

An aerial photograph showing a river meandering through a vast, dense green forest. The river is a light blue-green color, contrasting with the deep green of the surrounding trees. Several small, forested islands are visible in the river. The perspective is from a high angle, looking down at the landscape.

Protection of a moving target

How well is the global river network protected—and how can we measure this?

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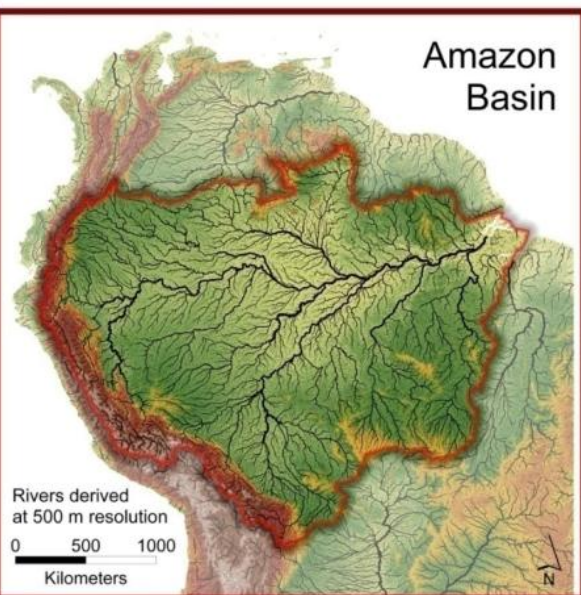
WWF-US, McGill University, Griffith University,
and UNEP-WCMC



HydroSHEDS

Global **Hydro**logical data and maps based on **Shuttle Elevation Derivatives** at multiple **Scales**

