state of natural capital (Tittensor et al., 2014).

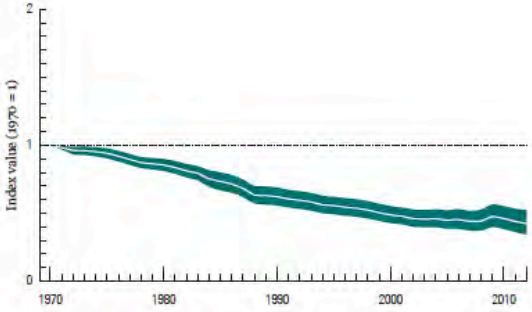
The Global Living Planet Index

The LPI measures biodiversity by gathering population data of various vertebrate species and calculating an average change in abundance over time. The LPI can be compared to the stock market index, except that, instead of monitoring the global economy, the LPI is an important indicator of the planet's ecological condition (Collen et al., 2009). The global LPI is based on scientific data from 14,152 monitored populations of 3,706 vertebrate species (mammals, birds, fishes, amphibians, reptiles) from around the world.

From 1970 to 2012 the LPI shows a 58 per cent overall decline in vertebrate population abundance (Figure 2). Population sizes of vertebrate species have, on average, dropped by more than half in little more than 40 years. The data shows an average annual decline of 2 per cent and there is no sign yet that this rate will decrease. The *Living Planet Report 2014* reported a 52 per cent decline from 1970 to 2010; although the marine and terrestrial datasets have been augmented with new data, it is the stronger decline in freshwater species that has had more influence on the global decline in this report.

FROM 1970 TO 2012 THE LPI SHOWS A 58 PER CENT OVERALL DECLINE IN VERTEBRATE POPULATION ABUNDANCE

Figure 2: The Global Living Planet Index shows a decline of 58 per cent (range: -48 to -66 per cent) between 1970 and 2012
Trend in population abundance for 14,152 populations of 3,706 species monitored across the globe between 1970 and 2012. The white line shows the index values and the shaded areas represent the 95 per cent confidence limits surrounding the trend (WWF/ZSL, 2016).



Key

Global Living Planet Index

Confidence limits

OVER 3,000 DATA SOURCES ARE COMPILED WITHIN THE LPI DATABASE

Monitoring species

Over 3,000 data sources are compiled within the LPI database. One requirement for including a data source is that the population in question has been consistently monitored using the same method over the entire length of the study time period. Some sources are long-term monitoring studies such as the breeding bird surveys in Europe (EBCC/RSPB/BirdLife/Statistics Netherlands, 2016) and North America (Sauer et al., 2014). Others are short-term projects that addressed a particular research question. The majority of these sources are derived from articles found in peer-reviewed scientific journals.

Combined into one dataset, the species census data provides an important tool for monitoring the state of nature. However, the distribution of locations represented by the data is uneven, lacking ideal coverage for all species groups and regions (Figure 3). By targeting data searches toward identified gaps in the dataset, researchers are trying to solve this problem. The LPI database is continually evolving and for each *Living Planet Report* a larger dataset is available to use for the analysis. As such, the percentages reported for LPIs often change from year to year as the dataset increases (see page 40-41 for more details). The new percentages stay within the same range (as measured by the confidence intervals) as previous results so there are similar overall trends even if the final percentage value is often different.

Freshwater Living Planet index

Freshwater habitats – such as lakes, rivers and wetlands – carry immense importance for life on Earth. Freshwater accounts for only 0.01 per cent of the world's water and covers approximately 0.8 per cent of the Earth's surface (Dudgeon et al., 2006) but provides a habitat for almost 10 per cent of the world's known species (Balian et al., 2008). Because humans and almost every living being require water, these habitats command high economic, cultural, aesthetic, recreational and educational value.

Freshwater habitats are challenging to conserve as they are strongly affected by the modification of their river basins as well as by direct impacts from dams, pollution, invasive aquatic species and unsustainable water extractions. Further, they often cross administrative and political boundaries so they require extra effort for collaborative forms of protection. Several studies have found that species living in freshwater habitats are faring worse than terrestrial species (Collen, et al., 2014; Cumberlidge et al., 2009). The freshwater LPI substantiates this finding, showing that on average the abundance of populations monitored in the freshwater system has declined overall by 81 per cent between 1970 and 2012 (Figure 12), with an average annual decline of 3.9 per cent. These figures are based on data for 3,324 monitored populations of 881 freshwater species.

FRESHWATER HABITATS ARE CHALLENGING TO CONSERVE AS THEY ARE STRONGLY AFFECTED BY THE MODIFICATION OF THEIR RIVER BASINS AS WELL AS BY DIRECT IMPACTS FROM DAMS, POLLUTION, INVASIVE AQUATIC SPECIES AND UNSUSTAINABLE WATER EXTRACTIONS

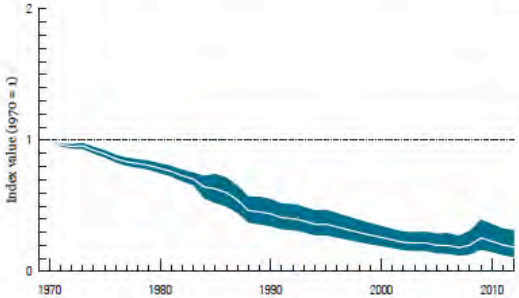


Figure 12: The freshwater LPI shows a decline of 81 per cent (range: -68 to -89 per cent) between 1970 and 2012
Trend in population abundance for 3,324 populations of 881 freshwater species monitored across the globe between 1970 and 2012 (WWF/ZSL, 2016).

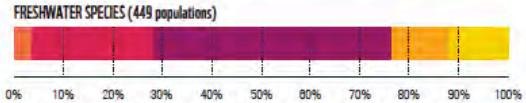
Key

- Freshwater Living Planet Index
- Confidence limits

THE MOST COMMON THREAT TO DECLINING FRESHWATER POPULATIONS IS HABITAT LOSS AND DEGRADATION

The LPI database contains threat information for 31 per cent of its declining freshwater populations (n=449). Based on this information, the most common threat to declining populations is habitat loss and degradation. This is mentioned in 48 per cent of threatened species cases (Figure 13). Freshwater habitat loss because of humans can occur through direct intervention, for example through excavation of river sand or interruption of a river's flow. But habitat loss and degradation can also occur through indirect effects. For example, deforestation can increase river sediment load, leading to more erosion of the river's bank (Dudgeon et al., 2006) with subsequent changes in the water quality and flow. Direct overexploitation – through unsustainable fishing or collection for subsistence or commercial purposes – is the second most frequent threat to freshwater populations (24 per cent), followed by invasive species and disease (12 per cent), pollution (12 per cent) and climate change (4 per cent).

