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Colloque international sur l'étude, la restauration et la gestion de l'alose
International symposium on restoration and conservation of shads

Obstacles à la circulation : l'approche française et le cas de la Dordogne

Migration barriers: the French approach and the case of the Dordogne river

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Session 2 : State of the science / Etat des connaissances

Bergerac
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Notion of fishpass efficiency

- **Fishpass efficiency depends on :**
  - **Attractivity: do fish find the entrance(s) and enter ?**
  - **Passability : do fish that enter exit upstream ?**

  ➔ Assessment through percentage of passage and delay

- **Attractivity is the most important and difficult point**
  - **It's not « natural » for a fish to enter inside a confined structure (reluctance, hesitation)**
  - **Fish generally need multiple presentations at fishpass entrance before entering**

Particularity of shad behaviour and life cycle (1/2)

- **Shads are more demanding with respect to flow pattern**
- **Migration in shoals**
- **Lower swimming and prospection capacity than salmonids**

➔Shads are particularly reluctant to enter and progress into fishpasses

➔Necessary to be much more demanding with respect to the size and the siting of the device, the location of the entrance(s) and the quality of the attraction at the obstruction

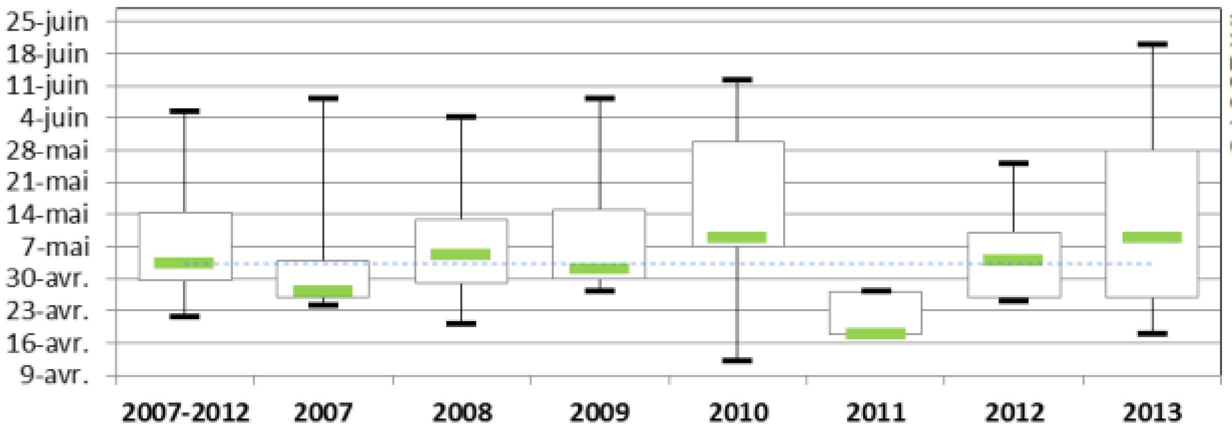
- **Downstream migration not taken into account**
  - **Nearly all adults of Allis shad die after spawning (twaite shad not really concerned)**
  - **Juvenile damages through turbines are limited and generally acceptable**

