# An Industry Shift Towards Environmental Enrichment in Aquaculture

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## Introduction

The studies analyzed in this article illustrate the variety of benefits for both animals and producers that come with an enriched environment.

## Key Findings

Many enrichments can be very easy to implement, and would require minimal capital investment and disruption to a farm's operations. Positive outcomes could directly translate to decreased mortality rates, enhanced growth rates, improved feed conversion ratios, and resistance to disease, creating a mutually beneficial situation for all beings involved.

## Methods

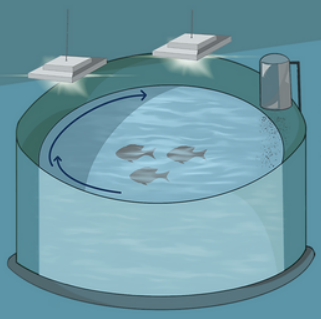
We analyzed and gathered enrichment interventions for 15 commonly farmed species, tested and shown to have favorable outcomes for welfare and productivity. This was achieved through reviewing existing literature, and grouping types of enrichment according to their immediate surroundings.

## Conclusions

Advocates can utilize the information presented in this report and encourage producers to incorporate environmental enrichment within their production practices by raising consumer awareness of seafood label requirements.

## Results

### *Standard enclosure*



**Lighting**
Bright, artificial lights around tank

**Water Complexity**
Water currents unchanging - fish tend to school as a result

**Feeding System**
One feeder that dispenses at the same time, and from the same place

**Substrate Provisions**
No substrate

### *Enclosure with enrichment features*

**Shelter**
Arrangements, such as submerged structures or overhanging covers, that allow animals to hide from conspecifics or seek refuge from unfavorable conditions

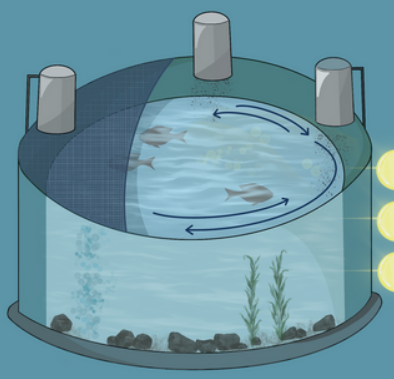
**Atlantic salmon (Salmo salar) Larvae - Fry**
- Use cobbles and boulders to create interstitial spaces used for shelter and rest by young fish (Heggenes, 1990)

**Water Complexity**
Favorable flow rates, current directions, water features and variations, etc.

**Nile Tilapia (Oreochromis niloticus) - Adult**
- Depth: minimum of 2-6m, ideally up to 20m. Must provide range of depth within enclosure (FishEthoBase).
- Water exchange rate: 6x tank volume/h at stocking density of 8 individuals per 60L (Adu Obirikorang et al., 2019)

**Structures**
Interactive, submerged materials (ropes, artificial plants, debris) placed strategically throughout the animals' surroundings

**Grass carp (Ctenopharyngodon idella) - Adult**
- Floating macrophytes (Domingues et al., 2017)
- Submerged vegetation (Zuberi et al., 2020)



**Substrate Provisions**
Materials such as rocks, sand, gravel, or vegetation that occupy the foundation of the habitat

**North African catfish (Clarias gariepinus) - Juvenile**
- For the most natural solution, provide mud, shale, sand, and vegetation (FishEthoBase)

**Feeding System**
Nutritional delivery that prevents adverse behavior (aggression, food monopolization, etc.) while providing some level of cognitive choice

**Rainbow trout (Oncorhynchus mykiss) Larvae - Fry**
- Juvenile feeding diets by self-feeders proved to attain growth and feed performance comparable to those fed by hand (Yamamoto et al., 2002)

**Enclosure Coloration**
Colors, patterns, and/or other visualizations that comprise the animals' entire holding environment

**Pangasius (Pangasianodon hypophthalmus) - Juvenile**
White or green preferred over black (Na wang et al., 2019)

**Lighting**
Natural or artificial illumination, using suitable intensities and colors, strategically placed to provide appropriate day/night simulations

**Atlantic salmon (Salmo salar) - Adult**
- Natural photoperiod is 8-18 hours, depending on the season. Provide access to natural (or at least simulated) photoperiod and daylight (FishEthoBase).
- Do not expose salmon to low intensity blue light (0.82 µmol/m2/s) (FishEthoBase)