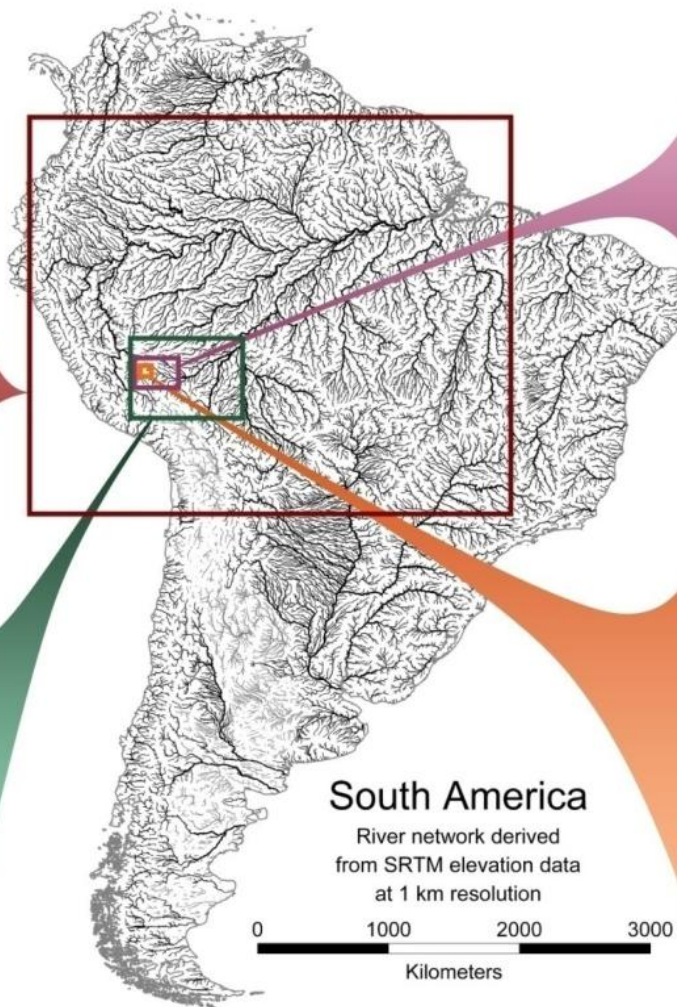
Amazon Basin



Madre de Dios Basin



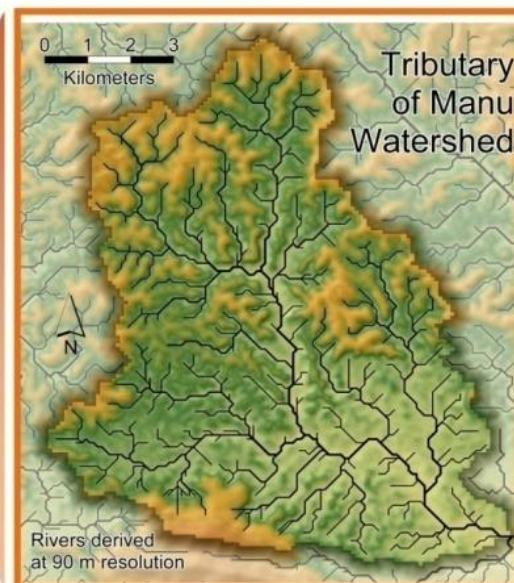
South America



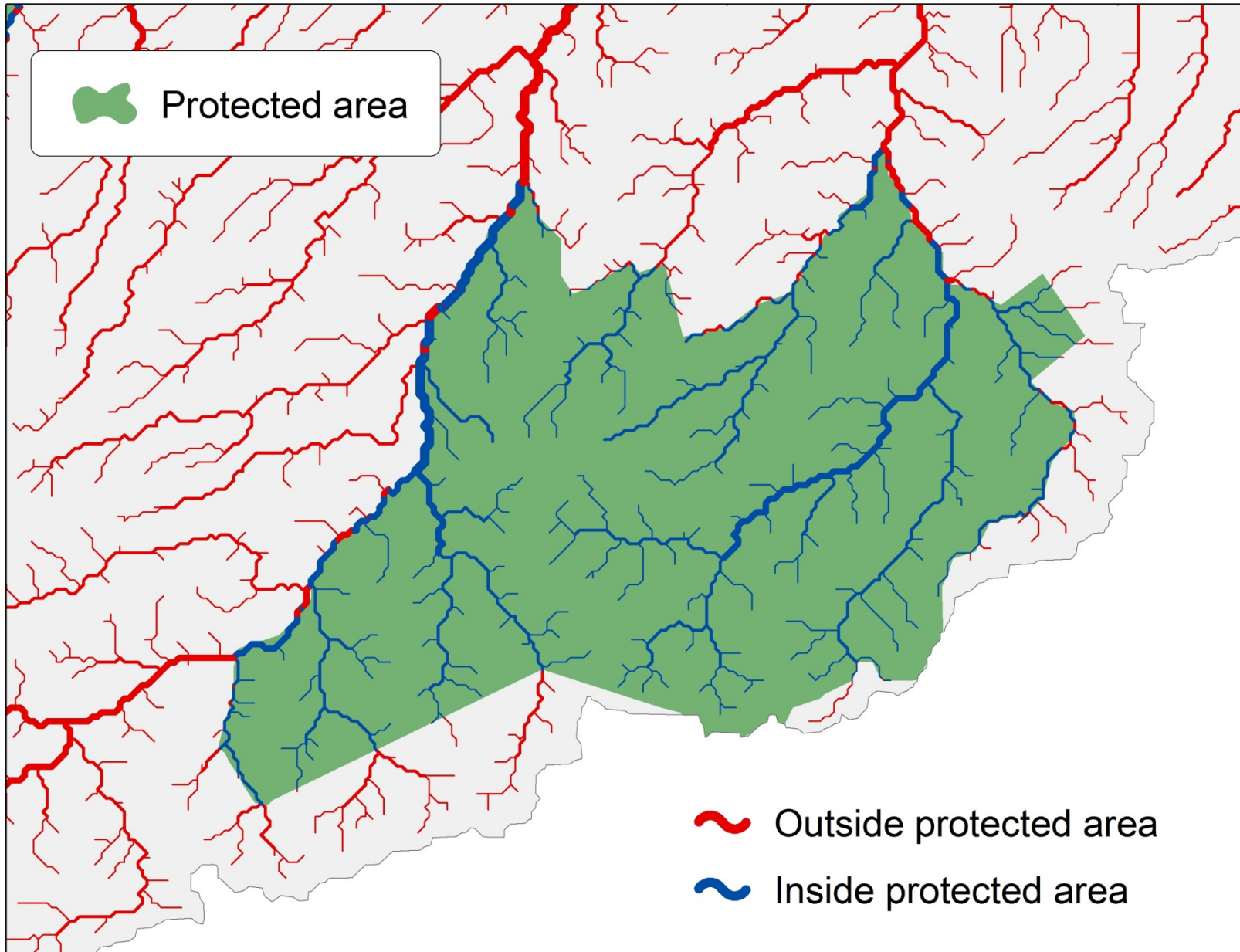
Upper Madre de Dios Basin



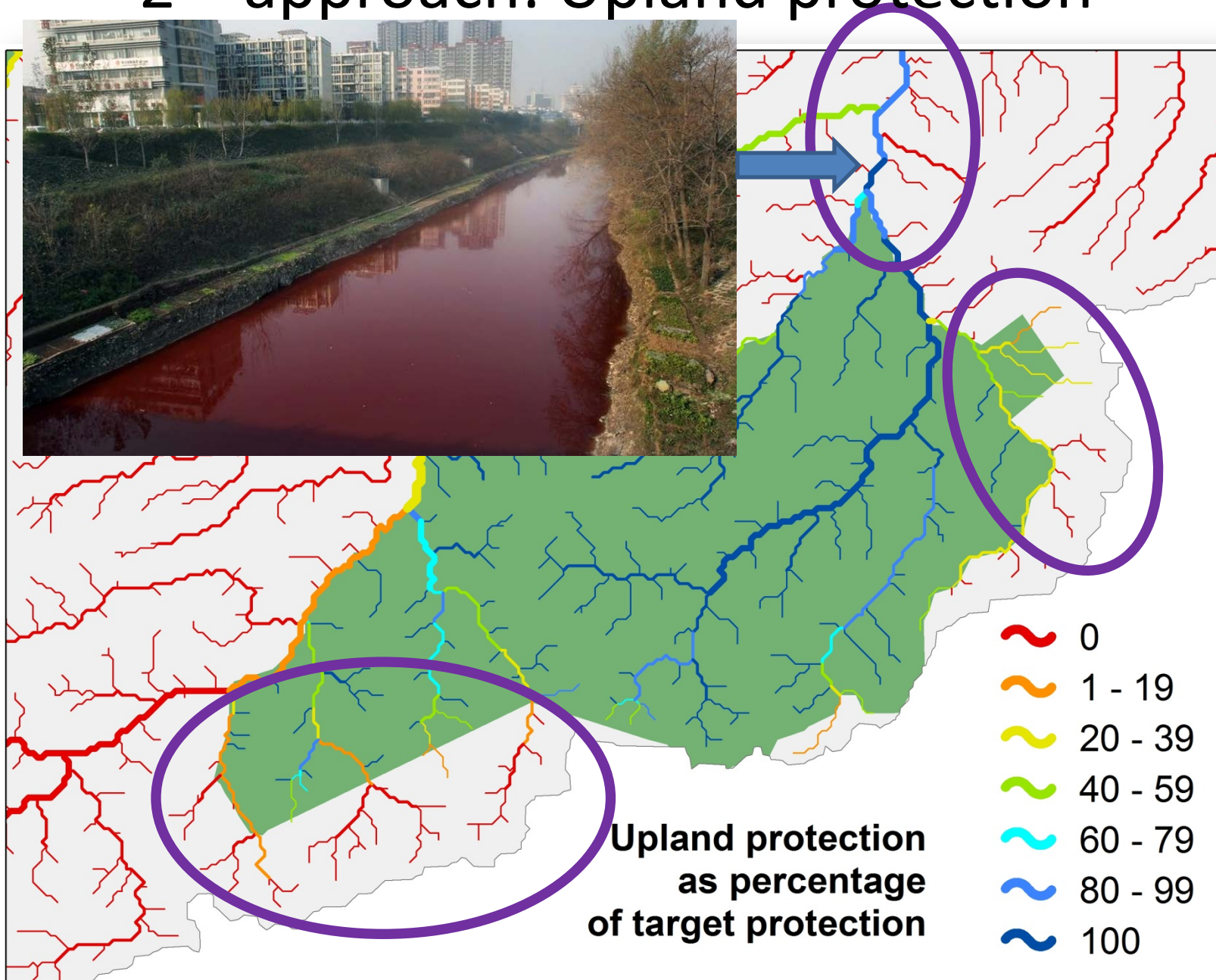
Tributary of Manu Watershed



Traditional calculation: Local protection



2nd approach: Upland protection



Three-tiered approach to define the protection status of a river

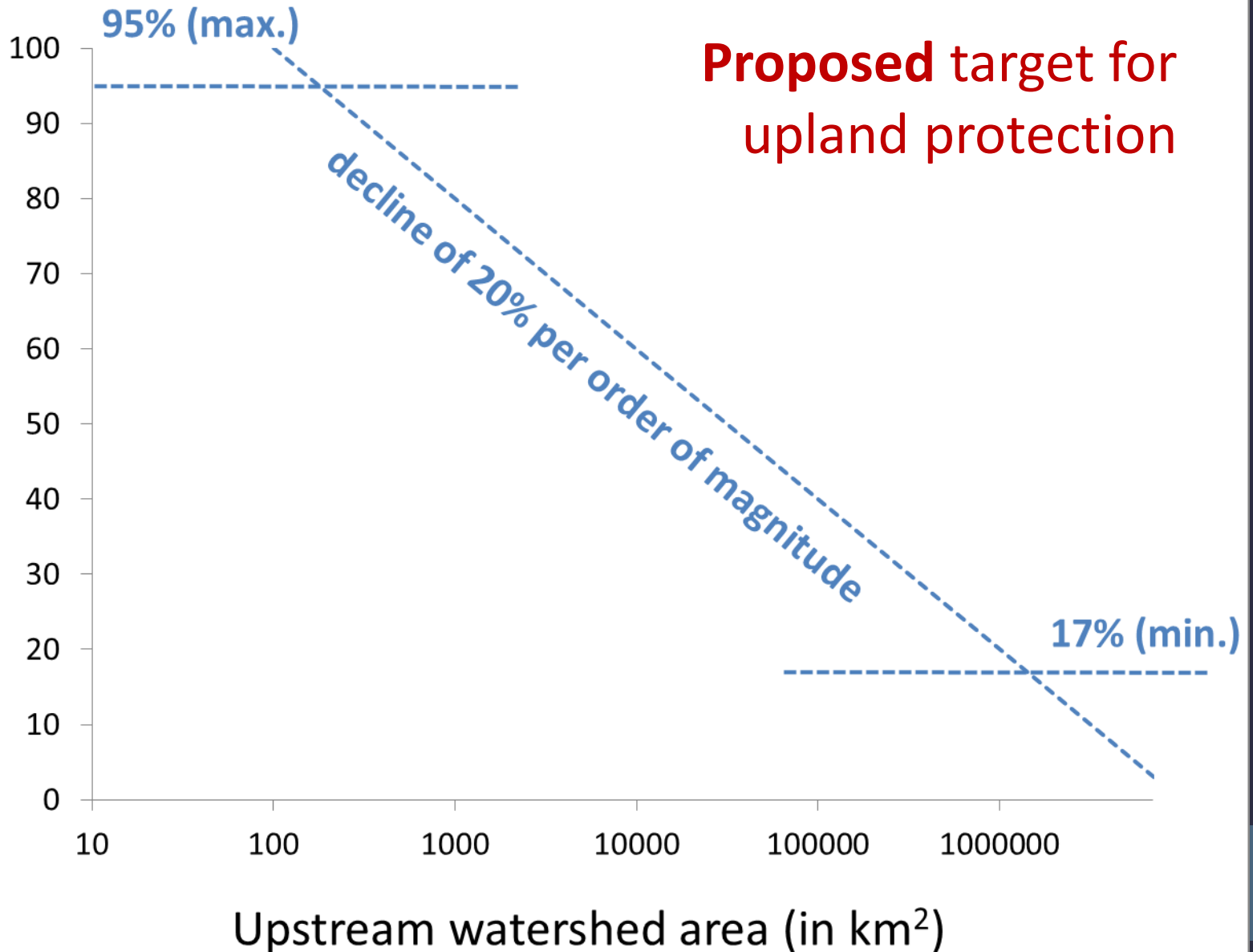
1. Local protection (percent of river length protected)
 - this is the traditional approach (“inside PAs”)
 - does not account for unprotected upstream areas
2. Upland protection (percent of watershed protected)
 - does not consider whether reach itself is protected
3. Integrated protection
 - combination of local and upland protection