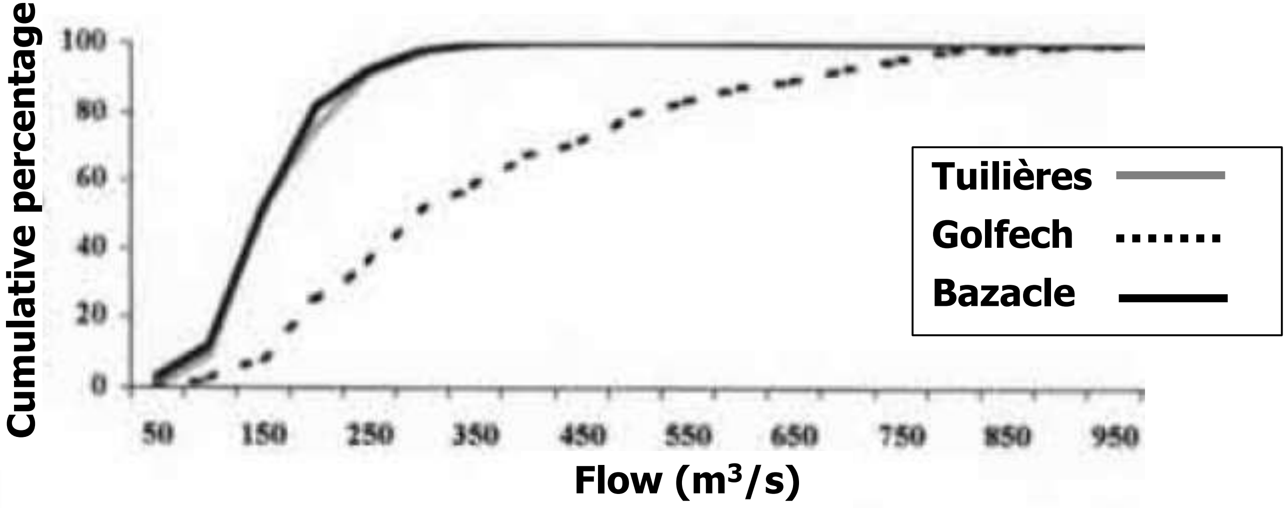
Particularity of shad behaviour and life cycle (2/2)

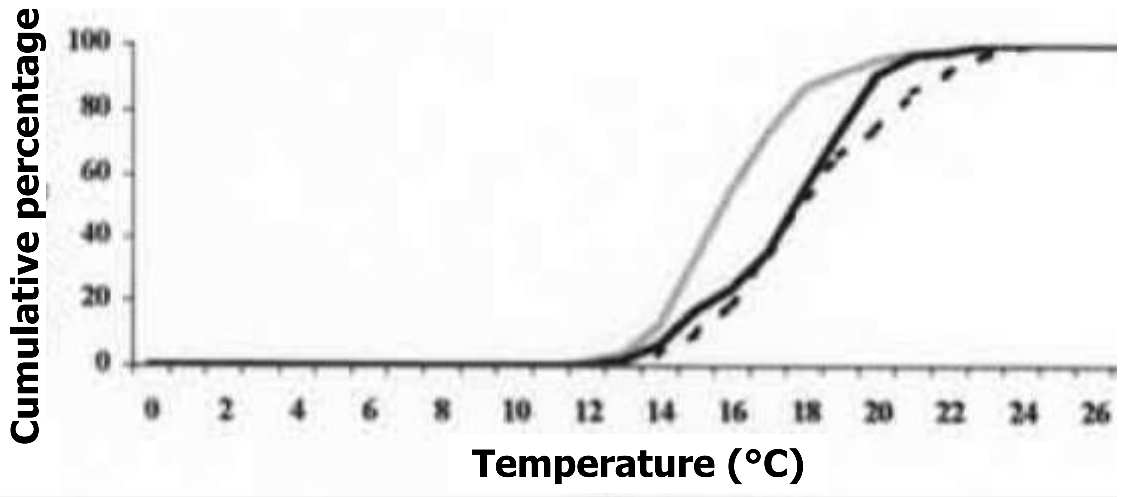
- **A narrow period of migration (4-8 weeks ; 15-20°C, up to ≈ 2 * the mean annual flow)**

➔ Devices need to be fully operational during this period and limit delay

Migration period at Descartes on the Creuse river (LOGRAMI)







River mean annual flow :

Tuilières : 271 m³/s, Golfech : 391 m³/s, Bazacle : 178 m³/s

Upstream migration devices recommended in France (1/3):