Figure 13: Threat type frequency for 449 declining freshwater populations in the LPI database showing 781 recorded threats
Each population has up to three threats recorded, so the total number of recorded threats exceeds the number of populations (WWF/ZSL, 2016).



Key

- Climate change
- Overexploitation
- Habitat loss / degradation
- Invasive species and disease
- Pollution

The frequency with which different threats are mentioned in the database varies according to taxonomic group (Figure 14). For amphibians, invasive species and disease represents the second most prevalent threat after habitat loss. It is cited as a threat in 25 per cent of cases, potentially reflecting the impact of *Batrachochytrium dendrobatidis*, a species of fungus responsible for chytridiomycosis, a disease of amphibians. This pathogen is implicated in the steep decline or extinction of more than 200 species of amphibians (Wake and Vredenburg, 2008) and threatens many more (Rödder et al., 2009). Furthermore, the rapid global spread of the disease has been linked to climate change (Pounds et al., 2006). The amphibian trade is likely to have contributed to the original spread of the pathogen (Weldon et al., 2004) and can still facilitate introduction into new regions (Schloegel et al., 2009).

- Cause naturali intrinseche

- . Fragilità intrinseca legata alla vita esclusivamente all'interno delle vie d'acqua

- Fragilità intrinseca legata a percorsi migratori obbligati

- Cause antropiche

- . Perdita, alterazione e frammentazione degli habitat

- . Problemi causati dall'immissione di specie aliene

- . Pratiche gestionali non finalizzate alla conservazione delle popolazioni selvatiche

- . Mancanza di conoscenza della biologia delle specie e problematiche tassonomiche

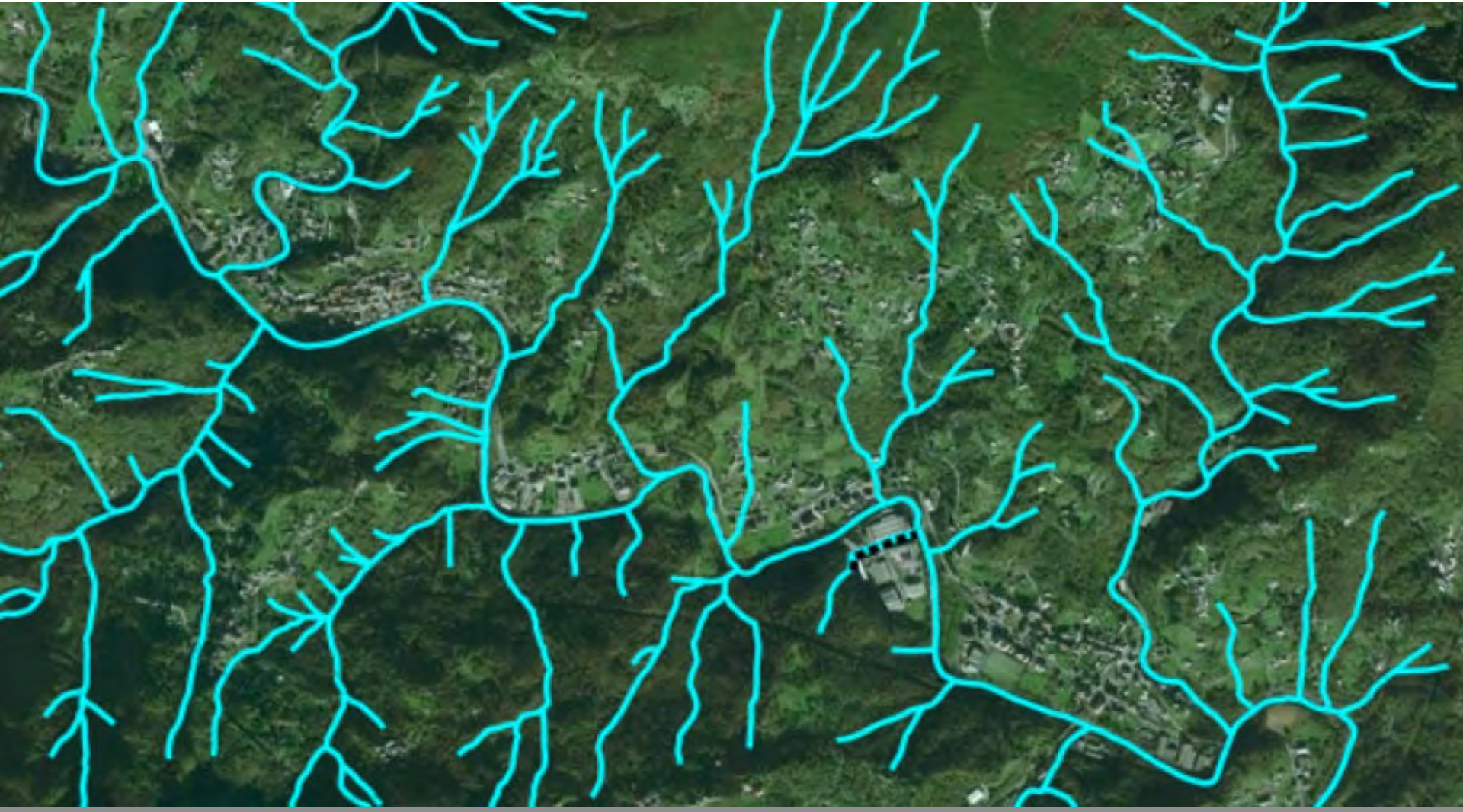
- . Cambiamenti climatici

Nei vertebrati terrestri, anche in quelli con riproduzione e sviluppo acquatico (anfibi), la dispersione avviene sulla terra o attraverso vie aeree (uccelli e chirotteri)

Questo meccanismo permette agli individui in dispersione di superare le barriere geografiche, con tempi molto diversi a seconda dei gruppi zoologi, colonizzare nuovi territori e scambiare i geni con popolazioni diverse da quella di origine.