Area-dependent target for “sufficient” upland protection

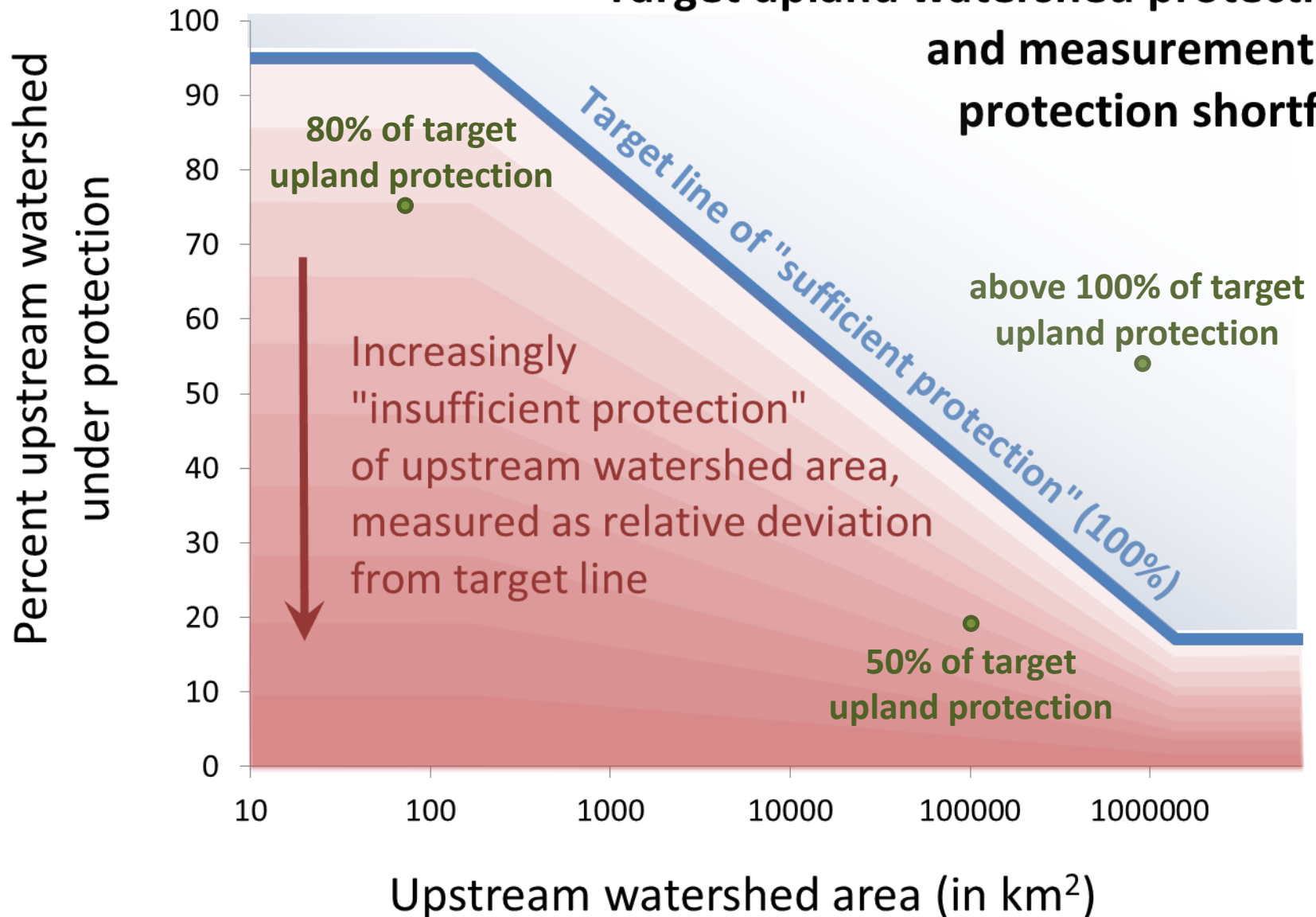
We propose the following definition of a protection target for rivers with different watershed sizes:

- Small catchments ($< 100 \text{ km}^2$) should have their entire watershed (or at least 95%) under protection
- Larger basins are allowed to have increasingly smaller ratios of upland protection
- But even the largest basins should have at least 17% of their upland area protected (i.e. the target of terrestrial)

Percent upstream watershed
under protection



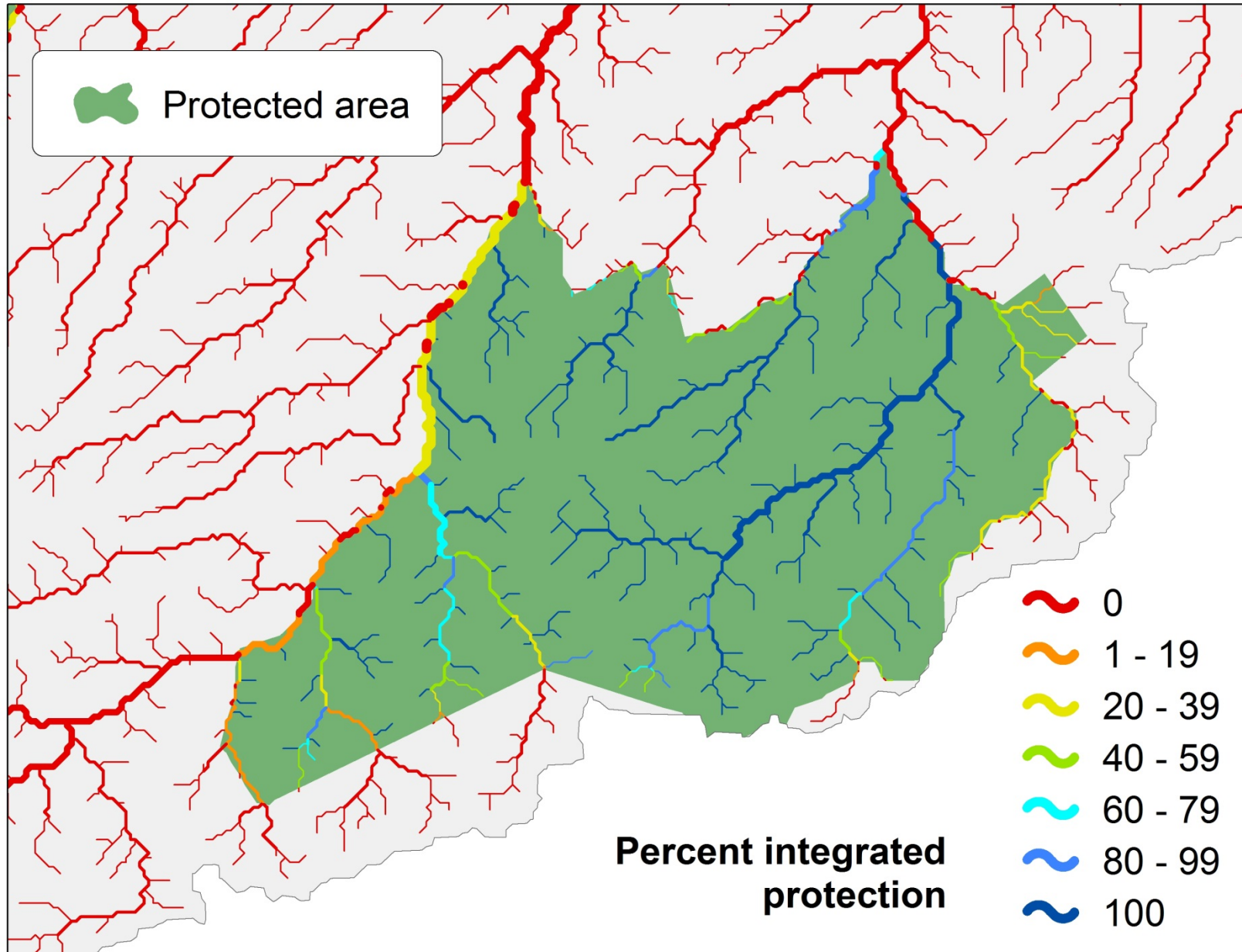
Target upland watershed protection and measurement of protection shortfall



Definition and calculation of integrated river protection

- To be fully (100%) protected, a river reach needs to
 - a) be inside a protected area; and
 - b) match or exceed the target upland protection
- If a reach is outside a protected area, it is considered unprotected (independent of upland protection)
- If a reach is inside a protected area and achieves, say, 75% of the target upland protection, it is counted as 75% protected, etc.