- **Rough ramps or pre-barrages (preliminary weirs) for drops ≤ 1 m**

Belleville, Loire

Dampierre, Loire

- **Rocky ramp with perturbation boulders for drops ≤ 2-3 m**

  ➔Slopes of 5-6% max, $H \geq 0.4$ m, $V_{MAX} \leq 2$ m/s

Callet, Gardon

Bourg Charente, Charente

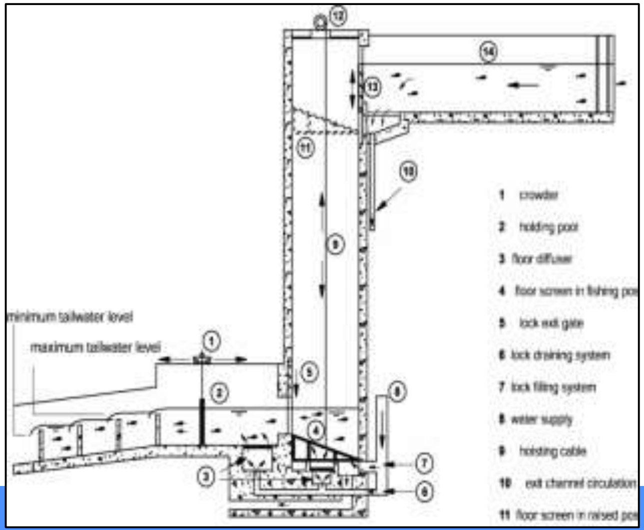
Upstream migration devices recommended in France (2/3):

- **Single and preferably double vertical slot fishways for higher drop**
  - **➔ ΔH ≤ 0.25 m, b ≥ 0.45 m, PV ≤ 150 W/m³, H ≥ 1.2 m, surface jet**
  - **➔ Particularly at hydroelectric powerplant**

Iffezheim, Rhin

Puyoo, Gave de Pau

- **Fish lifts for high drops (8 – 10 m)**
  - **Large holding pool (min 5 m x 2.5 m x 1.5 m) + mechanical crowder to confine shads above the lifting tank**

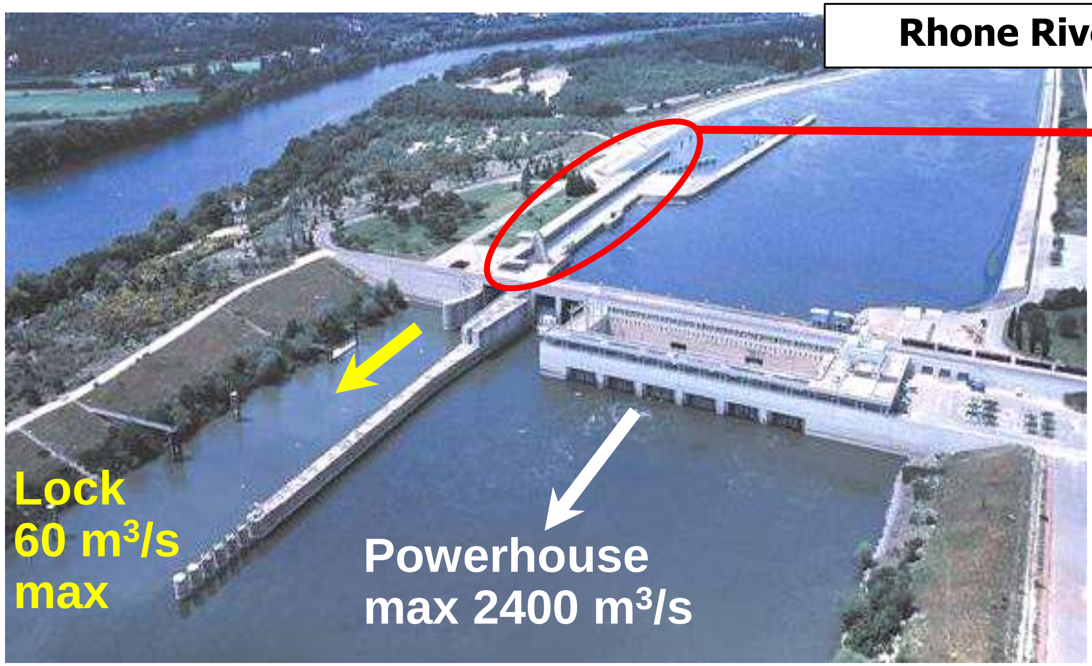


Golfech, Garonne

Upstream migration devices recommended in France (3/3):

