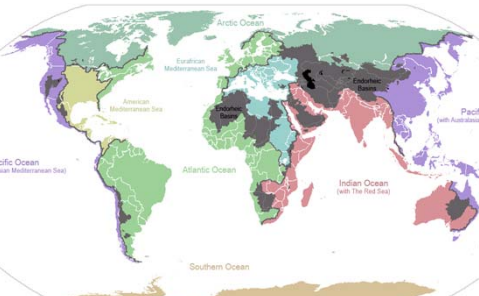


# TROPICAL FRESHWATER ECOSYSTEMS



A world map illustrating global watersheds, color-coded by region. The map shows the following major watersheds and their associated oceans/seas:

- Pacific Ocean (with Australasian Mediterranean Sea):** Includes watersheds in North America, Central America, the Caribbean, South America, and Australia.
- Atlantic Ocean:** Includes watersheds in Europe, Africa, and South America.
- Indian Ocean (with the Red Sea):** Includes watersheds in Africa, Asia, and Australia.
- Pacific Ocean (with Australasian Mediterranean Sea):** Includes watersheds in North America, Central America, the Caribbean, South America, and Australia.
- Arctic Ocean:** Includes watersheds in Northern Europe and Northern Asia.
- European Mediterranean Sea:** Includes watersheds in Southern Europe and Northern Africa.
- Asian Mediterranean Sea:** Includes watersheds in Southern Asia and Northern Australia.
- Southern Ocean:** Includes watersheds in Antarctica.

Global watersheds

Kricher Chapter 12

Kricher Chapter 12

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## Amazon Basin

A map of the Amazon Basin showing the catchment area in purple. The map includes the following labels:

- Geographical Features:** Guyana Shield, Brazilian Shield, Amazon catchment area: 6.5 million km<sup>2</sup>.
- Countries:** VENEZUELA, COLOMBIA, GUYANA, BRASIL, PERU, BOLIVIA.
- Cities:** Caracas, Bogotá, Georgetown, Belém, Imperatriz, Brasília, São Paulo, Rio de Janeiro, La Paz, Cochabamba, Santa Cruz.
- Rivers:** Orinoco, Negro, Amazon, Japurá, Jurua, Purus, Madeira, Tapajós, Tocantins, Paranaíba, Paraguai, Guaporé, Beni, Madre de Dios, Acre, Napo, Tarma, Huancabamba, Ucayali, Marañón, Yacuriza, Yari, Negro, Branco, Trombetas, Xingu, Araguaia, Tocantins, Paranaíba, Paraguai, Guaporé, Beni, Madre de Dios, Acre, Napo, Tarma, Huancabamba, Ucayali, Marañón, Yacuriza, Yari.
- Oceans:** Atlantic Ocean, Pacific Ocean.

Guyana Shield

### Brazilian Shield

Amazon  
catchment area:  
6.5 million km<sup>2</sup>

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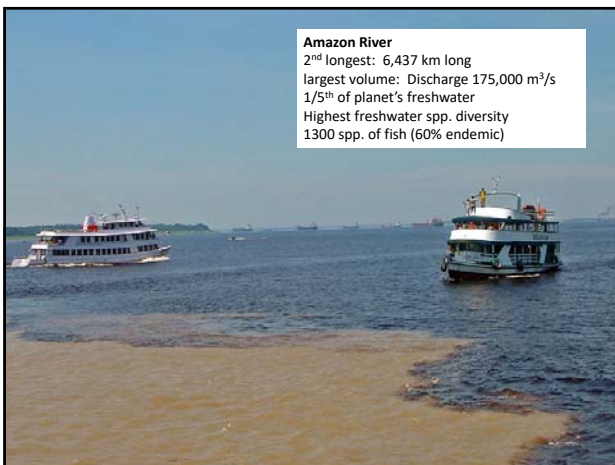
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2<sup>nd</sup> longest: 6,437 km long  
largest volume: Discharge 175,000 m<sup>3</sup>/s  
1/5<sup>th</sup> of planet's freshwater  
Highest freshwater spp. diversity  
1300 spp. of fish (60% endemic)