Proposed calculation: Integrated protection



Upland

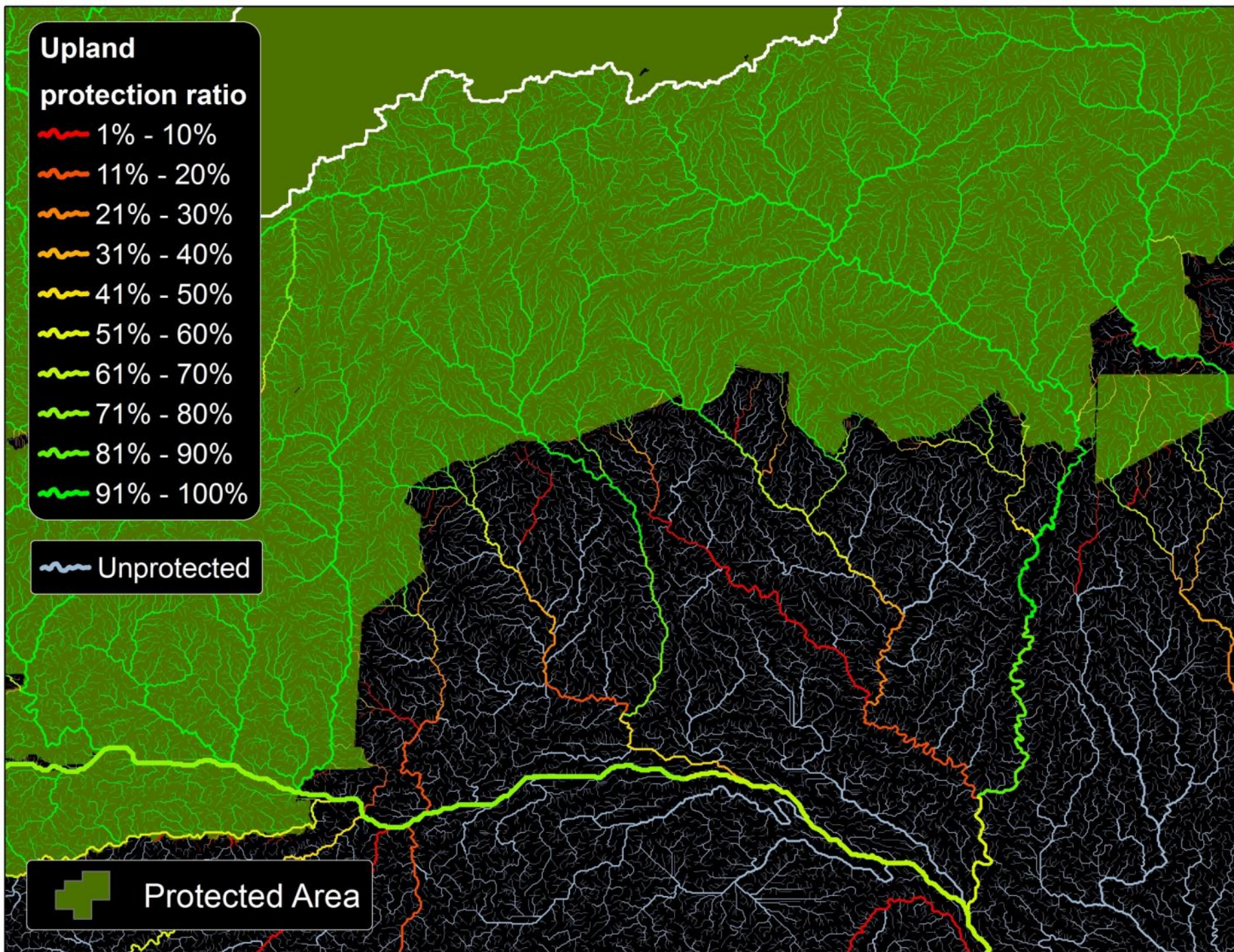
protection ratio

- 1% - 10%
- 11% - 20%
- 21% - 30%
- 31% - 40%
- 41% - 50%
- 51% - 60%
- 61% - 70%
- 71% - 80%
- 81% - 90%
- 91% - 100%

Unprotected

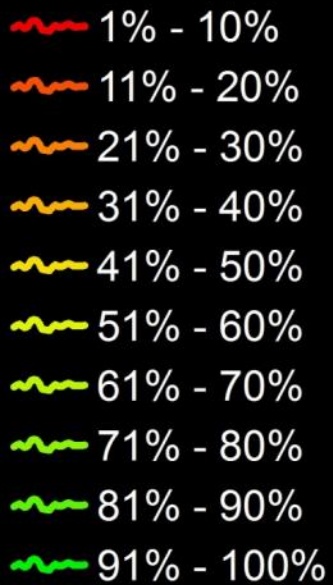


Protected Area

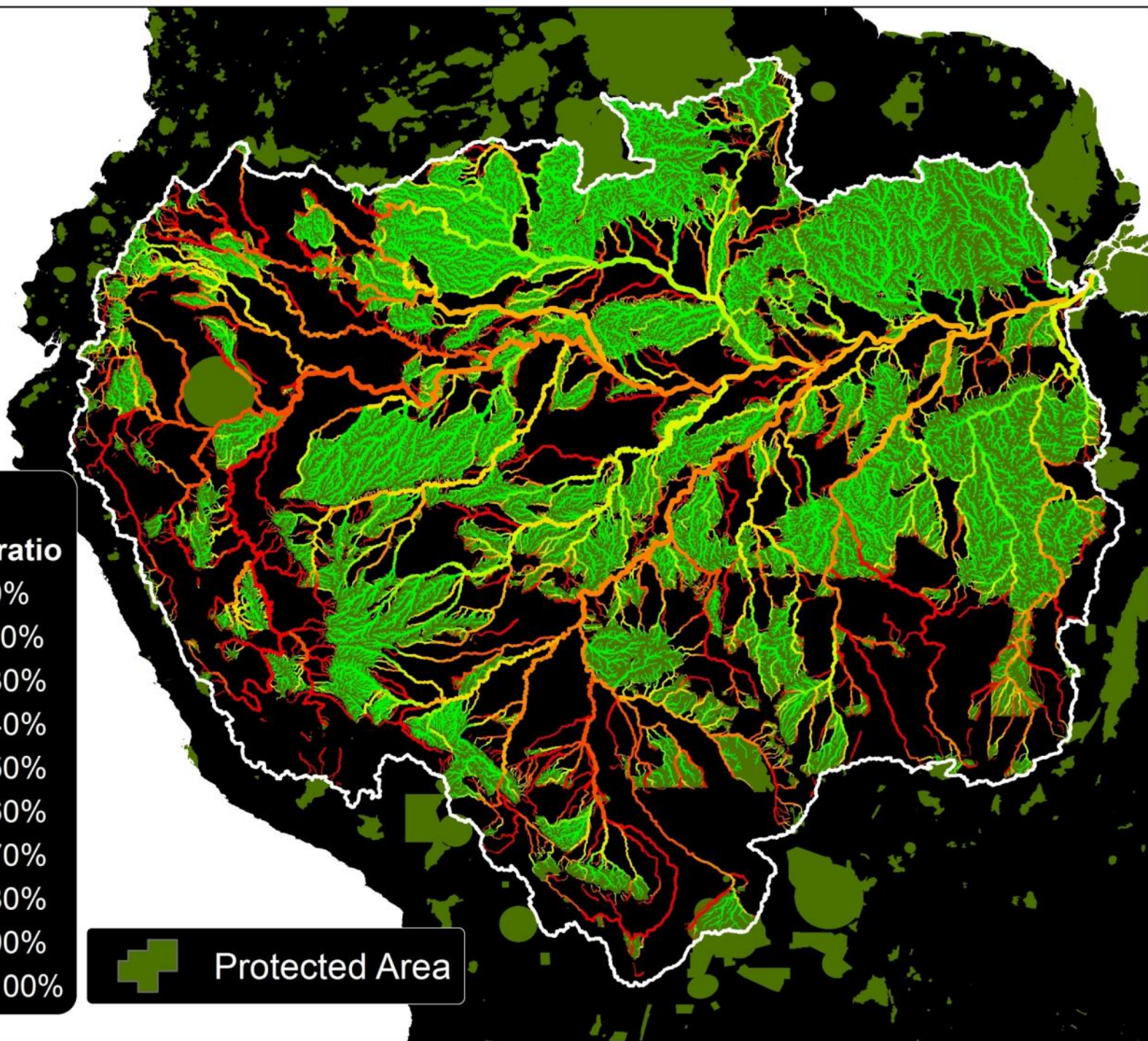


Upland

protection ratio



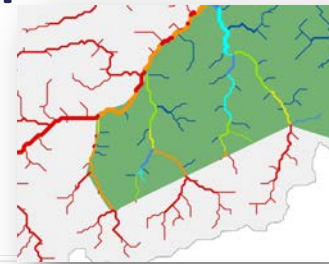
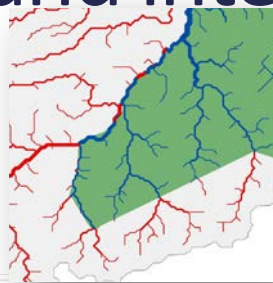
Protected Area