Questo permette di colonizzare nel tempo tutte le aree idonee per la specie, a 360 ° a partire dal punto in cui gli individui iniziano una nuova fase di dispersione

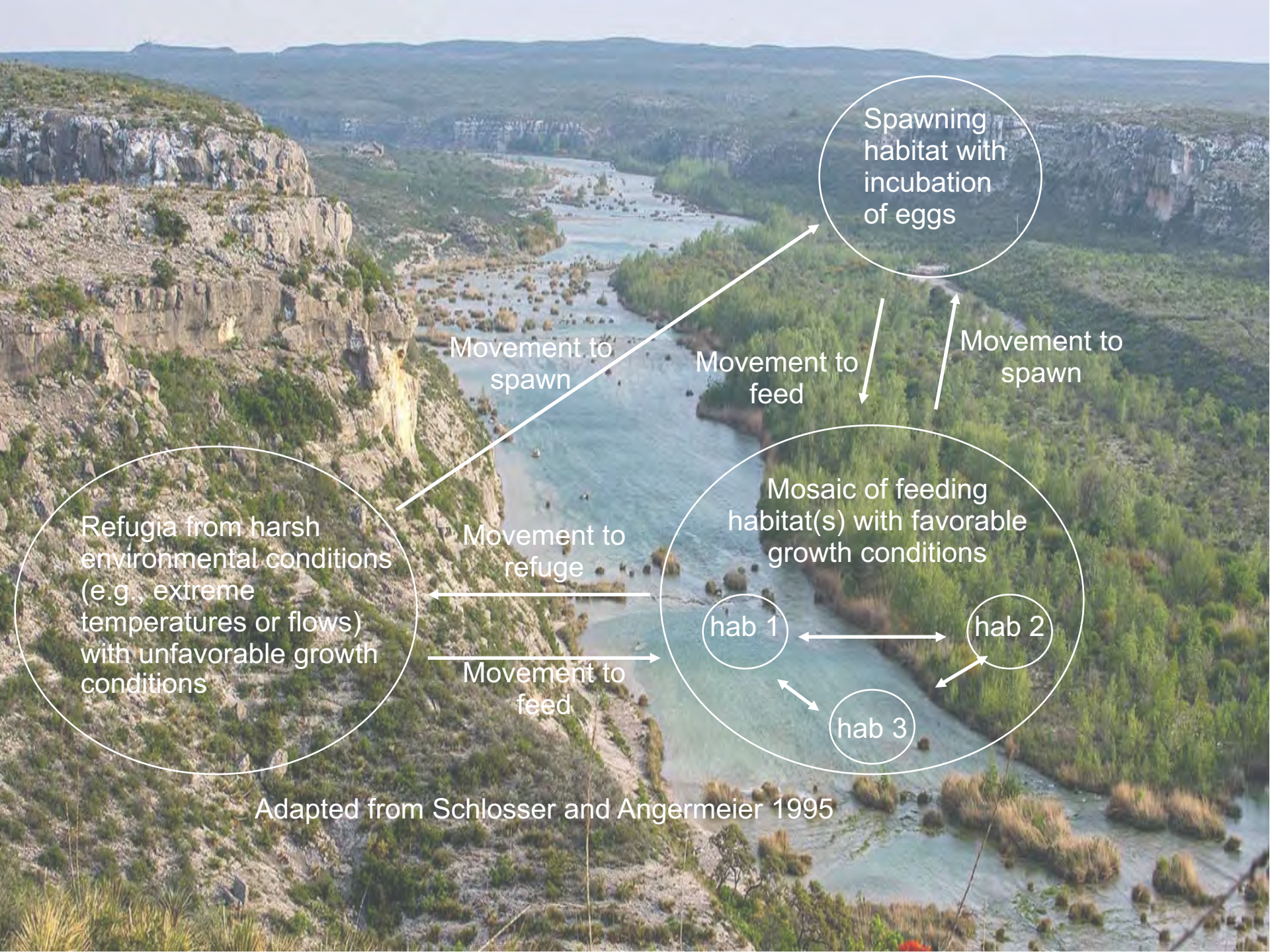
Dispersione dei giovanili in tritone crestato italiano
Triturus carnifex



Nei pesci la dispersione avviene esclusivamente all’interno del reticolo idrografico in cui vive la popolazione.

