Fisheries Management and Ecology, 2002, **9**, 123–125

Management and Ecological Note

The effect of a sluice gate and its mode of operation on mortality of drifting fish larvae in Bangladesh

F. MARTTIN

CPP project, Tangail, Bangladesh & FIRI, FAO, Rome, Italy

G. J. DE GRAAF

Nefisco foundation, Amsterdam, The Netherlands

Periodic inundation of the floodplain is the main driving force behind fish production in floodplain river systems (Junk, Bayley & Sparks 1989). In Bangladesh, the developing larvae of many rheophilic whitefish species, including those of the high-value Indian major carps, migrate or drift laterally from the main river channel into the inundated floodplain to exploit the ephemeral surge in primary and secondary production. Since 1970, the annual inundation of approximately 2 million ha of floodplain in Bangladesh has been either prevented altogether, or controlled by means of sluice gates or pumps positioned along earth embankments (Siddiqui 1990). These flood control and irrigation schemes (FCDI) provide an important defence against extreme flooding and a semicontrolled hydrological environment for growing crops, particularly rice. Several workers have examined the impacts of these hydraulic engineering structures on fish production in Bangladesh (Halls, Hoggarth & Debnath 1998, 1999; de Graaf 2000) and larval fish movement (de Graaf, Born, Uddin & Huda 1999).

This note reports on experiments carried out at the main regulator of the Compartmentalization Pilot Project (CPP) located in the River Lohajang in Bangladesh. The main regulator of CPP controls the water flow entering the project area with three main gates, each consisting of two vertically sliding doors 3 m wide typical of those used in Bangladesh, which can be operated separately under two different modes: undershot and overshot (Fig. 1). This note describes the impact on mortality rates of fish larvae passing this regulator operated under different conditions.

For the experiment, a mix of larvae, obtained from a commercial hatchery, consisting of *Labeo rohita* Hamilton, *Catla catla* Hamilton and *Cirrhinus mrigala* Buch was used. At least 20 000 larvae with an average weight of 0.21 $\pm$ 0.13 g (SE) were used per experiment. The total batch of larvae were released together upstream of the regulator, after which an average of 3500 were recaptured just before and after passing through the regulator. The recaptured larvae were stocked in 200-L oil drums with aeration. As a control group about the same number of larvae were taken from the original stock and also placed in an oil drum. All larvae were transported to the laboratory, where the mortality rates of the non-treated control group, and the upstream and downstream groups were determined by counting all dead and live larvae 1–2 h after release.

There were significant differences ($P < 0.05$) in the mortality rates upstream and downstream of the regulator (Table 1). The average mortality of the larvae caught just upstream of the regulator was 16.6% and this increased to 41.4% for the larvae caught just downstream of the regulator, indicating that about 25% of all hatchlings passing the main gates of the regulator died because of this passage.

Correspondence: Gertjan de Graaf, Nefisco Foundation, Lijnbaansgracht 14c, 1015 GN Amsterdam, The Netherlands (e-mail: degraaf@nefisco.org).

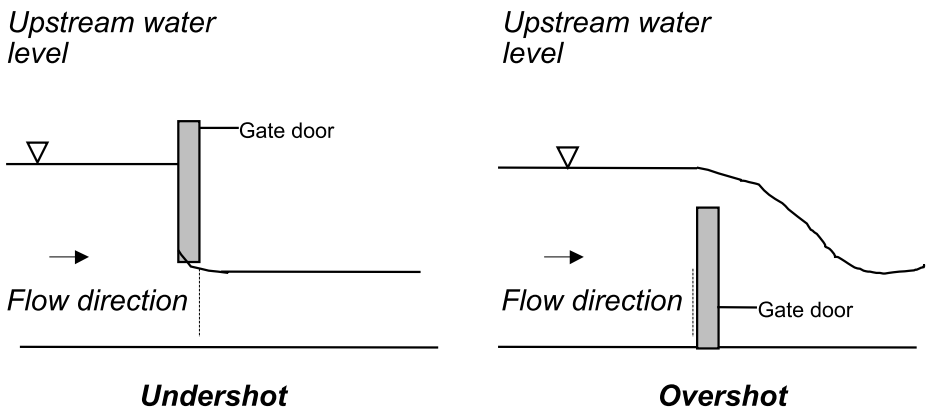

Figure 1. Illustration of under and overshot operation of the main regulator.