- **Navigation locks with specific operating cycles**

Rhone River



- **Baffle fishways are to avoid (turbulent and aerated flow)**

Recommendations for the attractivity

- **Locate the entrance(s) at the most upstream point where fish prospect**

- **Maintain an attractive flow at the entrance during the full range of discharge during migration :**
  - **Drop between 15-30 cm ⬄ Velocity between 1.7 à 2.4 m/s**
  - **Keep the entrance flow detectable for fish ➔ Not hidden by turbulence or eddies**

- **At least between 1-3% for large rivers and 3-5% for small rivers of competing flow in the entrance :**
  - **No problem at low-head dam without any important flow use**
  - **More difficult at large dam and/or hydroelectric plant**

  ➔ Size and cost of the fishpass and energy loss

Efficiency for shad and areas for improvement (1/2)

- **≈ 75% is the best efficiency achieved, ≈ 50% is considered as good efficiency and < 20% is a poor efficiency unfortunately frequent**

➔ Issue of cumulative impacts of several obstacles

<u>Main areas for improvement concern the attractivity, especially at hydroelectric dams</u>

- **Location of the entrance(s) :**
  - **Multiplication of entrances directly located over turbine outlet seems not a solution for shad (Cabot station, Vernon)**

  ➔ Concentrate the available flow in 2 or 3 large entrances along banks
  - **Really imperative to get detectable flow, even if it leads to displace entrance laterally or downstream from turbine outlet (Gatehouse, Safe Harbor)**
  - **Location over draft tubes, where possible, seems particularly suitable (Safe Harbor, Gambsheim)**

Efficiency for shad and areas for improvement (2/2)

- **Work on turbine priorization during the migration period (few weeks)**

- **Build several fishpasses at dam and powerplant, or on each bank**

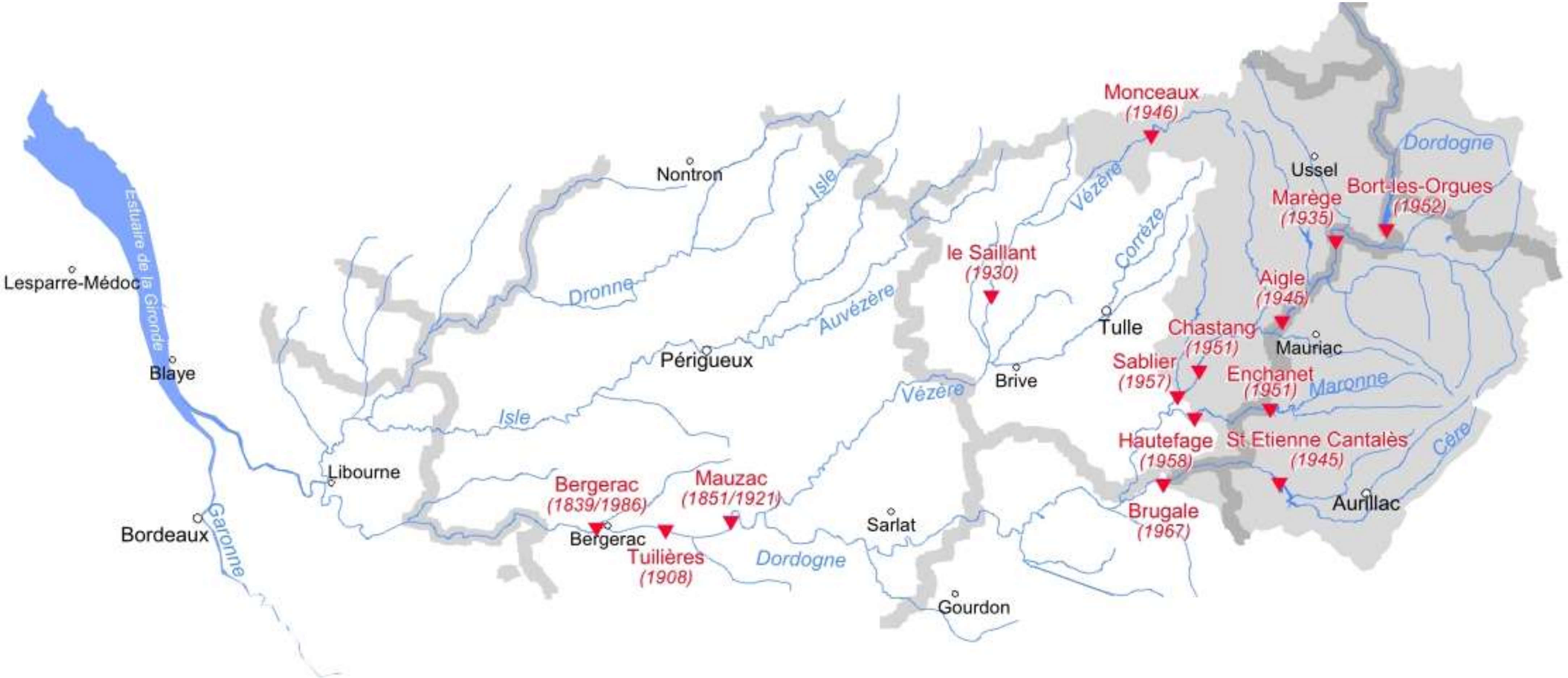
<u>Some improvements concerning passability</u>