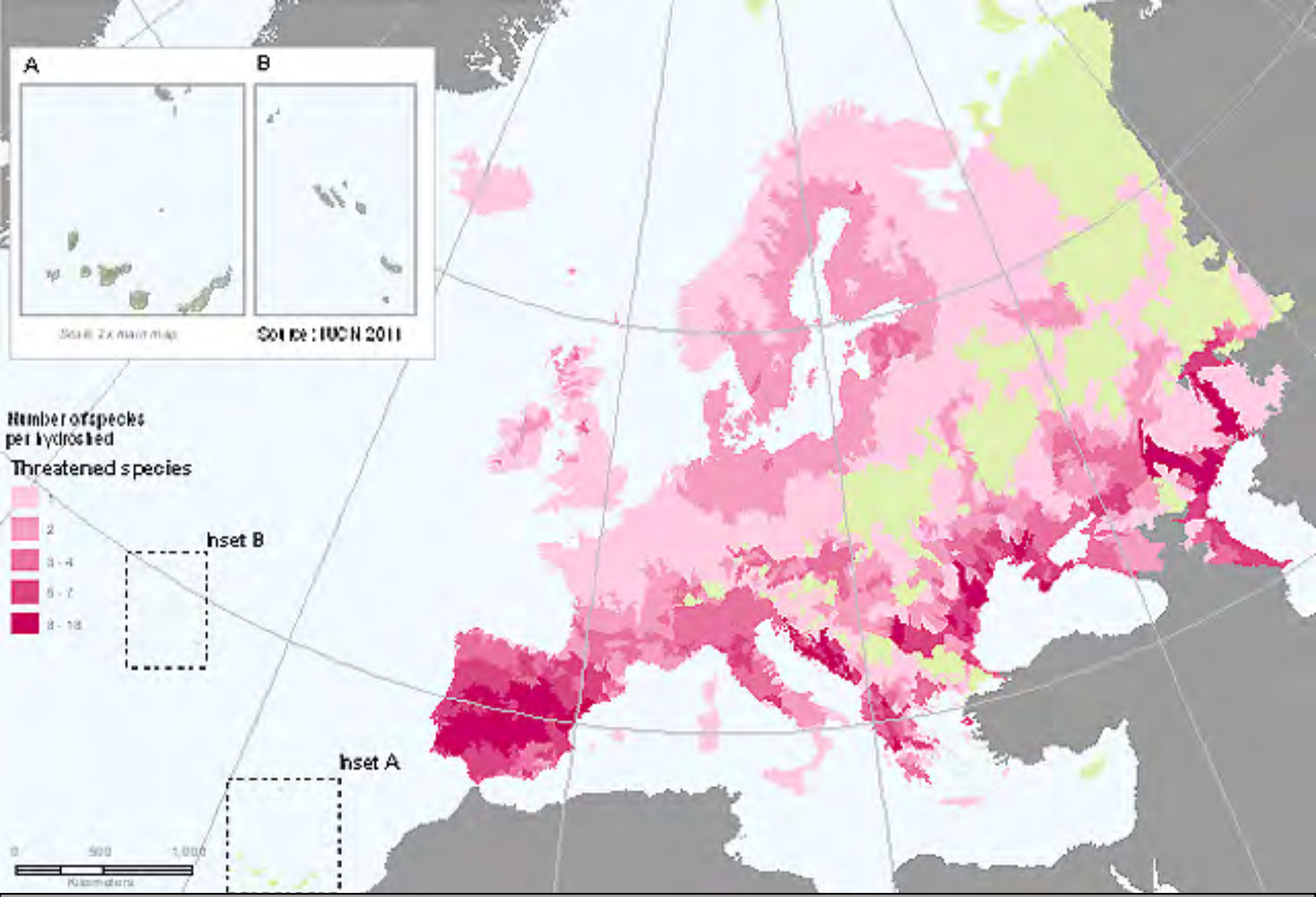
Alcune specie (note come potamodrome e/o ad alta vagilità) si spostano all’interno del bacino idrografico (es. salmonidi, ciprinidi reofili, luccio etc) per esigenze riproduttive e trofiche

Altre specie sono sedentarie e tendono a non compiere spostamenti importanti nel corso della loro vita (specie non vagili o sedentarie) (es.ghiozzi, cobiti, scazzone, cagnetta etc). In questo caso gli scambi genetici tra le popolazioni viventi nello stesso bacino idrografico avvengono su tempi molto lunghi, soprattutto quello da valle verso monte.


Spawning habitat with incubation of eggs
Movement to spawn
Movement to feed
Movement to spawn
Refugia from harsh environmental conditions (e.g., extreme temperatures or flows) with unfavorable growth conditions
Movement to refuge
Movement to feed
Mosaic of feeding habitat(s) with favorable growth conditions
hab 1
hab 2
hab 3
Adapted from Schlosser and Angermeier 1995

Le alluvioni sono molto importanti per gli scambi genetici da monte verso valle

Il distretto PV e il TL sono fortemente antropizzati e, di conseguenza, sono molto elevate anche le pressioni sulla fauna ittica



In Italia presenti oltre 18 specie endemiche e corrisponde a una delle aree di maggiore importanza ittiogeografica dell'intero Paleartico

La fauna ittica italiana è gravemente minacciata dalle attività umane che modificano gli habitat

- Banalizzazione del corso d'acqua che causa aumento della corrente, riduzione di *facies* diversificate e aree di rifugio. Riduzione dell'ombreggiatura. **Vengono meno le aree idonee alla frega e all'accrescimento**

Prelievi d’ acqua per uso irriguo e/o domestico

Virga, G., Arnieri, F., & Costantino, M. (2023). Differences in growth pattern in two freshwater fish species (Leuciscidae) during summer drought in North-West Italy. *Transylvanian Review of Systematical and Ecological Research*, *25*(1), 55–64. https://doi.org/10.2478/trser-2023-0004

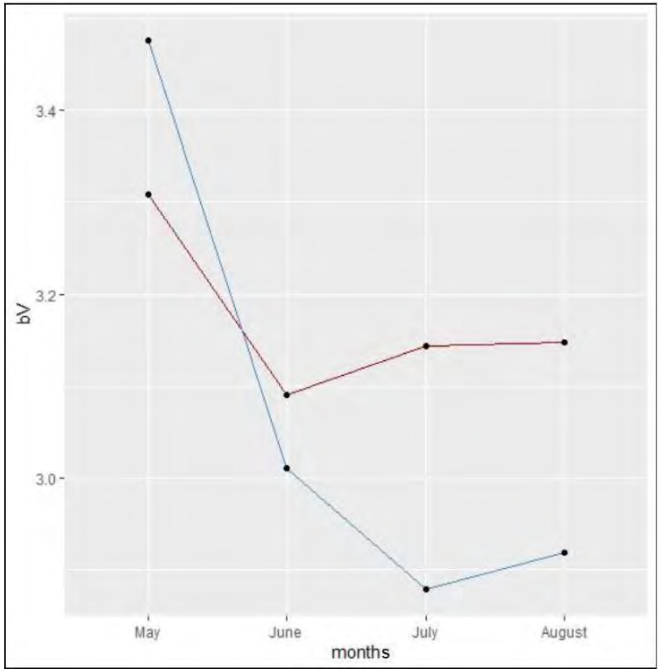


Table 1: Monthly values of parameters "a" and "b" from the length-weight relationship of both fish species.

Month	*Phoxinus* spp.				*Telestes muticellus*			
	Regression parameters		*p* value	r^2	Regression parameters		*p* value	r^2
	a	b			a	b		
May	0.00334	3.4761	< 0.0001	0.8138	0.00694	3.308	< 0.0001	0.9646
June	0.01888	3.0103	< 0.0001	0.869	0.01480	3.09059	< 0.0001	0.9675
July	0.00843	2.8792	< 0.0001	0.9387	0.01205	3.14316	< 0.0001	0.9897
August	0.00702	2.91898	< 0.0001	0.9129	0.01205	3.1469	< 0.0001	0.9898

Table 3: Data summary concerning the statistical analysis done in this study: finding differences between both species' "b" parameter and testing for each species if there were significant differences between the wettest month's "b" parameter and the mean of the other months. The minimum significant level for statistic tests was set at $p < 0.05$.