Table 1. Mortality rates (±SE) of released carp larvae caught in front of the regulator and after passing the main gates of the regulator in comparison with a non-treated control group (different superscripts indicate significant difference, ANOVA, $P < 0.05$)

Location	Mortality after 1–2 h (% of total larvae recaptured)	Number of experiments
Control group	$7.2^{A} \pm 1.5$	10
Upstream regulator	$16.6^{A} \pm 2.2$	10
Downstream regulator	$41.4^{C} \pm 7.2$	10

However, the overall average mortality was influenced by the way the regulator was operated during the experiments. Therefore, the mortality rates induced by the regulator, i.e. the difference between the mortality observed just before and after passing the regulator, for the two different modes of operation are determined (Table 2). About 44% of the hatchlings died within 2 h after passing the main gates of the regulator if used in an undershot mode, which is the standard mode of operation in Bangladesh. When the main gates of the regulator were used in an overshot mode the mortality reduced significantly ($P < 0.05$) to about 11%.

It was concluded that the regulator examined has a significant impact on the survival of passing fish larvae especially in the undershot mode of operation. Next to *Hilsa* species, most of the drifting larvae consisted of white fish species such as *Labeo rohita* and *Glossogobius giuris* (Hamilton) (de Graaf *et al.* 1999), and the impact of the regulator could explain the differences in species assemblage and production levels observed by Halls *et al.* (1998) inside and outside embanked floodplains in Bangladesh. However, hydrological modelling indicated that the regulator in CPP can be operated in overshot mode with no adverse impact on water regulation (de Graaf 2000). Therefore, it is strongly recommended that this aspect may be included in the future design, construction and operation of regulators in Bangladesh and other comparable floodplain ecosystems.

Undershot operation of regulators could be favourable for the outward migration of adults in the pre-monsoon if low water velocities can be maintained inside the regulator. However, this would only be of importance for the larger floodplains having a permanent hydrological connection with the major

Table 2. Mortality rates of carp hatchlings (±SE) for under and overshot operations of the main gates of the regulator

Mode of operation	Mortality rate (% of total larvae recaptured)	Number of experiments
Overshot	11.8 ± 3.6	6
Undershot	44.0 ± 5.6	4

river system. No data are available on this subject and it is therefore recommended that this aspect is studied and compared with the results on the effectiveness of the different fish passes constructed for this purpose in Bangladesh.

Acknowledgments

The work reported in this paper was carried out as part of the Compartmentalization Pilot Project carried out by the Ministry of Irrigation, Water Development and Flood Control, funded by the Government of the Netherlands and the Federal Republic of Germany. The views are those of the authors and not the Government of Bangladesh, the Government of the Netherlands or the Government of the Federal Republic of Germany. The field experiments were carried out with the support of the CPP monitoring staff; Mr Leonus Gomez, Mr Nuruzzaman, Mr Rafiquel Islam, Mr Liakat Ali and Mr Jamal Uddin and the different team leaders and project directors of the CPP project.

References

de Graaf G.J. (2000) Compartmentalisation Pilot Project, larval fish drift and water management. Experiences with flood management and its impact on riverine fish larvae in Bangladesh. CPP Fisheries Technical Paper No 2000/2, Dhaka: Bangladesh Water Development Board.

de Graaf G.J., Born A.F., Uddin A.M.K. & Huda S. (1999) Larval fish movement in the river Lohajang, Tangail, Bangladesh. *Fisheries Management and Ecology* **6,** 109–120.

Halls A.S., Hoggarth D.D. & Debnath K. (1998) Impact of flood control schemes on river fish migration and species assemblages in Bangladesh. *Journal of Fish Biology* **53,** 358–380.

Halls A.S., Hoggarth D.D. & Debnath K. (1999) Impact of hydraulic engineering on the dynamics and production potential of floodplain fish populations in Bangladesh. *Fisheries Management and Ecology* **6,** 261–286.

Junk W.J., Bayley P.B. & Sparks R.E. (1989) The flood pulse concept in river-floodplain systems. In: D.P. Dodge (ed.) *Proceedings of the International Large River Symposium. Canadian Special Publication of Fisheries and Aquatic Sciences* **106,** 110–127.

Siddiqui M.H. (1990) Flood control and drainage development: physical environment issues. In: A.A. Rahman, S. Huq & G.R. Conway (eds) *Environmental Aspects of Surface Water Systems of Bangladesh*. Dhaka: University Press Ltd, pp. 104–108.