

## Fish Protection and Downstream Passage at Hydro Power Stations Handbook of Bar Rack and Bypass Systems

Author: Dr. Guntram Ebel, Publisher: Büro für Gewässerökologie und Fischereibiologie  
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### Bioengineering Principles Modelling and Prediction Dimensioning and Design

#### Bibliographical information

Size / format: 20 x 28 cm (hardcover), 483 pages  
(all in colour), 70 drawings, 112 diagrams, 216 photos,  
66 charts, 32 tables, 785 references

#### Language

German (with an abstract in English, French and  
Russian)

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#### Intended readership

Planners, experts, hydro plant operators, administra-  
tors, fishing and nature conservation organizations,  
academics and students

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**Fish Protection and Downstream Passage at Hydro Power Stations – Handbook of Bar Rack and Bypass Systems.  
Bioengineering Principles, Modelling and Prediction, Dimensioning and Design.**

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## Contents

In order to meet the challenges posed by the continuous decline in fossil energy sources and to limit climate damaging emissions there is a worldwide surge towards regenerative sources. One of them is hydropower. Its exploitation, however, has often a deep impact upon water systems and aquatic life. The damage inflicted by turbines and other technical facilities to downriver migrating fish is clearly an influential factor. A variety of methodical principles and technical systems is used to reduce hydropower-induced damage to fish. Amongst them are biologically engineered bar rack bypass systems, which have a high potential for efficient fish protection.

The book gives a systematic overview of the geometric and hydraulic target figures for dimensioning bar rack bypass systems, and of the principles used to position and design such structures. The principles and methods involved are extensively discussed in separate chapters. On the basis of this discussion, the author develops new model equations whose application can help to quantitatively describe the requirements fish protection systems have to meet if they are to suit the physical abilities and behavioural patterns of downriver migrating fish. The practical operation of biologically engineered bar rack bypass systems will be explained with examples from already existing pilot plants.

The literature on which this book is based comprises 785 studies from Europe, North America, Asia and New Zealand and includes information on 111 power stations, 97 water bodies and 80 species of fish and lamprey. 216 photos, 70 drawings, 112 diagrams, 66 charts and 32 tables complement and illustrate the text. The book is not only intended to serve as a planning aid for bar rack and bypass systems but should also come in useful as a reference book that helps to answer specific questions in this field of expertise.

## Structure

Abstract in German, English, French, Russian (4 pages), Preface (2 pages), Acknowledgements (3 pages), Table of contents (7 pages), Introduction (3 pages), 9 chapters with 228 subchapters (326 pages), literature (41 pages), other lists and data (81 pages), index of topics and species (9 pages)

## Example pages

Schädigung abwandernder Fische

Tafel 3: Ingenieurbürolich bedeutsame Größen bei Kaplan-Turbinen

$$[1] u = \frac{2 \cdot z \cdot r \cdot d}{60} \cdot \frac{\pi \cdot d \cdot n}{60}$$

$$[2] w_{rel} = \frac{\pi \cdot d_{rot} \cdot n}{60} \cdot \frac{\pi \cdot (d_{rot} + d_{stat})}{2} \cdot \frac{\pi \cdot (d_{rot} + d_{stat})}{2} \cdot n$$

$$[3] v_{rot} = \frac{Q_{rot}}{4} \cdot \frac{\pi \cdot d_{rot} \cdot n}{60} \cdot \frac{\pi \cdot (d_{rot} + d_{stat})}{2}$$

$$[4] \beta = 13,802 \cdot \left( \frac{d_{rot}}{d_{stat}} \right) + 42,507 \quad (\text{nach MAHRE 1985)}$$

$$[5] v_{stat} = \frac{v_{rot} \cdot \cos \beta}{\sin \beta}$$

$$[6] \cos \beta = \frac{v_{rot}}{\sqrt{v_{rot}^2 + v_{stat}^2}} = \frac{v_{rot}}{v_{rel}}$$