Comparison	t	df	*p*
$b_{Phoxinus}:b_{Telestes}$	–110.61	2.4353	0.00970
$b_{wet\text{-}Phoxinus}:b_{dry\text{-}Phoxinus}$	–13.913	2	0.005126
$b_{wet\text{-}Telestes}:b_{dry\text{-}Telestes}$	–9.9631	2	0.009924

Interruzione della connettività longitudinale

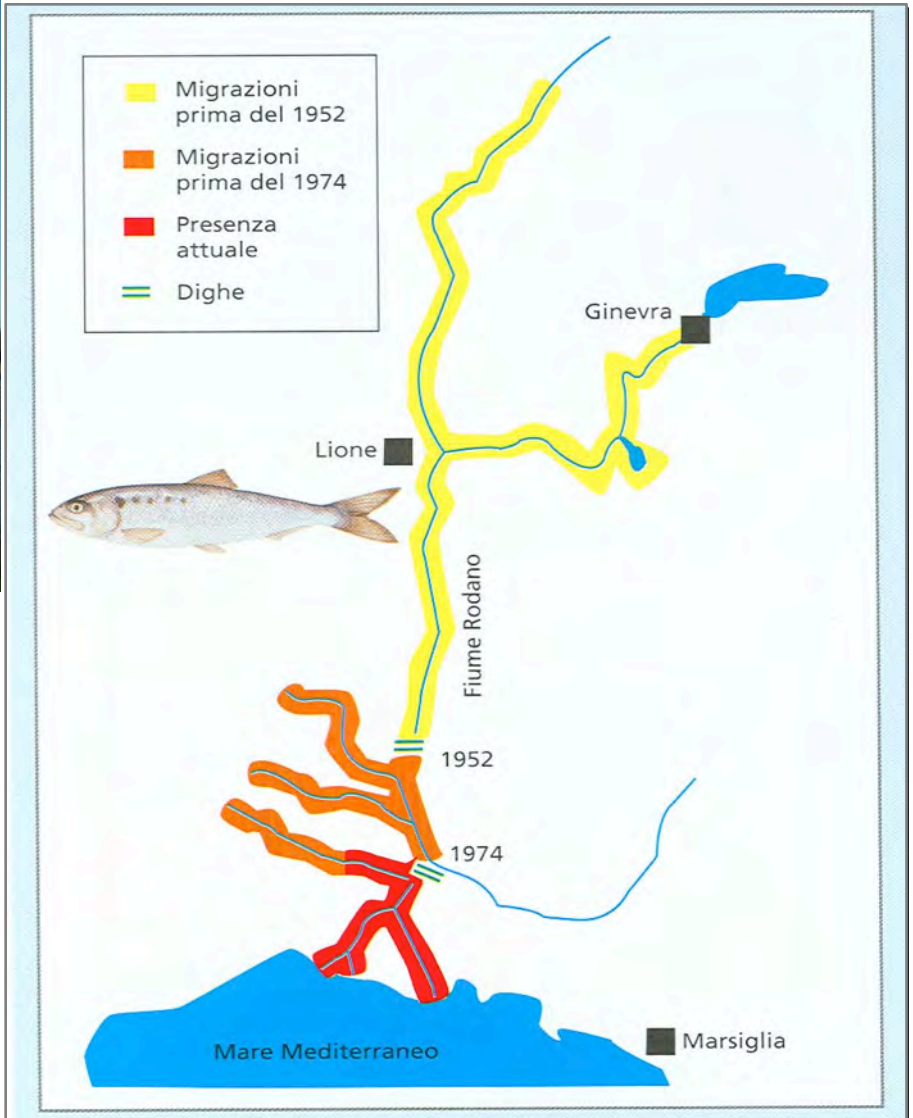


Fig. 3.12 - Progressiva scomparsa di *Alosa fallax rhodanensis* nel sistema idrografico del fiume Rodano (Francia sud-orientale), in seguito alla costruzione di dighe (da Maitland e Crivelli, 1996, ridisegnato).

Introduzione specie alloctone

La carpa (*Cyprinus carpio*) assieme al pesce persico reale (*Perca fluviatilis*) furono Introdotti in epoca romana. La trota fario fu introdotta a partire dal Medio Evo.

I mostri venuti dall’ Est

Tra le specie alloctone più pericolose per gli ecosistemi acquatici piemontesi, c’e il Siluro *Silurus glanis* .

Si tratta di un predatore formidabile e privo di nemici naturali

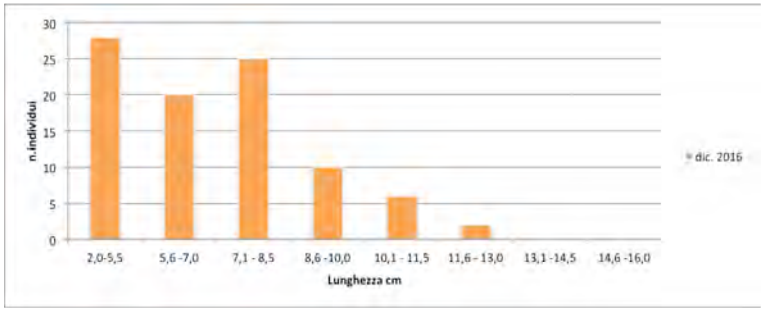
Scazzone *Cottus gobio*
Allegato II Direttiva Habitat

Presenza di due pinne dorsali, appena separate tra loro, pinne pettorali separate, coda arrotondata

Cottus gobio è specie molto esigente
necessita di acque ossigenate e limpide, comprese le risorgive dove può essere associato alla lampreda e al gambero nostrano

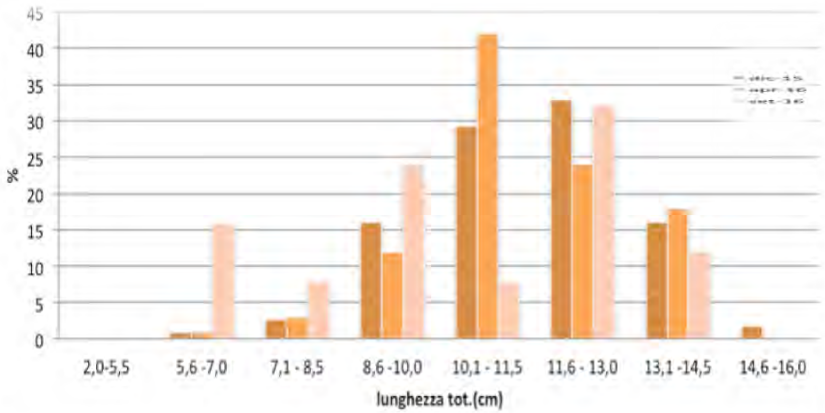
Cottus gobio vs *Salmo* spp.

