

## Data-Driven Conservation Modeling for Fish Species in Protected Areas

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Effective conservation planning in protected aquatic ecosystems requires analytical tools capable of identifying complex relationships among ecological indicators and management actions. This study proposes a data-driven conservation modeling approach to support sustainable management of fish species within protected areas. Using ecological and management data collected over seven years from Natura 2000 sites in Romania, we analyze conservation requirements for thirteen fish species of ecological and economic importance. Management measures were encoded as transactional data and analyzed using association rule mining with the FP-Growth algorithm implemented in RapidMiner. The analysis generated 573 association rules that satisfied predefined thresholds of minimum support (61%) and confidence (95%), from which 44 highly relevant rules were selected for interpretation. The results reveal strong co-occurrence patterns among conservation actions, highlighting interdependencies between habitat protection, pollution control, anti-poaching enforcement, and ecological monitoring. Several rules exhibited confidence values of 100%, indicating deterministic relationships between sets of management measures. These findings demonstrate that conservation actions often function synergistically rather than independently, suggesting that integrated management strategies are essential for maintaining favorable conservation status of fish populations. The proposed framework illustrates the potential of data mining techniques to extract actionable ecological knowledge from complex datasets and to support evidence-based decision-making in biodiversity conservation and protected area management.

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