Chemical risk assessment of fish populations - Application to the early life stages of migratory fish living in the Garonne catchment.

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INTRODUCTION.

In the **Garonne catchment** (Southwest France), **anadromous** (i.e. reproducing in freshwater and growing at sea) fish populations have severely **decreased** over the last decades[1]. Among the **potential causes** of this decline, questions about **water contamination** have **received limited attention**[2], although **hypotheses** concerning **early life stages** have been mentioned[3].

To study the **impact** of **water contamination** on **early life stages** of **anadromous fish**, a standardized **indicator** of **potential toxicity risk** (i.e. **PAF** approach) was used to estimate the **% of fish species potentially affected** by chemicals in **spawning grounds**.

French IUCN Red List

CR → European sturgeon, *Acipenser sturio*
&
Allis shad, *Alosa alosa*

MATERIALS & METHODS

1 **Environmental contamination** → quantified data in the water of the Garonne and Dordogne rivers (11 sites / 2007-2022, see the Figure. 1)

→ 95th percentile ($C_{env.}$) → **198 substances**

■ Metals ■ Agrochemicals ■ Hygiene & Care ■ Industrial

2 **Toxicity** → toxicity data obtained from toxicity tests carried out on early life stages of fish species in freshwater environments

→ Hazardous Concentration for 50% of species (HC_{50}) → **78 substances**

3 **Calculations** of Potentially Affected Fraction of [fish] species (PAF)[4]

single-substance (**ssPAF**): $0{,}5*(C_{env.}/HC_{50})*100$

multi-substance (**msPAF**): $0.5*\Sigma(C_{env.}/HC_{50})*100$

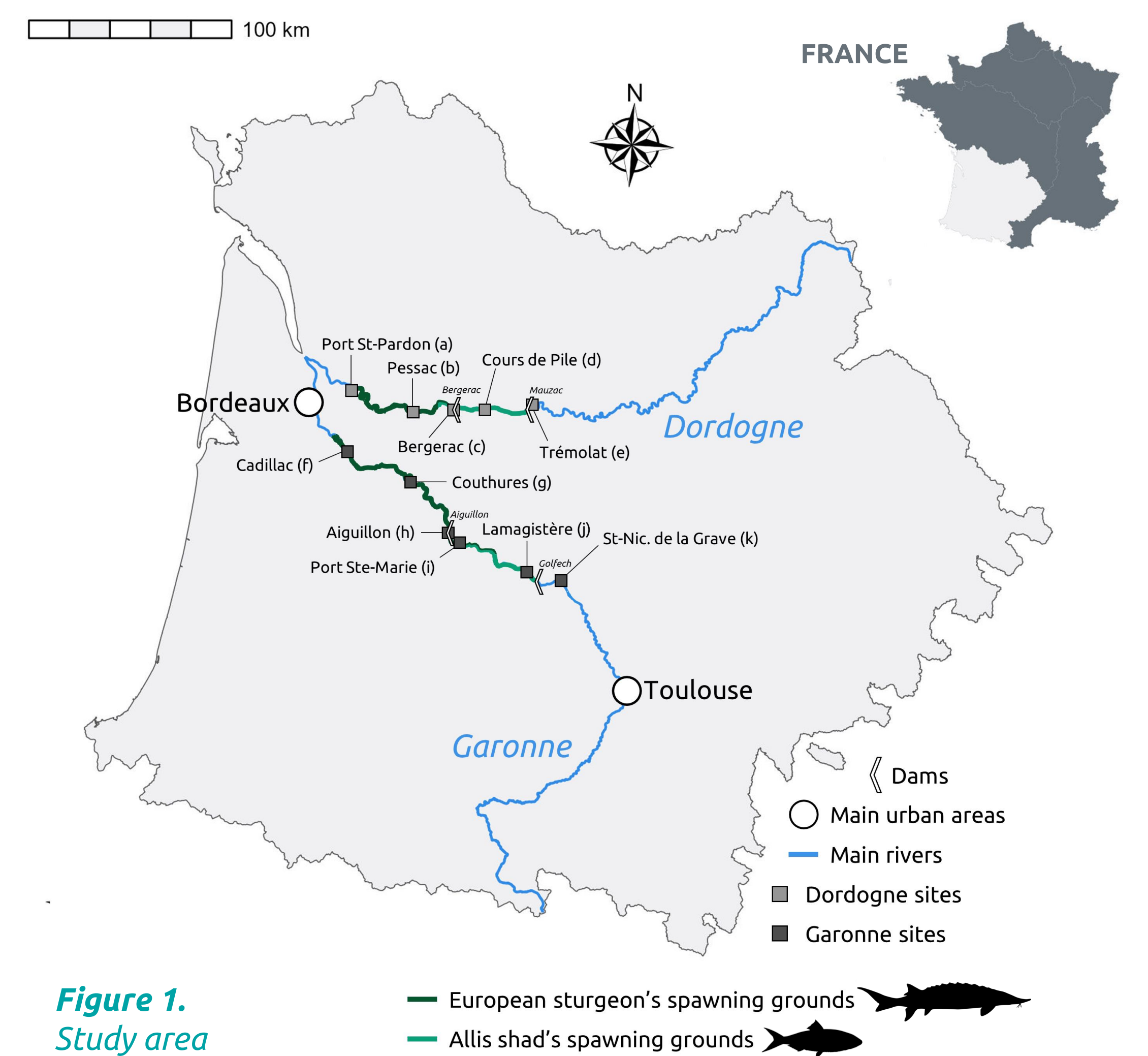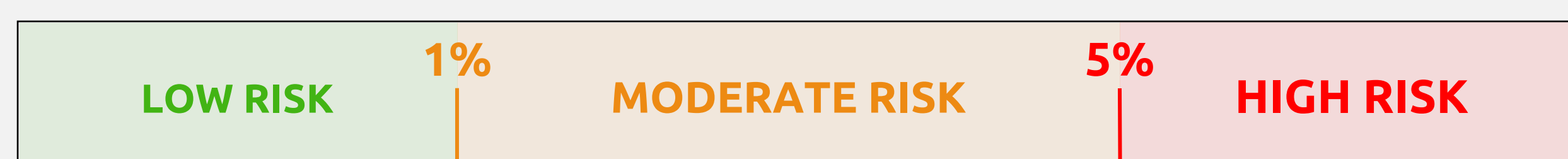**4** Estimation of potential toxic risk intensity: **low**, **moderate** and **high**[5]