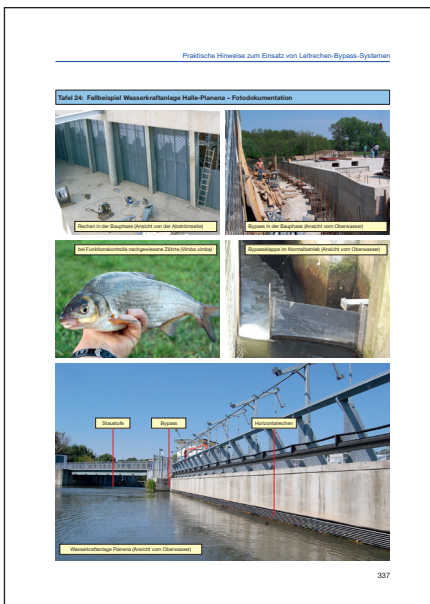
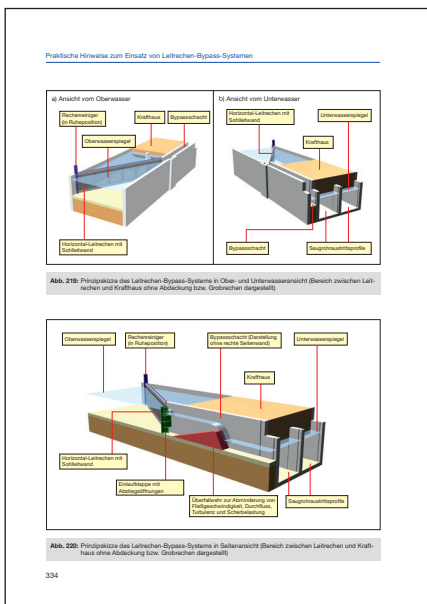
$$[7] v_{rel} = \frac{v_{rot} \cdot \sin \beta}{\sin \beta} = \frac{v_{rot}}{\sin \beta}$$

$$[8] v_{rel} = \frac{\pi \cdot d_{rot} \cdot n}{60} \cdot \frac{\pi \cdot (d_{rot} + d_{stat})}{2}$$

$$[9] v_{rel} = \frac{\pi \cdot d_{rot} \cdot n}{60} \cdot \frac{\pi \cdot (d_{rot} + d_{stat})}{2}$$

- v = Umfanggeschwindigkeit am Laufradius r bzw. Laufradiusmesser D [m/s]
- r = Laufradius abgesehen [m]
- d = Laufradiusmesser, abgesehen [m]
- d<sub>rot</sub> = Laufradius Laufringmessung [m]
- d<sub>stat</sub> = Laufradius Laufringmessung am mittleren Laufradiusmesser [m]
- Q<sub>rot</sub> = mittlerer Laufradiusmesser [m]
- Q<sub>stat</sub> = größter Laufradiusmesser [m]
- n = mittlerer Laufradiusmesser = Durchmesser der Nabe [m]
- w<sub>rel</sub> = Mittelwert der Fließgeschwindigkeit beim Eintritt in das Laufrad, Eintrittsgeschwindigkeit [m/s]
- v<sub>rot</sub> = Fließgeschwindigkeit relativ zur Laufradiusrel. Relativgeschwindigkeit [m/s]
- v<sub>stat</sub> = absolute Schubkraft an dem mittleren Laufradiusmesser [m]
- v<sub>rel</sub> = absolute Schubkraft an dem mittleren Laufradiusmesser [m]
- v<sub>rot, rel</sub> = Winkel zwischen den Vektoren v<sub>rot</sub> und v<sub>rel</sub> [°]
- v<sub>stat, rel</sub> = Winkel zwischen den Vektoren v<sub>stat</sub> und v<sub>rel</sub> [°]
- β = Winkel zwischen den Vektoren v<sub>rot</sub> und v<sub>rel</sub> [°]

Gelten der Winkel β nach der empirischen Bestimmung von MAHRE (1985) berechnet wird (Gleichung [6]), sind alle radial differenzieren Größen auf den mittleren Laufradiusmesser zu beziehen.



## Titles already published in the series

**Band 1 (Vol. 1):** Habitatsprüche und Verhaltensmuster der Äsche *Thymallus thymallus* (LINNAEUS, 1758) – Ökologische Grundlagen für den Schutz einer gefährdeten Fischart. Author: Guntram Ebel, ISBN: 3-00-005928-8, size: 15 x 21 cm, 64 pages, 14 charts, 21 diagrams, 3 photos, 115 references; published in 2000.

**Band 2 (Vol. 2):** Untersuchungen zur Stabilisierung von Barbenpopulationen – dargestellt am Beispiel eines mitteldeutschen Fließgewässers. Author: Guntram Ebel, ISBN: 3-00-009211-0, size: 18 x 25 cm, 152 pages, 34 charts, 49 diagrams, 8 photos, 3 coloured plates, 222 references; published in 2002.

**Band 3 (Vol. 3):** Turbinenbedingte Schädigung des Aals (*Anguilla anguilla*) – Schädigungsraten an europäischen Wasserkraftanlagenstandorten und Möglichkeiten der Prognose. Author: Guntram Ebel, ISBN: 978-3-00-025445-1, size: 21 x 30 cm, 176 pages (all in colour), 57 charts, 60 diagrams, 15 drawings, 24 photos, 167 references; published in 2008.