Fiume Po, Villafranca (TO): stazione con popolamento salmonicolo “naturale”



Nel dicembre 2016 un monitoraggio sul fiume Po, in una stazione in cui non vengono introdotti salmonidi, ha rilevato un popolamento di scazzone ben strutturato con buona presenza di classi giovanili

Torrente Pesio (CN): stazione con massicce introduzione di salmonidi



In base a uno studio effettuato sul Torrente Pesio in località Certosa tra il 2015 e il 2016 (Bovero, 2016) è stato evidenziato come la presenza di grandi quantitativi di salmonidi influisca negativamente sulla struttura delle popolazioni di scazzone a causa della pressione predatoria sugli stadi giovanili.

Salmo AT *vs* *Salmo* MA / AD.

Inquinamento genetico

X

Salmo marmoratus ⊥ *Salmo trutta*

Ibrido *Salmo trutta x marmoratus*

Salmo trutta

X

Salmo sp. AD

Ibrido *Salmo trutta x sp. AD*

Cambiamenti climatici

ARCO ALPINO SEMPRE PIÙ CALDO

La mappa delle temperature medie inferiori a zero ° C tra il 1970 e il 1979 a confronto con quelle registrate tra il 2010 e il 2018 - Fonte: Isac-Cnr

In calo i giorni con temperatura minima inferiore a 0° C nelle località sopra i mille metri di altitudine (media registrata nelle località > 1000 m di altitudine)

Variazione annua

-0,2%

Variazione sul periodo 1971-2018

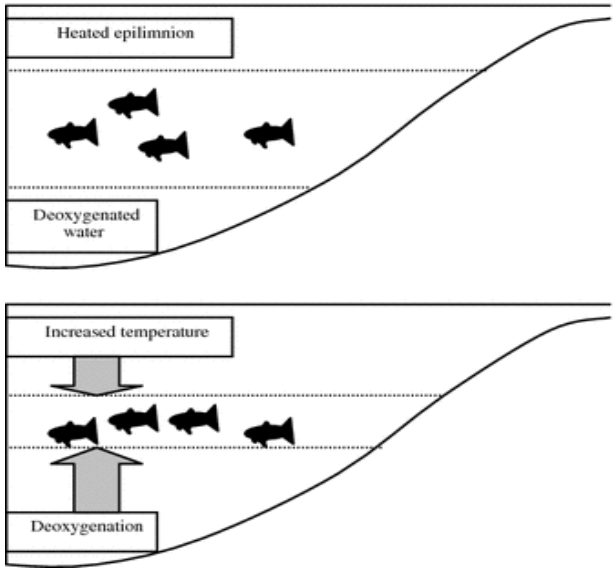
-10,1%

Numero di giorni sul periodo 1971-2018

-36,7

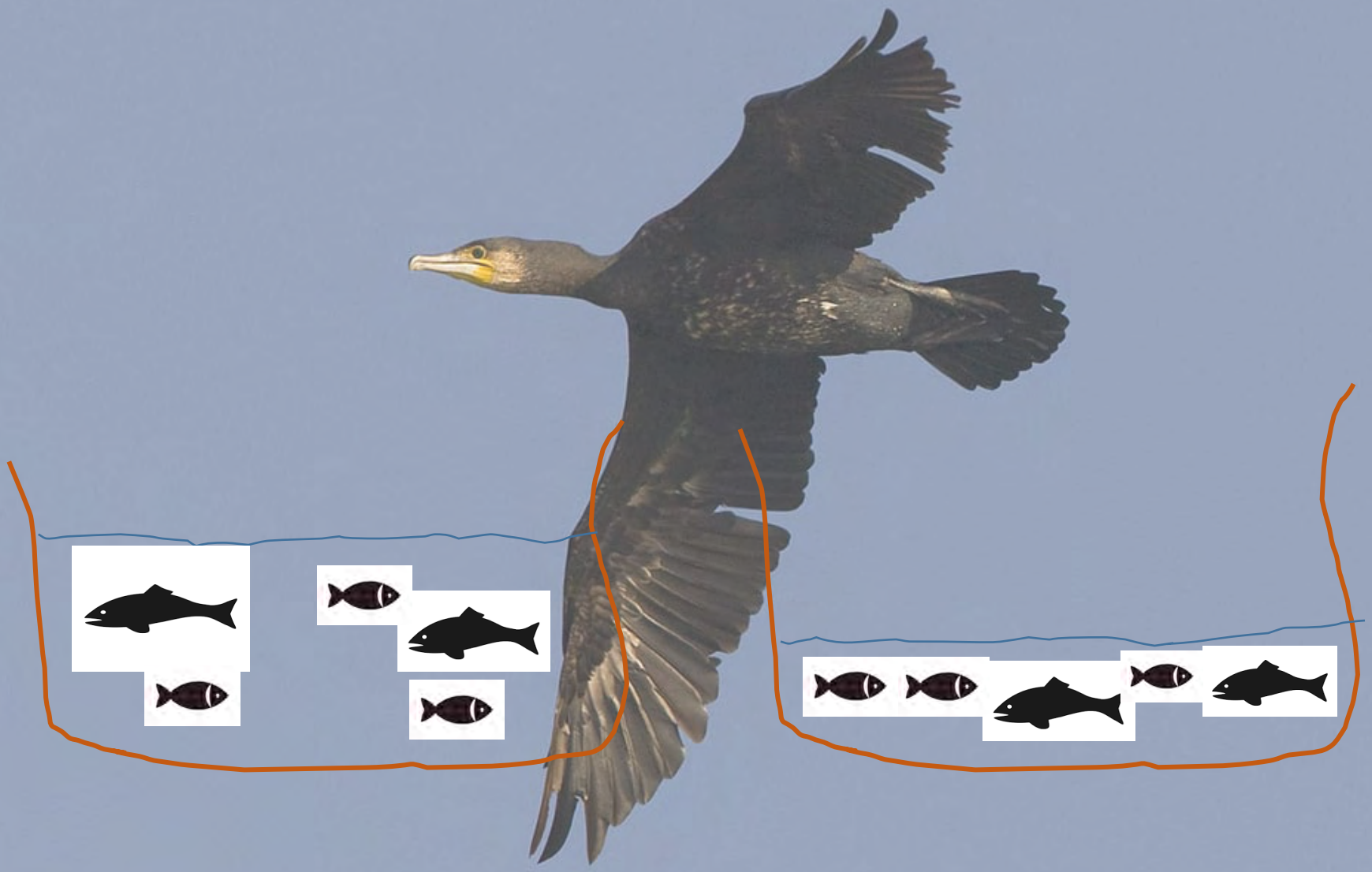
Sui pesci moltissima preoccupazione:

