

## FW 400 EXAM 1 – 2007 - Answers

Write answers on only one side of your paper. When finished with the exam, ***write your name on the back of the last page only***. Answers receiving the highest grades will be those that convey a well-organized, detailed synthesis in a concise form. Make sure to provide evidence to support your statements in the form of citations of relevant papers where appropriate. *Answers must be written in complete sentences, using correct spelling and grammar, unless indicated otherwise (i.e., using phrases only). No abbreviations will be allowed unless they are defined.*

### Essay question

2. Flow is a primary abiotic factor affecting stream fishes in both temperate and tropical ecosystems, especially at early life stages. First, contrast the flow regimes in one tropical and one temperate freshwater ecosystem that we've learned about in lecture or readings, and describe how fish populations are adapted to cope with these fluctuations. Second, describe how Fausch et al. (2001) used this understanding to test factors affecting where rainbow trout (*Oncorhynchus mykiss*) would likely invade in the Holarctic region, and summarize their results.

***Tropical system:*** Many tropical lotic systems are characterized by flooding during the rainy season (Lewis et al. 2000). Water levels in the Orinoco and Amazon basins may rise 10-15 meters and inundate floodplains outside of natural levees and flood tropical forests. Turbid, nutrient rich waters support dense phytoplankton blooms, but invertebrates filter this material and maintain clear water early in the flooding season. As floodplains are isolated, decomposition reduces dissolved oxygen, phytoplankton blooms eventually reduce water clarity as nitrogen becomes limiting and blue-green algae abound.

Fishes of these tropical basins are well adapted to cope with the fluctuations in flow, and those in floodplain lakes appear to sort themselves into distinct communities during the isolation season (Lewis et al. 2000). When floodplain forests are inundated during the rainy season, many fish species eat allochthonous materials that are washed in or inundated by the floods, such as leaves, flowers, and fruits of trees. Many tropical species time their upstream migrations and spawning to coincide with the flooding, so as to put their young in an environment favorable for growth. Many are also adapted for hypoxic (low-oxygen) environments, because oxygen is rapidly depleted by the decomposing organic material on floodplains. As the isolation (dry) season proceeds, fish communities in floodplain lakes become related primarily to water transparency, with visual feeders (e.g., characins) in clear lakes and tactile (catfishes) and electrosensory feeders (knifefishes) favored in turbid ones.

***Temperate system:*** Flows in warm water streams such as the one Schlosser (1985) studied in Illinois are predictably high during spring, but decrease and are more variable through late summer and autumn. Thunderstorms during summer can produce floods, and periods without rain can produce droughts, so fish may be exposed to extreme high or low flow depending on the month and year.

Larval and juvenile stream fishes are typically very small (<10 mm) and highly susceptible to fluctuations in flow. Hence, the timing of floods is critical in determining annual abundance of the age-0 cohort of many stream fishes. Schlosser (1985) showed that juvenile abundance of different species in an Illinois stream varied greatly between two years with markedly different flow regimes, one with prolonged high spring and summer flow and the other with lower flow and summer drought. Early spring spawners such as darters and suckers were not affected much by the differences in flow between years, probably because these benthic fishes can better withstand high flows. In contrast, taxa that spawn in late spring and early summer, such as sunfishes and minnows, had much greater recruitment during the drought year. Minnows with prolonged breeding such as the bluntnose minnow (*Pimephales notatus*) were particularly successful at capitalizing on periods of low flow, which makes them well adapted to streams with fluctuating flows.

*Fausch et al. (2001)*: These authors hypothesized that rainbow trout would invade in regions where the flow regime matched that in their native range. They used flow records to determine the average percentage of floods by month, and compared that to the timing of fry emergence in the native range on the Pacific coast of North America, and in four regions to which rainbow trout have been introduced and where invasion success varied from highly successful to general failure. They found that the regions where invasion was successful had flow regimes that matched those in the native range of rainbow trout. In these regions, the frequency of floods was low or declining when the fry emerged, so they would be less likely to be displaced or killed by floods.

### Terminology and concepts

6. What is meant by an interaction between factors, such as we discussed for Ross et al.'s (1992) study of bayou darters?

An interaction (in a statistical and ecological sense) is when the level of one factor affects the response to another. In the laboratory experiments using bayou darters (Ross et al. 1992), the water temperature affected the percentage of darters that use flow refuges behind bricks. At lower water temperatures, more darters used flow refuges in medium than slow flow, whereas at warmer temperatures there was no difference in refuge use at the two flows. Thus, temperature affected how flow affected darter refuge use (the interaction), probably because darters are poorer swimmers at lower temperatures due to their lower metabolic rate (the mechanism).

10. How did Mion et al. (1998) use otoliths to determine factors influencing walleye recruitment in Lake Erie?

**Mion et al. (1998) captured walleye fry drifting from spawning areas in two Ohio rivers throughout the spawning and early larval period. They sectioned otoliths and counted daily rings of larvae caught just downstream of the spawning area (upstream site), and at midstream and downstream sites in the river. They found that the hatch date distribution of larvae caught upstream was very different than those caught midstream or downstream, and inferred that other processes like high flow that damages fry, food availability, and predation caused high recruitment variation in this walleye population.**

13. List, and describe in one complete phrase each, the main types of large-scale migration patterns of fishes.

**A. Oceanodromous – fish migrate solely within salt water**

**B. Diadromous – fish migrate across a salinity barrier**

**1. Anadromous – adult fish spawn in freshwater and juveniles rear there, but then migrate to the ocean and grow to adulthood**

**2. Catadromous – adult fish spawn in salt water, but juveniles migrate to freshwater and grow to adulthood there**

**C. Amphidromous – fish migrate between fresh and salt water for purposes other than breeding**

**D. Potamodromous – fish migrate solely within fresh water**

**1. Adfluvial – fish migrate between lakes and streams (spawn in streams, rear in lakes)**

**2. Fluvial – fish migrate within larger river systems (usually spawn in headwaters, rear in larger rivers)**