Results

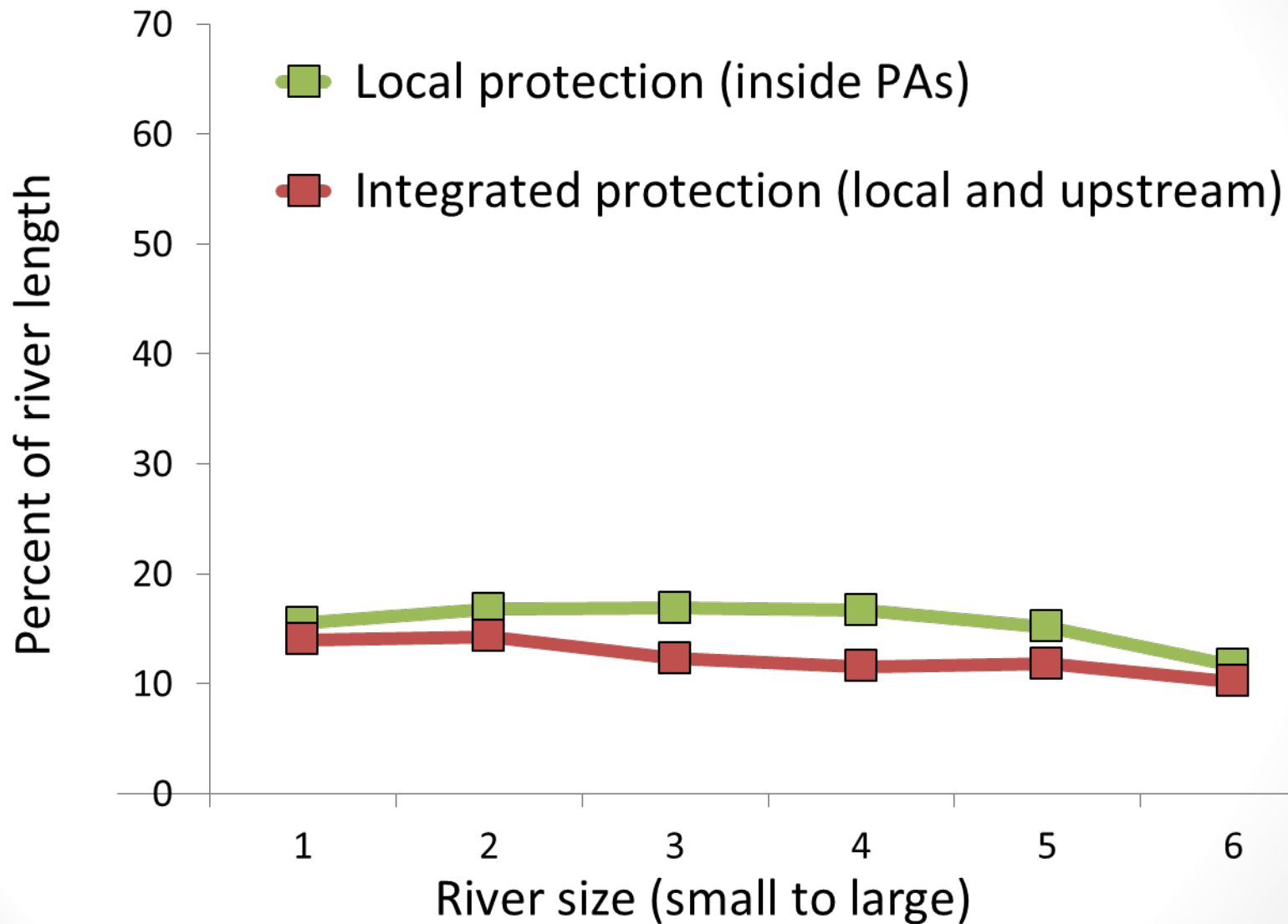
- We analyzed 6.3 million river reaches (average length: 3.9 km), representing all rivers globally with an average flow of 100 liters/sec ($0.1 \text{ m}^3/\text{s}$) or more, amounting to 23.4 million river kilometers in total
- Rivers were distinguished by size into 6 logarithmic stream orders according to their long-term average discharge (from $0.1 \text{ m}^3/\text{s}$ to $> 10,000 \text{ m}^3/\text{s}$)

Comparison of protection status (%) between local and integrated protection

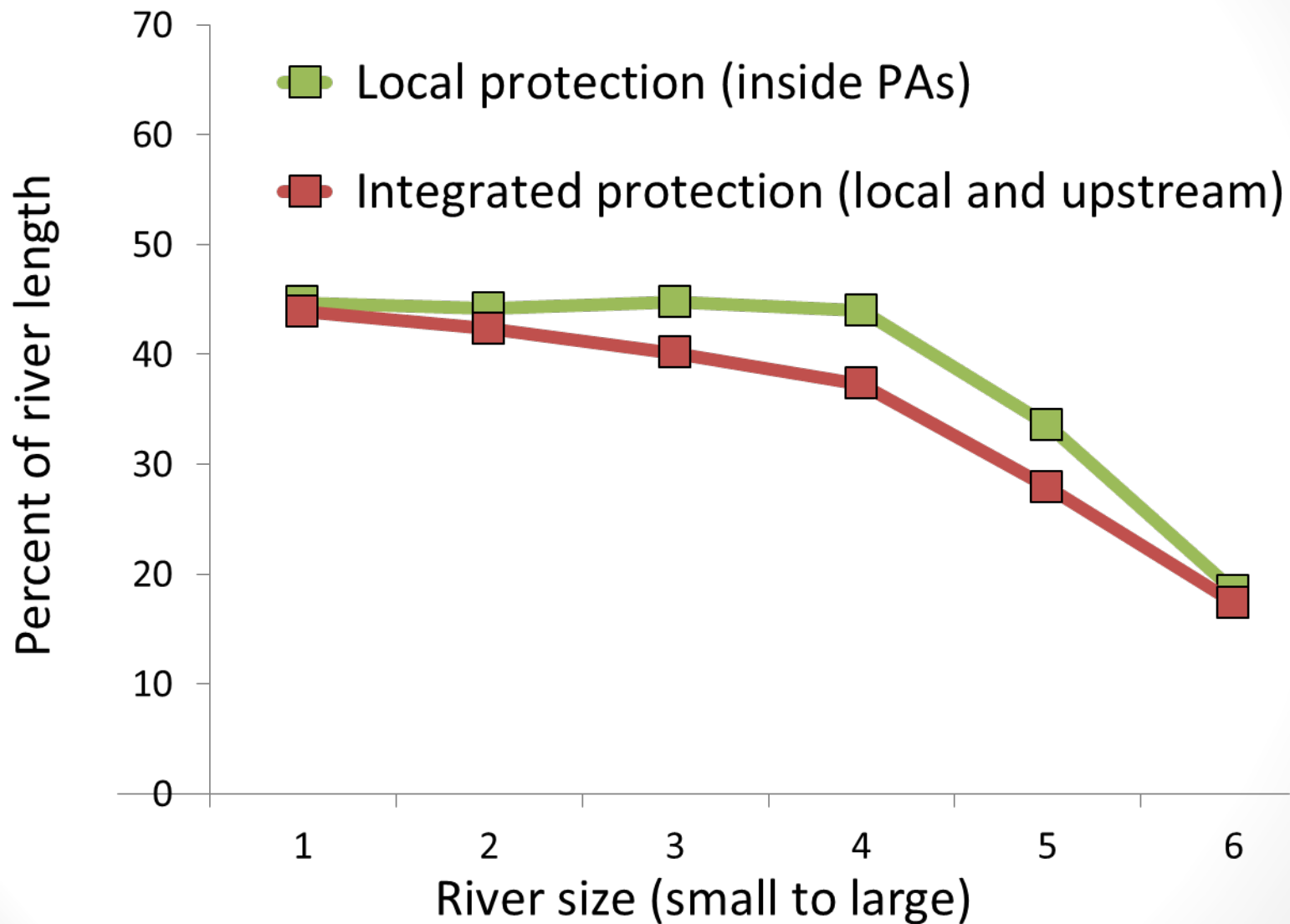


| <i>Basin</i> | <i>Local Protection</i> | <i>Integrated Protection</i> |
|---------------------|--------------------------------|-------------------------------------|
| Global | 16.0 | 13.5 |
| Amazon | 44.2 | 42.5 |
| Yukon | 33.2 | 30.2 |
| Zambezi | 25.7 | 21.5 |
| Mekong | 17.9 | 15.8 |
| Danube | 14.9 | 9.2 |
| Yangtze | 14.7 | 12.6 |
| Colorado | 14.9 | 7.2 |
| Congo | 11.4 | 10.1 |
| Murray-Darling | 8.1 | 3.5 |
| Rio Grande | 6.1 | 3.3 |
| Orange | 5.7 | 1.7 |
| Mississippi | 5.6 | 1.9 |
| Euphrates-Tigris | 1.4 | 0.9 |