| LOW RISK | 1% | MODERATE RISK | 5% | HIGH RISK |

Figure 1. Study area

100 km — FRANCE

Port St-Pardon (a), Pessac (b), Cours de Pile (d), Bordeaux, Bergerac (c), Cadillac (f), Trémolat (e), Couthures (g), Aiguillon (h), Lamagistère (j), St-Nic. de la Grave (k), Port Ste-Marie (i), Toulouse

Dordogne, *Garonne*

Dams, ○ Main urban areas, — Main rivers, ▫ Dordogne sites, ▪ Garonne sites, — European sturgeon's spawning grounds, — Allis shad's spawning grounds

RESULTS & DISCUSSION

A Contribution of chemical categories to potential toxic risks (msPAF)

DORDOGNE — msPAF (in %) — Site a *downstream*, Site b, Site c, Site d, Site e *upstream*

GARONNE — msPAF (in %) — Site f *downstream*, Site g, Site h, Site i, Site j, Site k *upstream*

1 No existing potential toxic risk gradient from downstream to upstream spawning ground sites in both rivers.

2 Toxic risk mainly: moderate > low ~ high and explained by: metals > hygiene & care ~ industrial > agrochemicals

Average Intensity: Low (<1%) 27,3%, High (>5%) 21,7%, Moderate (1-5%) 50,9%

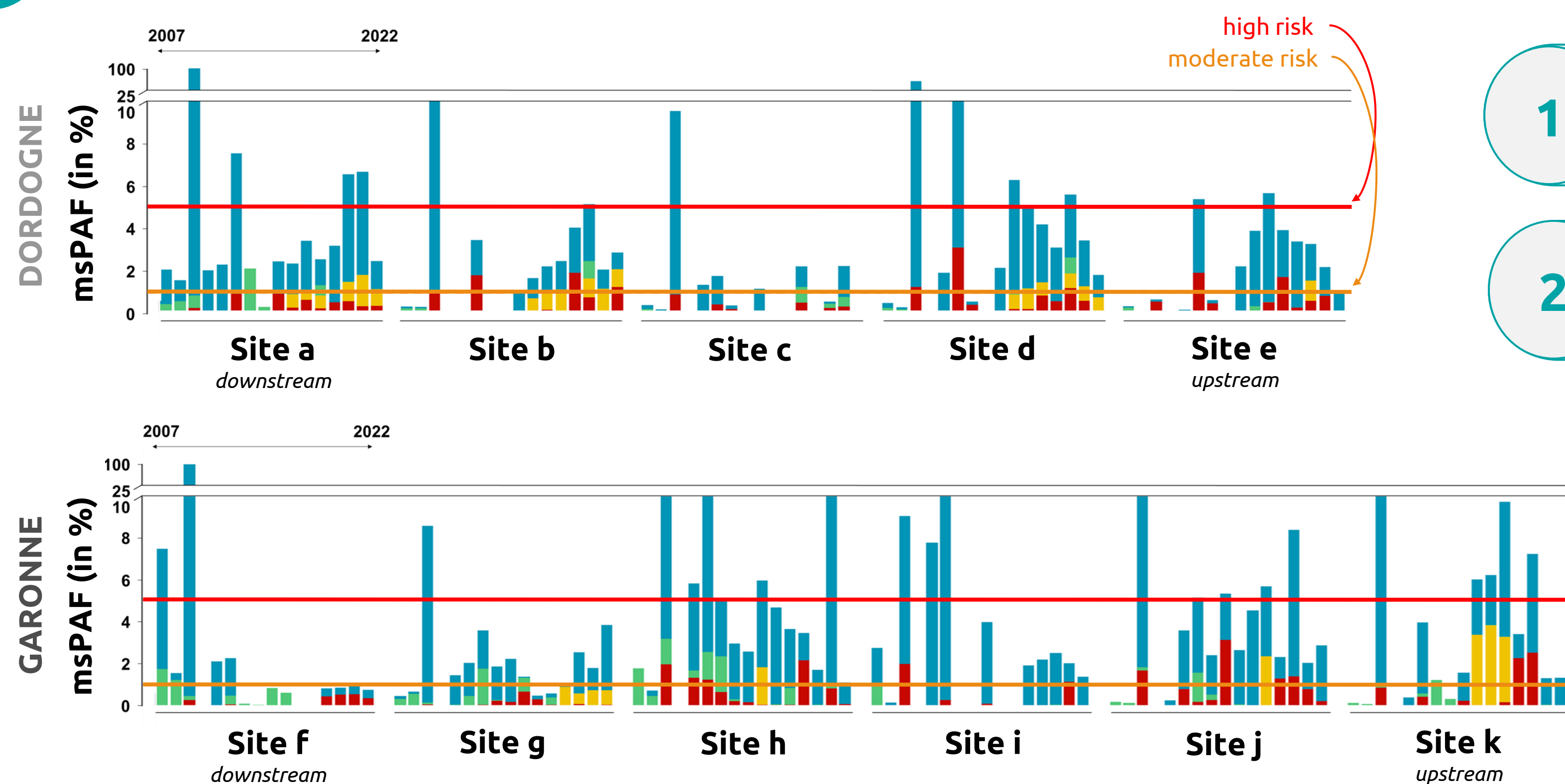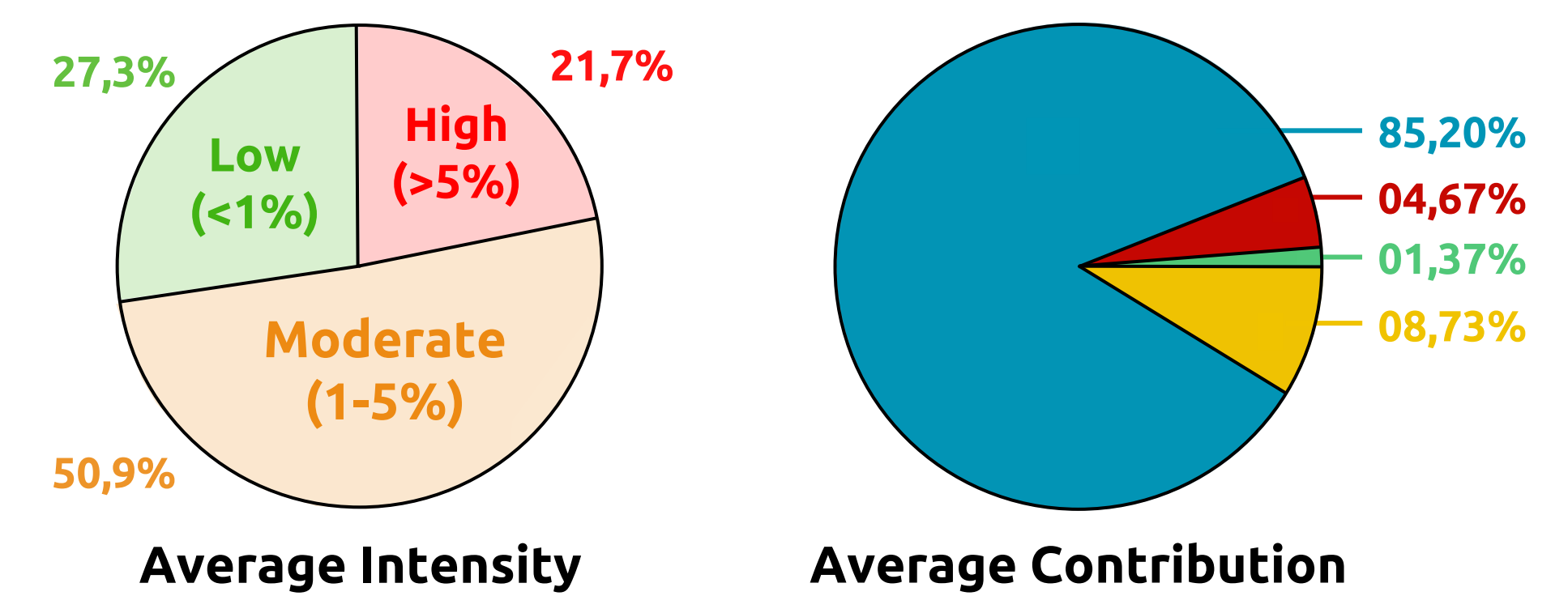Average Contribution: 85,20%, 04,67%, 01,37%, 08,73%