- **Injection of additional flow in downstream pools ➔ more progressive injection in several basins (Gersteim)**

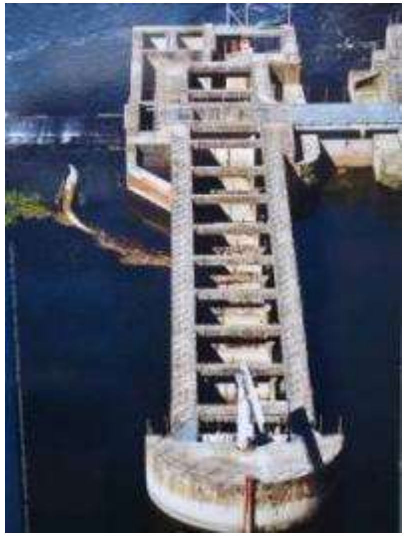
- **Avoid or limit turning pools if possible**

The Dordogne case

3 main dams on the lower part of the basin (200 km from ocean) in a stretch of 30 km of river



Bergerac dam



- Dam built in 1840 and powerplant in the 60'
- Powerplant maximum turbine discharge : 57 m^3/s (mean annual flow 280 m^3/s)
- Height : 4 m
- Double vertical slot fishways built in 1986

River flow (m^3/s)	Fishpass discharge	Additional flow	Total discharge at entrance
50	2.5	0	2.5 (5%)
840	6	5	11 (1.3%)

Tuilieres dam

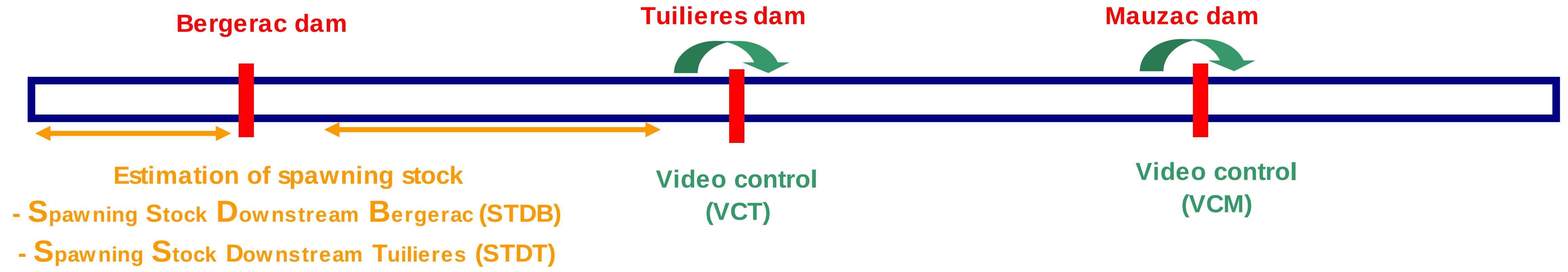
- Built in 1908
- Maximum turbine discharge : 380 m^3/s
- Height : 12.5 m
- Fish lift built in 1989 + single vertical slot fishpass:
  - Discharge : 2.5 to 4.5 m^3/s
  - Video station control