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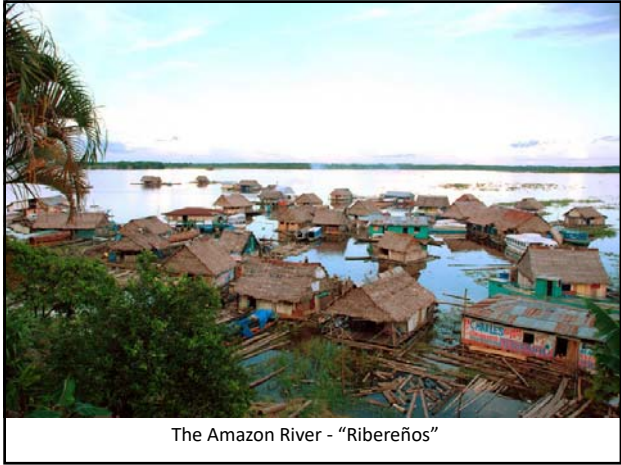
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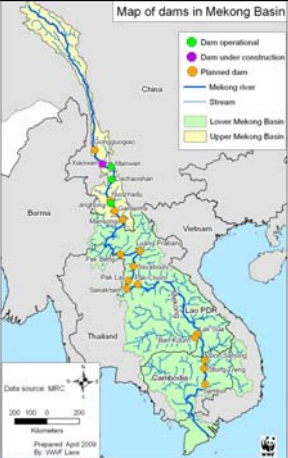
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### Mekong Basin

- Discharge 16,000 m<sup>3</sup>/s
- 800+ spp. of fish
- Highest diversity of large fish
- High endemism: waterfalls, rapids
- Dams, flood control, pollution, fishing threaten biodiversity




Map of dams in Mekong Basin

Legend:

- Dam operational
- Dam under construction
- Planned dam
- Mekong river
- Stream
- Lower Mekong Basin
- Upper Mekong Basin

Data source: MRIC  
Prepared April 2009  
By: WWF Laos



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### The Mekong River



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Tropical “Whitewater” Rivers

Physical & Chemical Properties

- Amazon is largest one!
- warm water (upper 5-13°C, lower 28°C)
- **very turbid** (0.1-0.5 m secchi disk)
  - drain mountains
  - soft clay substrate
- little light penetration
- **allochthonous** nutrient sources
- low oxygen, near neutral pH
- **annual floods**

deliver nutrients (0.8-0.9 billion tons/yr from Andes)

flood forest, expand aquatic habitat



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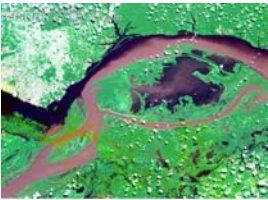
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Blackwater Rivers

- drain sandy soils (Guyana shield)
- very slow moving
- low in sediment (and nutrients)
- lots of tannins; tea-colored water
- **acid pH (4.5-5.1)**
- low diversity

pirañã





Rio Negro meets Amazon

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Clearwater Rivers

- small forest interior streams
- often ephemeral
- **shady** (little **autochthonous** production)
- high pH range (4.5-7.8)
- low diversity, but ecologically important



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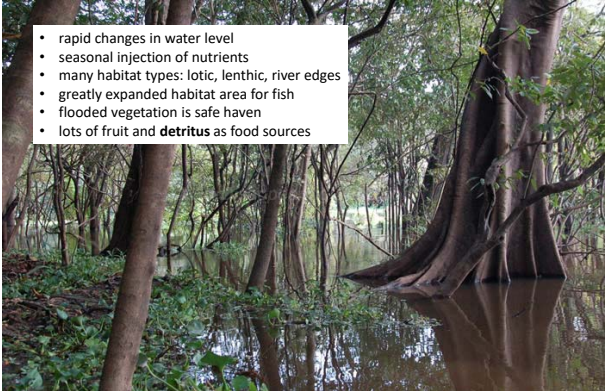
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The Flooded Forest = Riverine or Gallery Forest

- rapid changes in water level
- seasonal injection of nutrients
- many habitat types: lotic, lentic, river edges
- greatly expanded habitat area for fish
- flooded vegetation is safe haven
- lots of fruit and **detritus** as food sources



Kricher pg 451 "Amazon flood cycle"

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Oxbow lakes & tropical lagoons



low diversity and abundance  
persistent thermocline (little mixing)  
very low oxygen

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Phytotelmata



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Adaptations of Amazon Fish

Amazon: 2,400 – 3,200 fish spp.