- Contrazione habitat per specie frigofile (alpine)
- Riduzione livello di ossigeno

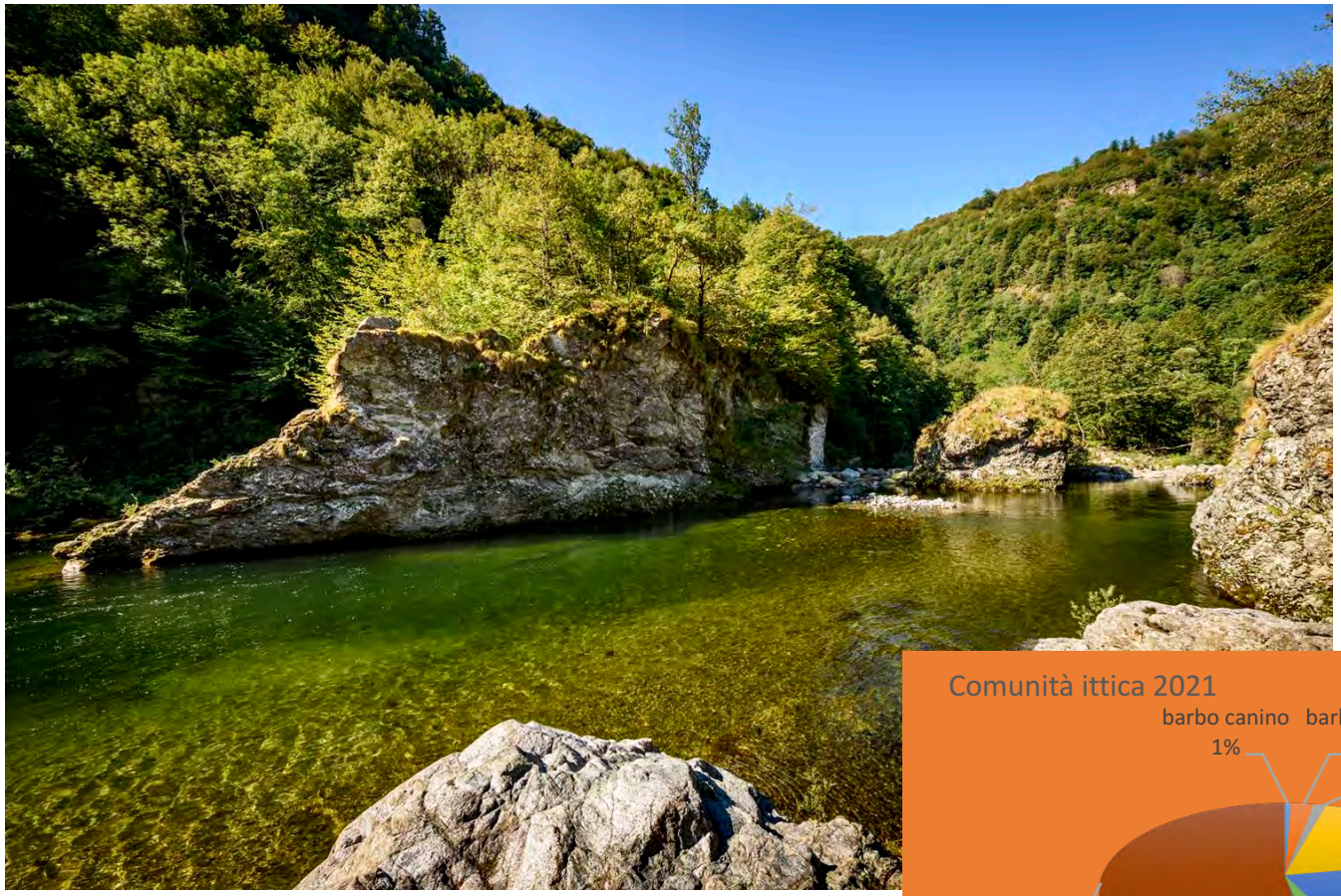


- Tendenza delle popolazioni a risalire il verso ambienti ancora freddi ma limitati e subottimali

- Aumento della pressione predatoria per volume di acqua

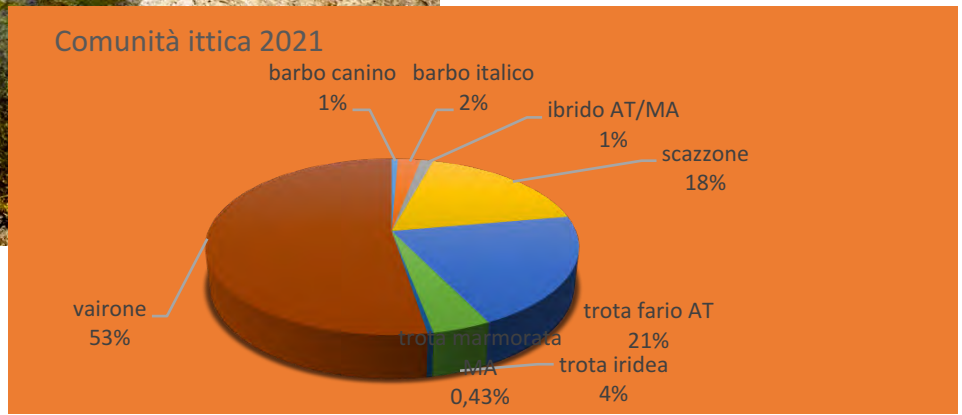


- Incremento di habitat per specie più termofile o più plastiche (specie alloctone e specie autoctone di altro contesto ambientale, es planiziale) che vengono a sottrarre risorse ambientali alle specie alpine