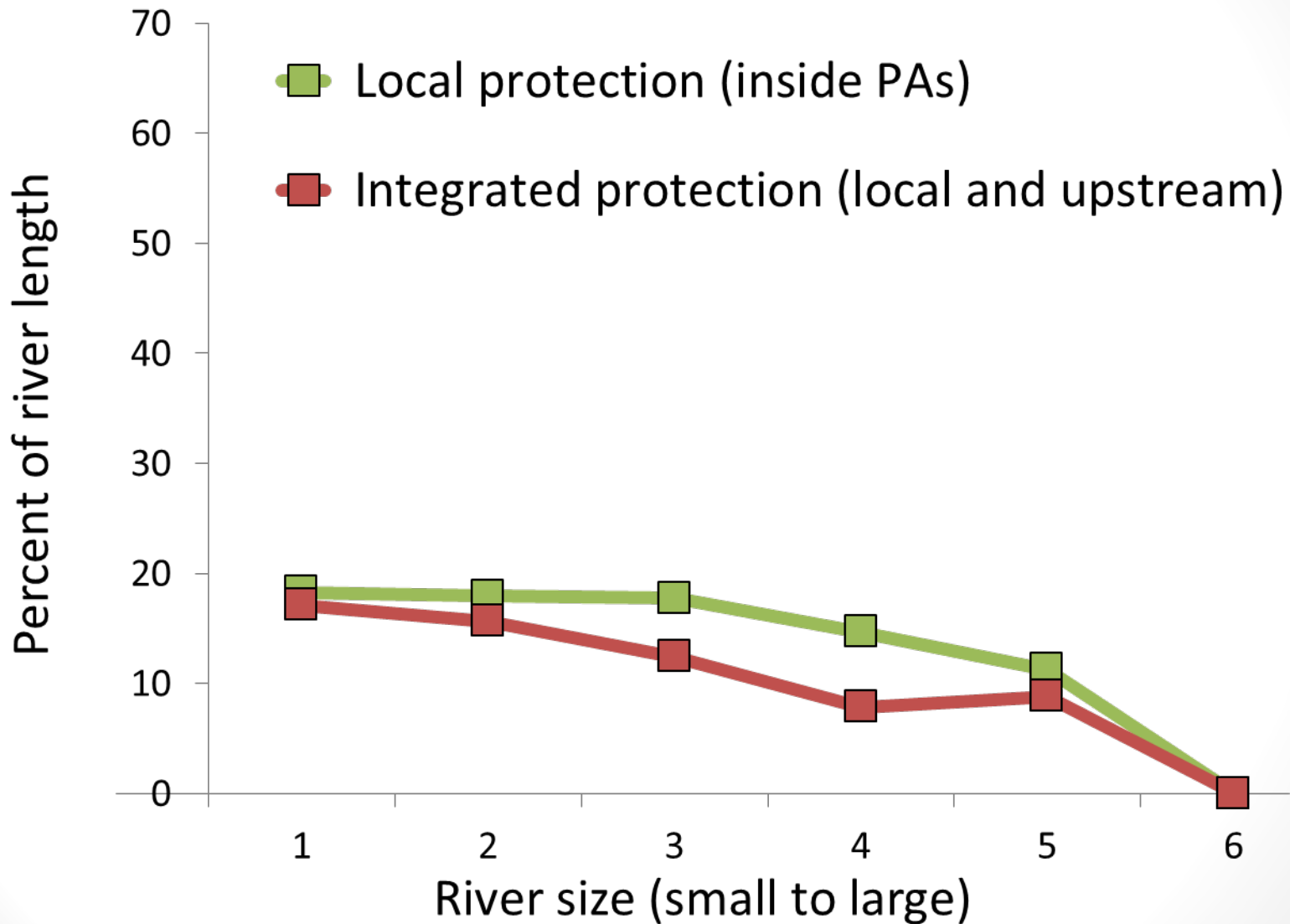
Global



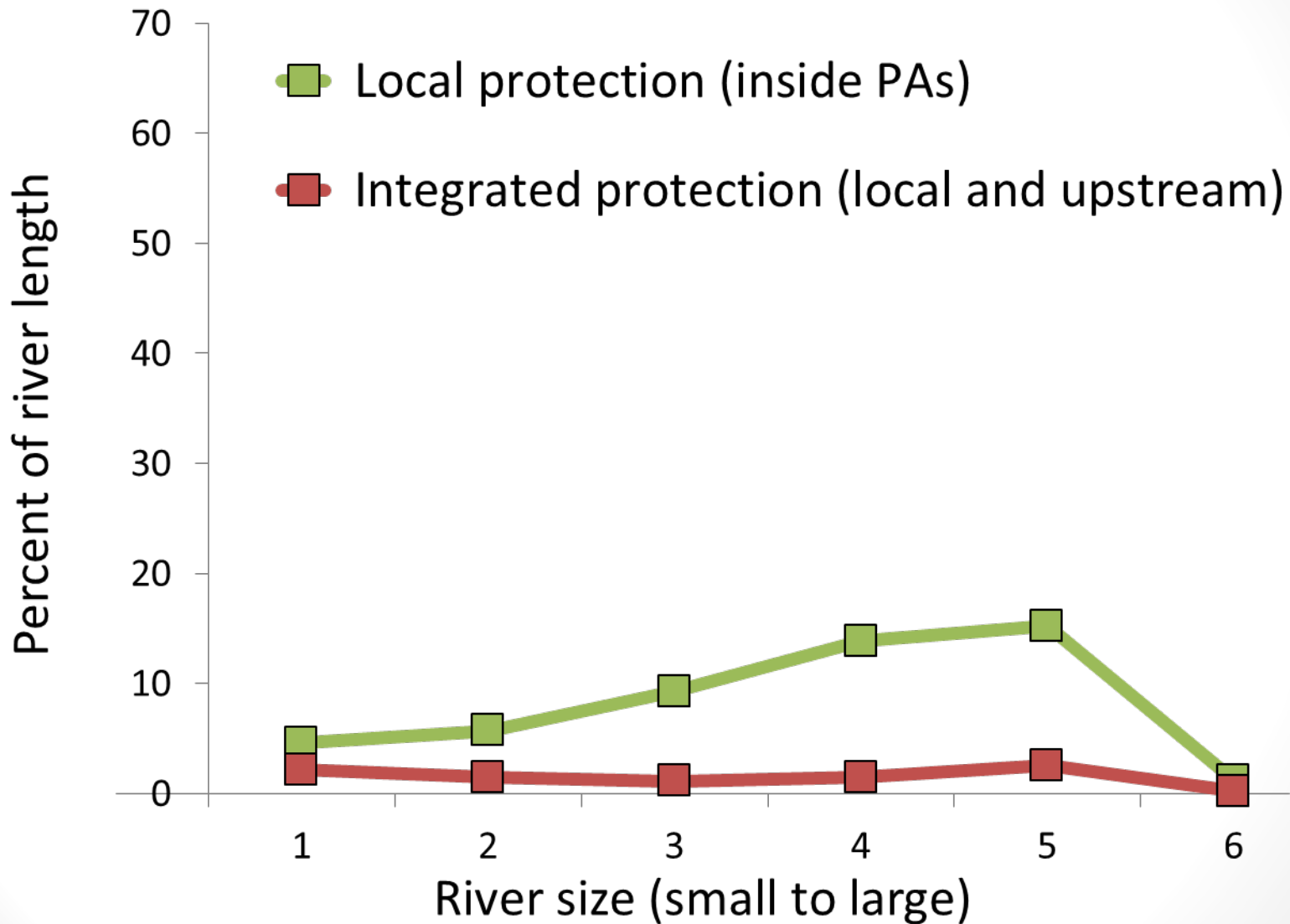
Amazon



Mekong



Mississippi





Major findings

- **69%** of rivers have no protected areas in their upstream basin
- **16.0%** of the length of all rivers is in PAs (local protection)
- Integrated protection is lower at **13.5%** globally
- Integrated protection varies substantially by basin/region, and can be significantly lower than local protection