1. Changing Water Levels

- Migration
- Rapid development
- Move over land (catfish, lungfish)
- Estivation in mud



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Adaptations of Amazon Fish

2. Turbidity / low light

- Non-visual communication
  - pressure, electroreception (lateral line)
  - chemosensory / olfactory (barbels)
  - sound & hearing (Weberian apparatus)
- Split eyes (e.g. Arowana)
- Influences color



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Adaptations of Amazon Fish

3. Low primary production

- Detritivory, **frugivory**, predatory
- (allochthonous food sources)

4. Low oxygen

- Air-breathing (Labyrinth organ)



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Flooded Forest  
Arowana – allochthonous food sources



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Adaptations of Amazon Fish to:

5. High predation risk

- Mouth-brooding (many Cichlids, paiche)
- Burrow nesting (catfish)



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Amazon Fish Diversity (~2400 – 3200 spp)





Order Characiformes (piraña, tetras, etc)

- ~1150 neotropical spp., >10 families
- ~40% of Amazonian freshwater spp.
- laterally compressed bodies, soft ray fins
- upturned mouths
- soft fin rays
- Large teeth (predatory or frugivorous)

See Kricher pg 449-453

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Order  
Siluriformes  
(catfish)

~34 families



39% of Amazonian freshwater fish  
dorsoventrally depressed  
spiny fin rays, most lack scales  
small eyes, downturned mouth, **barbels**  
scavengers, bottom-feeders, gill-feeders

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The dreaded "Candiru"



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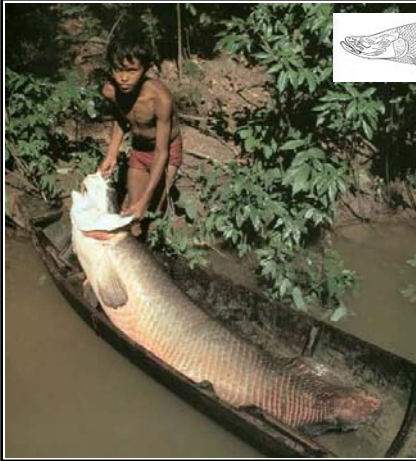
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Order Osteoglossiformes  
*Arapaima gigas*

"pirarucú"  
"paiche"

- scales protect against piraña
- air-breather
- top predator in low O<sub>2</sub> lakes
- seasonal breeding
- mouth brooder
- endangered

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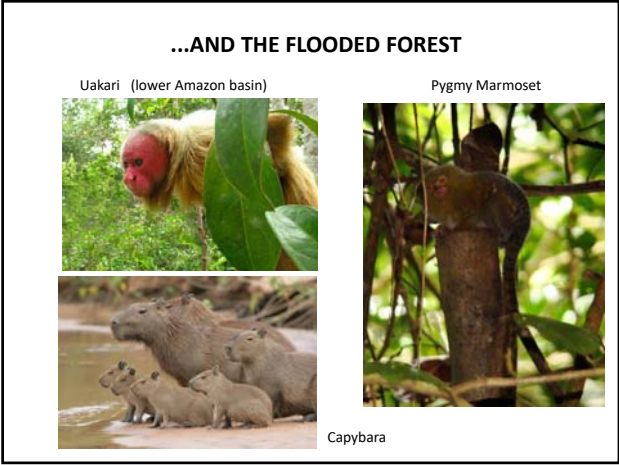
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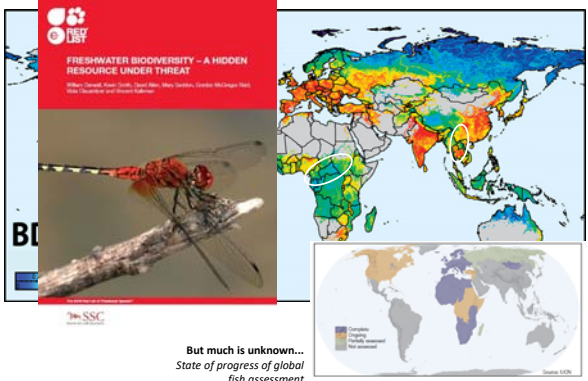
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Global Freshwater Biodiversity Threat



But much is unknown...  
State of progress of global  
fish assessment

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Global Freshwater Biodiversity Threat

- habitat loss
- hunting
  - turtles and eggs
  - caiman skins
  - otter pelts
  - mammals
- Fishing



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Global Freshwater Biodiversity Threat

- gold mining
- pollution
  - mercury
  - agrochemicals
  - petroleum



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Global Freshwater Biodiversity Threat

- dams



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