Figure 2. Percentage of fish species potentially affected for each site-year, river and chemical category, with overall average percentages for each intensity and chemical category.

B Contribution of individual chemicals to potential toxic risks (ssPAF)

Dordogne / Garonne

Benzo[a]pyrene (n = 2) / (n = 0) Benzo[a]pyrene
Bisphenol A (n = 1) / (n = 0) Bisphenol A
Acetochlor (n = 0) / (n = 4) Acetochlor
Metformin (n = 3) / (n = 2) Metformin
Hydroxyterbuthylazine (n = 1) / (n = 4) Hydroxyterbuthylazine
Dioctyl phthalate (n = 0) / (n = 3) Dioctyl phthalate
Branched 4-nonylphenol (n = 0) / (n = 4) Branched 4-nonylphenol
Estrone (n = 0) / (n = 5) Estrone
4-tert-octylphenol (n = 0) / (n = 1) 4-tert-octylphenol
Iron (n = 1) / (n = 2) Iron
Zinc (n = 9) / (n = 11) Zinc
Copper (n = 23) / (n = 37) Copper
Lead (n = 13) / (n = 21) Lead

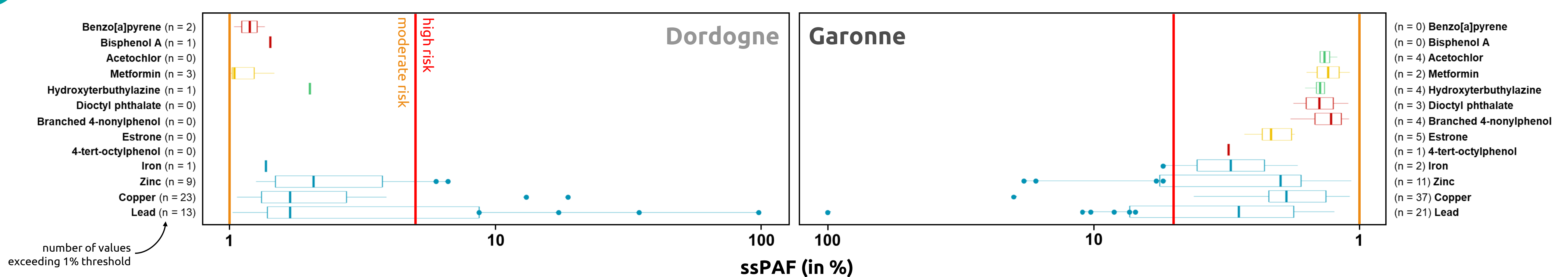number of values exceeding 1% threshold

ssPAF (in %)

Figure 3. Boxplots of chemical values exceeding 1% of potentially affected fish species (moderate risk) per river. Points indicate values exceeding 5% of potentially affected fish species (high risk).

3 13 problematic chemicals & 3 main: lead, copper (widely used in agriculture, cf. "bouillie bordelaise") and zinc

4 All chemical categories represents individually at least a moderate toxic risk = high diversity of toxic pressure

CONCLUSION.

This study highlights the **potential influence of water contamination** on the **decline**, **fate** and **restoration of anadromous fish populations** in the **Garonne catchment**, focusing notably on the **toxic effects on early life stages**, a previously **understudied topic**. **Increased monitoring of chemicals** in terms of quality and quantity (currently limited data) and **more studies** on the **early life stages** of these anadromous fish species are **suggested**.

SOURCES.

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