Mastallone Varallo Sesia ottobre 2021

Popolazione acclimatata di *Barbus plebejus,* specie precedentemente presente solo molto più a valle



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Stato dell'ittiofauna nei fiumi e torrenti in Piemonte

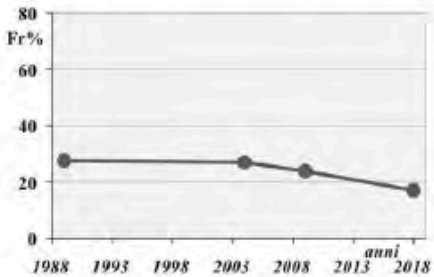
ABSTRACT - *State of the riverine ichthyofauna in Piedmont.*

Four major fish surveys were performed on the whole hydrographic network of Piedmont (NW Italy): 297 stations were monitored in 1988/1989, 202 in 2004, 428 in 2009 and 209 in 2017/2019. A considerable number of stations were common in all four monitoring campaigns and this allow us, by means of data comparison, to assess the evolution of the riverine fish fauna over the last thirty years. These are the main remarks:

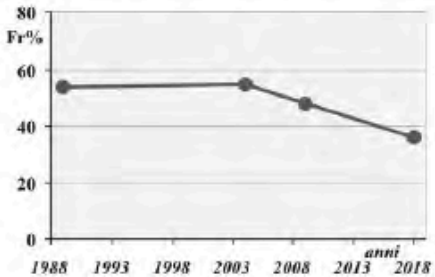
- The initial presence of twenty eight native species has been confirmed.
- Three diadromous species, the Atlantic sturgeon *Acipenser sturio*, the Eel *Anguilla anguilla* and the Twait shad *Alosa fallax*, are actually absent and furhter studies would be needed to confirm recent reports about the presence of the Adriatic sturgeon *Acipenser naccarii*.
- Eight species, the Italian golden loach *Sabanejewia larvata*, the Savetta *Chondrostoma soetta*, the Lasca *Protochondrostoma genei*, the Italian gudgeon *Gobio benacensis*, the Pigo *Rutilus pigus*, the Southern pike *Esox cisalpinus*, the Adriatic grayling *Thymallus aeliani* and Tenc *Tinca tinca* wild populations, are critically endangered and some of these appear to be almost extinct from the hydrographic network.
- Two species, the Italian barbel *Barbus plebejus* and the Italian rudd *Scardinius hesperidicus*, are vulnerable with decreasing populations in Piedmont.
- Twelve species are listed as least concern and their populations have remained stable or show only slight regression.
- Twenty three alien species are present. Among them two species, the Carp *Cyprinus carpio* and the Alpine charr *Salvelinus alpinus*, are considered "para-autochthonous" in Italy, twenty one are dangerous and five, allochthonous barbels *Barbus* spp., the Asp *Aspius aspius*, the Pseudorasbora *Pseudorasbora parva*, the Bitterling *Rhodeus amarus* and the European catfish *Silurus glanis* are very dangerous for native species.

Our study highlights that the conservation status of the ichthyofauna of rivers and streams in Piedmont is seriously compromised. Major threats to freshwater fishes include: habitat modification, fragmentation and destruction; excessive water withdrawals for agricultural purposes; lack or ineffectiveness of fish passes; invasive species; overfishing; environmental pollution; forestry practise; local increase of piscivourous birds; and climate change.

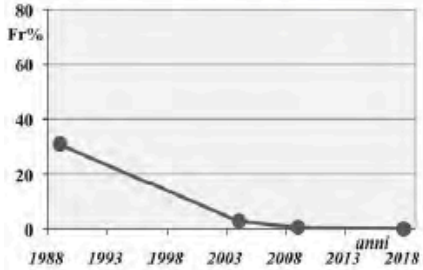
KEY WORDS - Monitoring, ichthyic communities, ichthyofauna evolution, Piedmont (NW Italy).



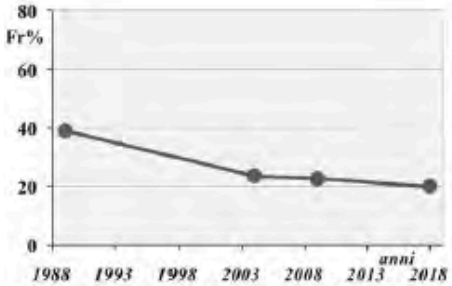
2.7 - *Barbus caninus* (barbo canino)



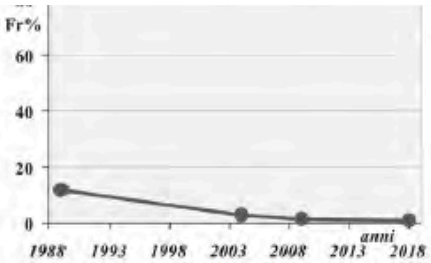
2.8 - *Barbus plebejus* (barbo)



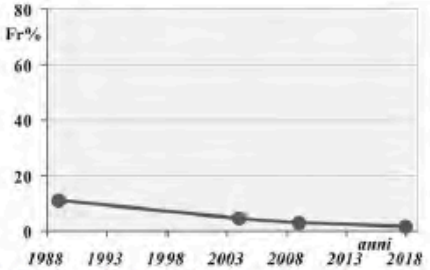
2.1 - *Anguilla anguilla* (anguilla)



2.10 - *Protochondrostoma genei* (lasca)



2.21 - *Esox lucius*, *E. cisalpinus* (lucci)



2.29 - *Thymallus thymallus*, *Thymallus aeliani* (temoli)