Local protection

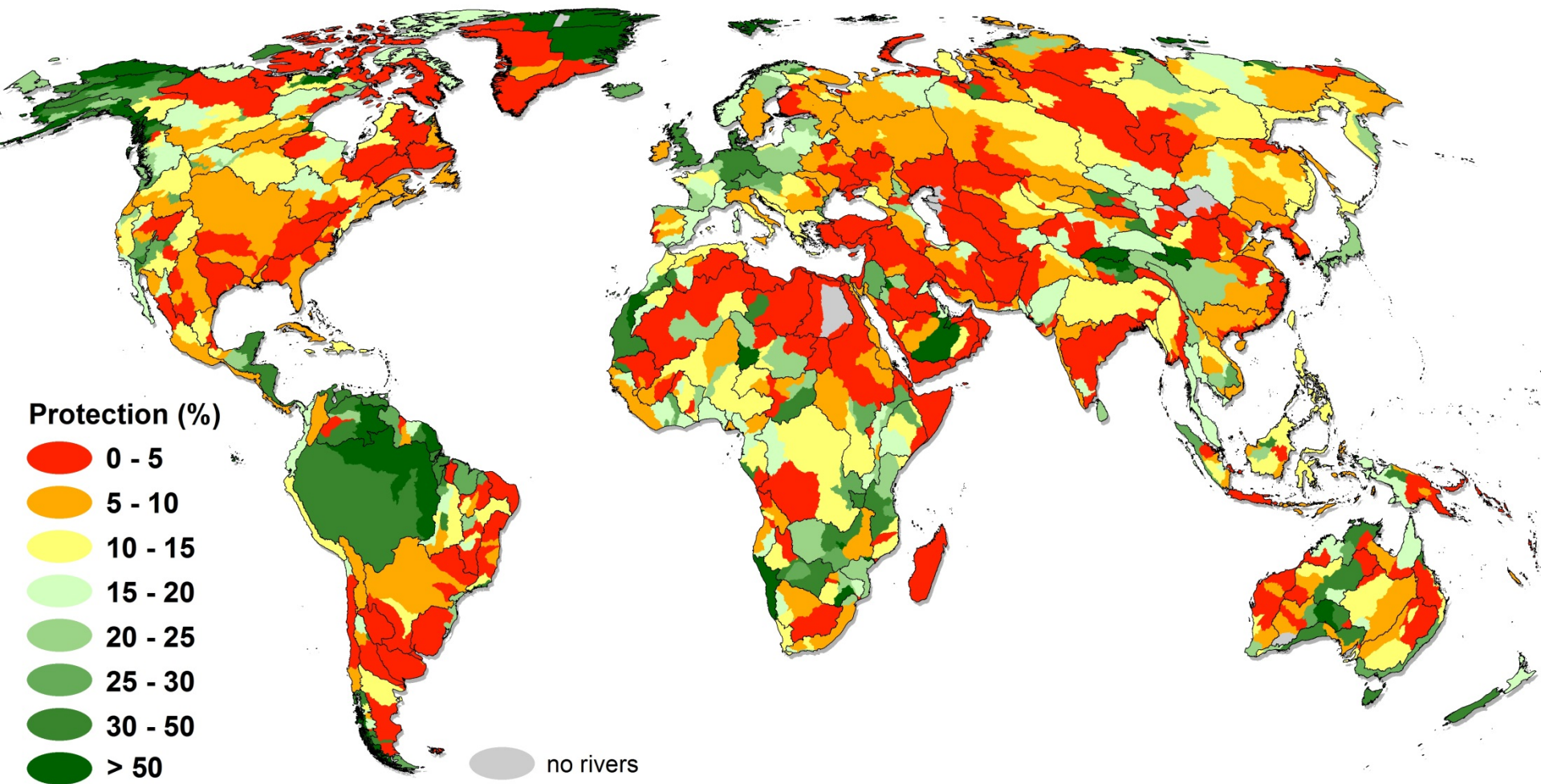


Figure shows values for subbasins at Pfafstetter level 4

Integrated protection

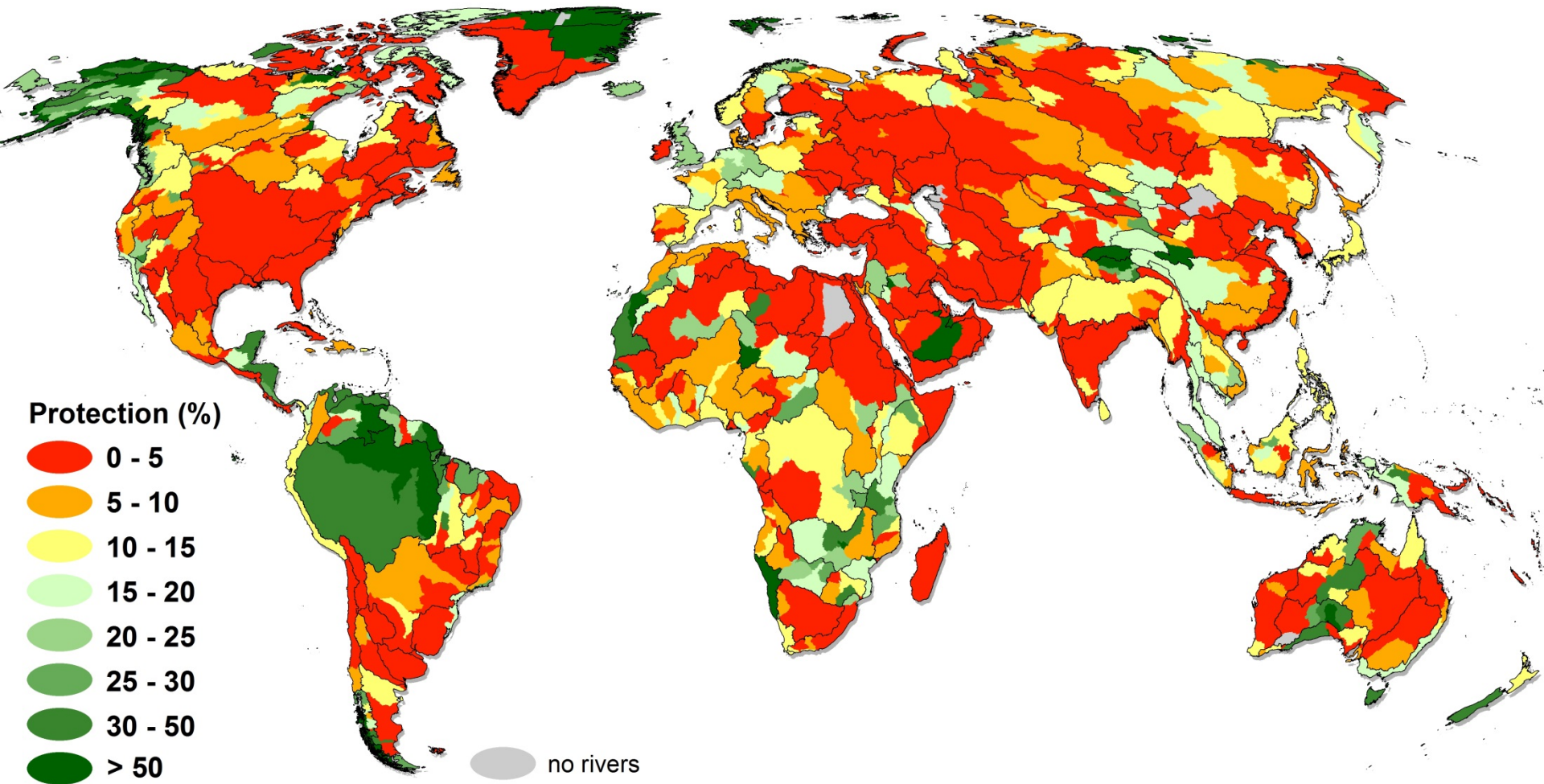


Figure shows values for subbasins at Pfafstetter level 4

Protection levels by region

| Region | Local Protection (% river length in PAs) | Integrated Protection (local and upstream) |
|---------------|---|---|
| Africa | 13.8 | 11.2 |
| Asia | 10.8 | 8.9 |
| Australia | 14.6 | 12.1 |
| Europe | 13.1 | 8.3 |
| Middle East | 9.2 | 7.6 |
| North America | 13.5 | 10.8 |
| South America | 29.3 | 27.5 |

Thank you!