Mauzac dam

- Built in 1840 (elevation in 1920)
- Maximum turbine discharge : 280 m^3/s
- Height : 7.5 m
- Single vertical slot fishpass built in 1986:
  - Water discharge : 1 m^3/s + 2 – 4 m^3/s attraction flow
  - 2nd fish pass entrance built in 2004
  - Video station control

Estimation of fishpass efficiency

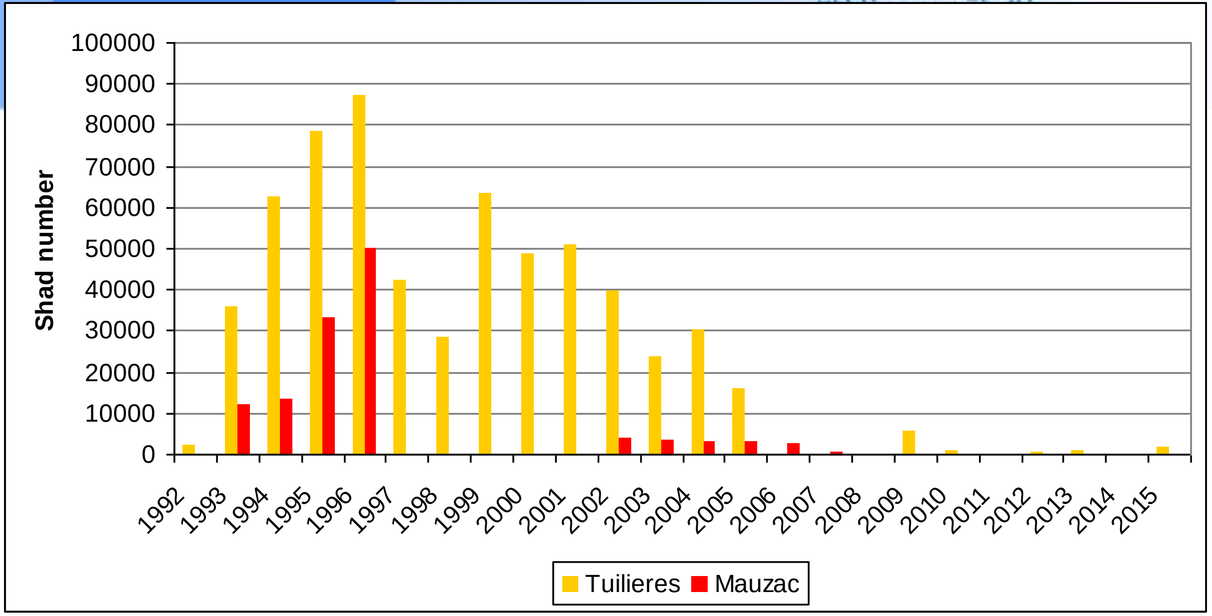
- **Fish passage (video) at Tuilieres and Mauzac fish pass**
- **Estimation of the spawning stock downstream Bergerac and Tuilieres dams (see next presentation)**



→ **Transfer rate between obstacles (minimum efficiency) –** hypothesis that all fish that spawn downstream one dam try to pass over before spawning (« forced » spawning zone)

