

## LANDSCAPE CHARACTERISTICS OF RIFFLES IN MIDDLE REACHES OF RIVER

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Riffles in a stream provide diverse habitats for aquatic creatures. The riffles have been investigated for long periods by many researchers in order to evaluate the habitats. But the condition of physical environment is usually represented by depth, velocity, substrate and so on without thinking about the comprehensive property of riffles. However, the diverse environment in a riffle is expressed as the diverse texture of its water surface. It is conceivable that the texture of water surface can represent the comprehensive property of the environment.

Against such a background, we considered there is a chance that the physical conditions in a riffle can be classified into several groups based on the texture of water surface. Therefore, we analyzed the relationship between physical conditions and wave patterns in riffles.

At first, wave patterns in some riffles were investigated. Then, they were categorized into nine patterns in consideration of spatial scale of each wave. Every wave type is generated by different fluid and riverbed property, hence the distribution of hydraulic and riverbed configurations in a riffle that determine wave patterns was also investigated. Riverbed configurations were represented by mean diameter and roughness of the riverbed.

After some field observations and hydraulic experiments, it was clarified that the physical elements which determined wave patterns were Froude number ( $Fr$ ), the ratio of mean depth to mean gravel diameter ( $h/d$ ), water surface slope ( $I_w$ ), and gravel protrusion ratio to mean riverbed surface ( $d_p/h$ ). The conditions of some of the wave patterns could be explained by using these four factors (see Fig. 1).

Based on the result, the distribution of wave types in a riffle was examined. In the riffle shown in Fig. 2, there is a medium slope zone at a head. In this area, the depth is not so deep due to the wide width and the protrusion ratio becomes large where the big stone exists. Then the protrusion type wave and the tranquil flow are found. At the side of this riffle, the riverbed and water surface slope are very steep, hence the depth is very shallow. In this area, falling type wave is dominant. In the center of this riffle, riverbed slope is very steep and the depth is also deep due to the convergence of discharge. In this area, V-shaped waves are created in upstream side, and weak jumps are found in the tail end.

In this way, we showed that the physical environment in riffles can be classified visually

based on the wave patterns. The approach shown in this paper will be very advantageous for evaluation of habitats in a riffle.

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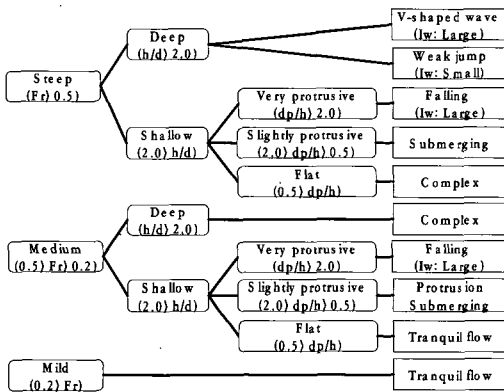


Fig. 1 The condition for each wave type

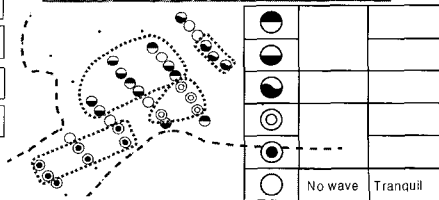


Fig. 2 Wave patterns found in a riffle