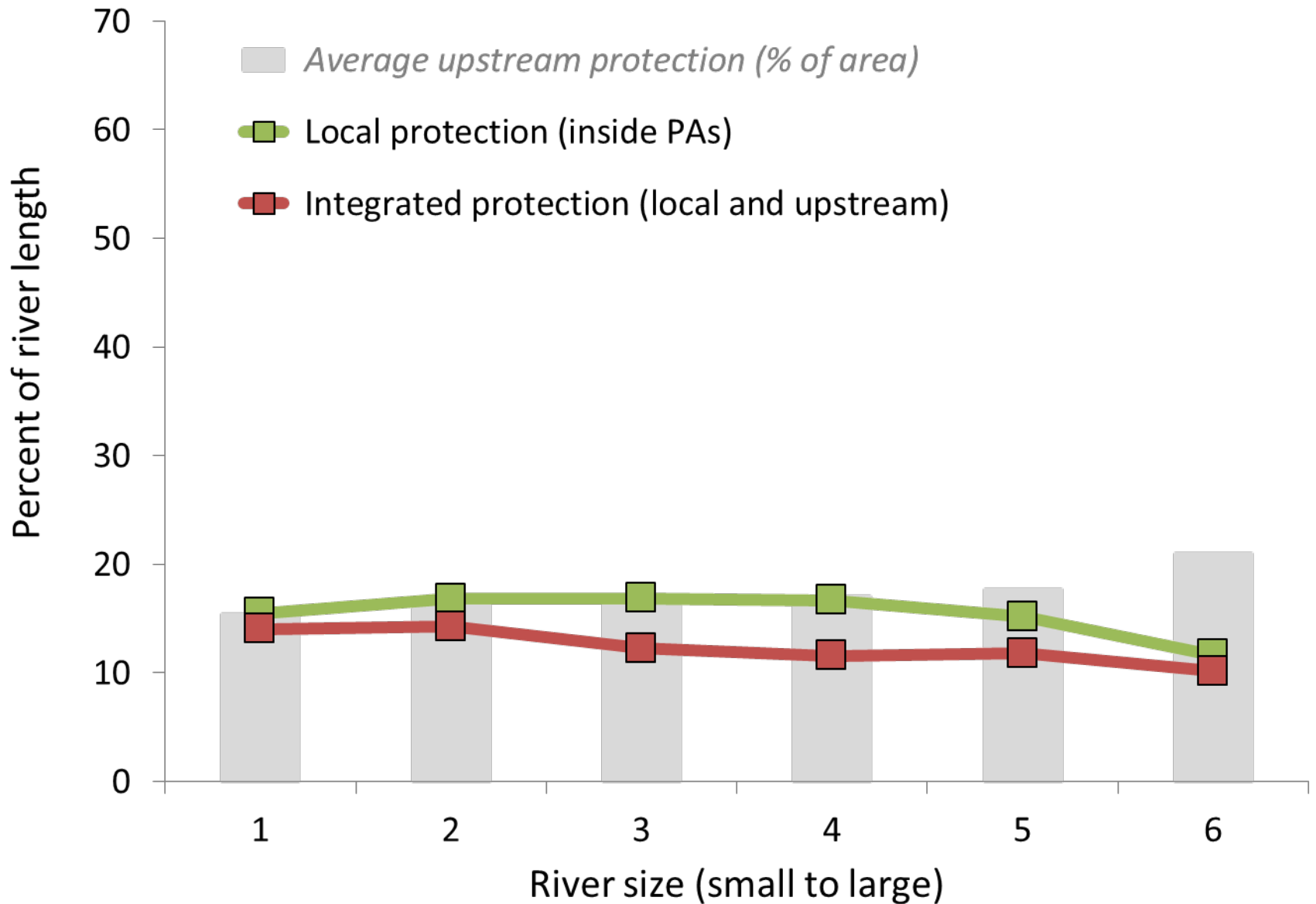
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Extra slides

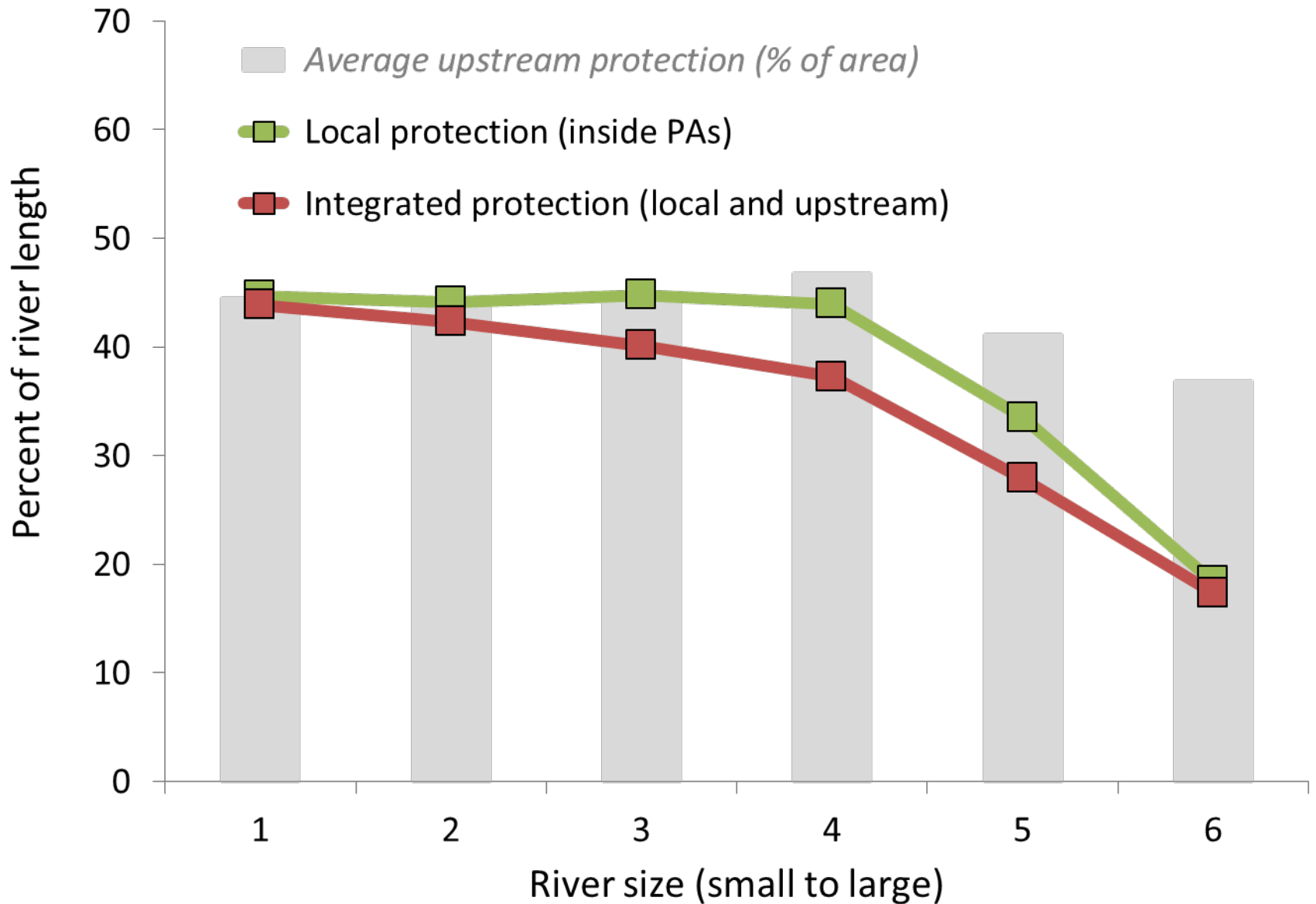
Comparison of protection status (%) between local and integrated protection

| <i>Basin</i> | <i>Local Protection</i> | <i>Average upland protection</i> | <i>Integrated Protection</i> |
|------------------|-------------------------|----------------------------------|------------------------------|
| Global | 16.0 | 15.9 | 13.5 |
| Amazon | 44.2 | 44.4 | 42.5 |
| Yukon | 33.2 | 32.8 | 30.2 |
| Zambezi | 25.7 | 24.6 | 21.5 |
| Mekong | 17.9 | 20.6 | 15.8 |
| Danube | 14.9 | 14.1 | 9.2 |
| Yangtze | 14.7 | 15.5 | 12.6 |
| Colorado | 14.9 | 14.4 | 7.2 |
| Congo | 11.4 | 11.5 | 10.1 |
| Niger | 10.8 | 11.2 | 7.9 |
| Amur | 10.1 | 9.1 | 7.0 |
| Volga | 8.2 | 6.8 | 4.1 |
| Murray-Darling | 8.1 | 7.1 | 3.5 |
| Rio Grande | 6.1 | 6.6 | 3.3 |
| Orange | 5.7 | 2.4 | 1.7 |
| Mississippi | 5.6 | 3.7 | 1.9 |
| Euphrates-Tigris | 1.4 | 1.6 | 0.9 |

Global



Amazon



Amur