- **Bergerac efficiency : Σ (STDT + VCT) / Σ (STDT + VCT + STDB)**
- **Tuilieres efficiency : Σ VCT / Σ (VCT + STDT)**
- **Mauzac efficiency : Σ VCM / Σ VCT**

Estimation of fishpass efficiency



- **Bergerac fishpass efficiency for shad globally (2003 – 2015) : 55 to 65%**

- **Tuilieres fish pass efficiency for shad globally (2003 – 2015) : 35% to 55%**

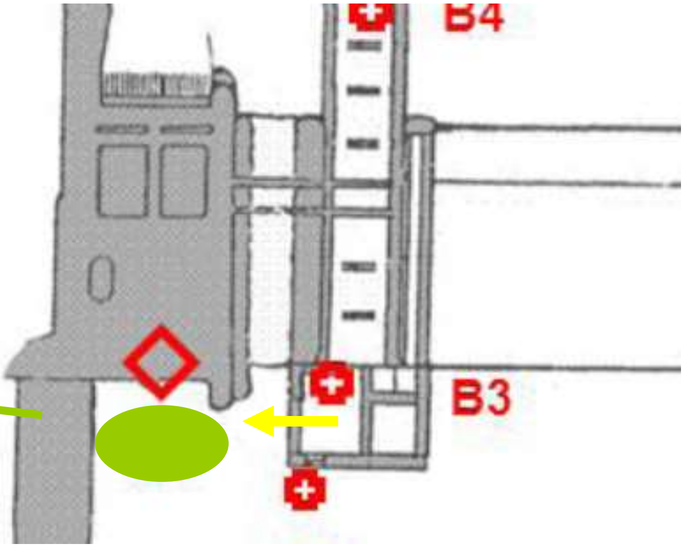
- **Mauzac fishpass efficiency for shad:**
  - **20-50% in 1993-1996 (mean ≈40%), when fishpass were correctly operated**
  - **5-15% since the 2000s, in relation with :**
    - **Probably an influence by the importance of the stock / shoal behaviour**
    - **Problems in the fishpass operation :**
      - **Turbine priorization not effective**
      - **Problems with the additional flow injection (intake clogging, aerated flow at injection)**
      - **Problems to configure the controller of the second entrance gate during 10 years (2004-2014)**

➔ **Less than 5% of shad upstream the third dam** (probably less than 50% for salmon and less than 25% for lamprey)

➔ **Necessity to improve the passability of all three dams**

Reflections to improve the situation for shad (lamprey and salmon also)

- **Objective for shad : minimum efficiency of 70% at each dam**
- **At Bergerac dam :**
  - **Limit the « corner effect »➔ create a second entrance near the fish accumulation area just downstream the powerplant**
  - **If it's not enough, as the powerplant is low equipped / river discharge, build a second fishpass on the left bank + attractive flow (small power plant ?)**



- **At Tuilieres dam:**
  - **Prioritize turbine operations. For example : T6 – T7 – T5 – T4 – T3 – T2 – T1 – T8**
  - **Improve the entry of fish in the fish lift**
  - **Build a second fish pass on the left bank of the dam (in relation with spilled flow for downstream passage solution)**

- At Mauzac dam:
  - At the dam : build a second fish pass (2017)
  - At the powerplant :
    - Prioritize turbine operations more effectively
    - Improve additional flow injection
    - Create one or several attractive entrance(s)



Conclusions

- Necessity to improve the passability of all three dams is one of the solution to improve the situation of shad population

- But even if 70% of shads pass each dam, ≈ 65% of the stock will remain downstream Mauzac

➔Necessity also to assure / improve the functionality of spawning area downstream dams

- Improvement of fishpass will also benefit other species, especially salmon and lamprey

- We still need to acquire feedbacks on fishpass efficiencies for shads:
  - Recent and new facilities on the Rhine and Rhone River
  - Rocky ramp with perturbation boulders (Gardon, Gave d'Oloron, Charente, …)