The influence of specialization and target species choice on angler mental models of fish population ecology

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Specialization

“a continuum of behavior from the general to the particular, reflected by equipment and skills used in the sport and activity setting preferences”
Bryan (1977)
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Recreationists are expected to vary predictably in a range of traits, including, Psychological Commitment, Skills, and Behaviors (Scott and Shafer 2001)
As specialization changes so do preferences for:
- motives for participation (Ditton, Loomis, and Choi 1992)
- harvesting desires (Aas, Haider, and Hunt 2000)
- preferences for management policies and compliance with rules (Oh and Ditton 2006, 2008; Dorrow et al. 2010)
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Lowly Specialized

Highly Specialized
Specialization is thought to entail the acquisition of knowledge (Bryan, 1977; Scott & Shafer, 2001; Morgan & Soucy, 2008)
Specialization is thought to entail the acquisition of knowledge (Bryan, 1977; Scott & Shafer, 2001; Morgan & Soucy, 2008) but the relationship between specialization and the construction of knowledge is unclear.
Mental models as knowledge basis for fisheries management preferences

- Mental model about Resource dynamics
- Perceived consequences of fisheries management
- Specialization and Target Species
  - Attitudes towards fisheries management policies
  - Personal norms towards fisheries management
Mental models as knowledge basis for fisheries management preferences

- Mental model about Resource dynamics
- Perceived consequences of fisheries management
  - Specialization and Target Species
  - Attitudes towards fisheries management policies
  - Personal norms towards fisheries management
Recreational fishing in Germany

Most important type of use of freshwater in Germany
(Arlinghaus et al., 2002; Arlinghaus, 2004; Brämick, 2010)

- Anglers: ~ 1.5 – 3.3 million
- Harvest: ~ 45,000 t
- Expenses for management of recreational fisheries:
  ~ 5.8 m. € (= ~ 7 m. $)
Measuring Specialization of Anglers
Self-administered survey administered mailed to self-selecting anglers
\( N = 235 \) 97% Male, 47.7y(13.5), angling for 20.9y(13.9)

Psychological Commitment
Centrality to lifestyle (7 items)
Self-rate centrality scale (1 item)

Skill and Knowledge
Self-rated skill (4 items)
Self-rated knowledge (6 items)

Behavioural Commitment
Replacement tackle value
Days fishing in last calendar year

Target Species
Top 3 species targeted in the last year
Collecting Mental Models of Anglers

**Workshops** with 17 angling clubs
235 Mental Models of Anglers
- 112 Pike anglers
- 123 Non-pike anglers

**Fuzzy-logic Cognitive Mapping of Pike Population Dynamics**
Provided with:
- 19 concepts
- Directional Arrows
- Plusses and minuses
Example of a Mental Model
Relevance of concepts determined by converting + and − to numbers

++ = 1.0  + = 0.5  0  - = -0.5  -- = -1.0
Relevance of concepts determined by converting + and – to numbers

\[ ++ = 1.0 \quad + = 0.5 \quad 0 \quad - = -0.5 \quad -- = -1.0 \]
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Quantiative and Qualitative Analysis

Structural Differences

Compared by target species and specialization:

10 metrics (how anglers structure pike pop. dynamics)

7 Concepts (how anglers perceive the importance of these concepts in influencing pike pop dynamics)
Example of Structural differences

Number of concepts (N = 14)
Example of Structural differences

Number of connections (N = 13)
Importance of Components

Relevance of *stocking* concepts \((I++l) = 1\) and \(+ (l+l) = 0.5\)
Importance of Components

Relevance of habitat concepts
Importance of Components

Relevance of **angling pressure**
Quantitative and Qualitative Analysis

Structural Differences

Compared by target species and specialization:

10 metrics (how anglers structure pike pop. dynamics)

7 Concepts (how anglers perceive the importance of these concepts in influencing pike pop dynamics)

Functional Differences

Aggregated mental models by target species and specialization:

Group Understanding for Low Spec. Pike \((N=30, 26.7\% \text{ pike anglers})\)

Group Understanding for High Spec. Pike \((N=30, 26.7\% \text{ pike anglers})\)

Group Understanding for Low Spec. Non-Pike \((N=30, 24.3\% \text{ non-pike anglers})\)

Group Understanding for High Spec. Non-Pike \((N=30, 24.3\% \text{ non-pike anglers})\)
Mean of anglers mental models represents characterization of group beliefs of pike ecology by group.
Top 30 Highly Specialized Pike  

Bottom 30 Least Specialized Pike  

Mean of anglers mental models represents characterization of group beliefs of pike ecology by group.
Quantitative and Qualitative Analysis

Structural Differences

Compared by target species and specialization:

- 10 metrics (how anglers structure pike pop. dynamics)
- 7 Concepts (how anglers perceive the importance of these concepts in influencing pike pop dynamics)

Functional Differences

Aggregated mental models by target species and specialization:

- Group Understanding for Low Spec. Pike ($N=30$, 26.7% pike anglers)
- Group Understanding for High Spec. Pike ($N=30$, 26.7% pike anglers)
- Group Understanding for Low Spec. Non-Pike ($N=30$, 24.3% non-pike anglers)
- Group Understanding for High Spec. Non-Pike ($N=30$, 24.3% non-pike anglers)

Group models subject to scenario analysis to uncover differences:

- Scenario 1: Decrease Angling Pressure
- Scenario 2: Increase Riparian Vegetation
Hypothesis Testing

General Linear Models

Specialization
Target Species
Specialization x Target Species

10 Structural Metrics
- N(concepts), N(connections), C/N
- Overall centrality, Density, Hierarchy
- Number of transmitting, receiving, ordinary variables
- Complexity

Measure the "importance" of 7 concepts:
- Angling pressure, riparian vegetation, submerged vegetation,
- refuge, spawning habitat, stocking adults, stocking juveniles
Hypothesis Testing

General Linear Models

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Specialization x Target Species

10 Structural Metrics

N(concepts), N(connections), C/N, Overall centrality, Density, Hierarchy, Number of transmitting, receiving, ordinary variables, Complexity
Hypothesis Testing

General Linear Models

- Specialization
- Target Species
- Specialization x Target Species

10 Structural Metrics

- \(N(\text{concepts})\), \(N(\text{connections})\), \(C/N\), Overall centrality, Density, Hierarchy,
- Number of transmitting, receiving, ordinary variables, Complexity

Measure the “importance” of 7 concepts

- Angling pressure, riparian vegetation, submerged vegetation, refuge, spawning habitat, stocking adults, stocking juveniles
Results
Structural Differences

10 Structural Metrics

- N(concepts)
- N(connections)
- Number of transmitting variables
- Number of receiving variables
- Number of ordinary variables
- Overall Centrality
- N(connections)/N(concepts)
- Complexity
- Density
- Hierarchy

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Overall Centrality
- N(connections)/N(concepts)

Complexity
- Density
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Structural Differences

10 Structural Metrics

N(concepts)
N(connections)
Number of transmitting variables
Number of receiving variables
Number of ordinary variables

Overall Centrality
N(connections)/N(concepts)

Complexity
Density
Hierarchy

Indicates the perceived amount of overall dynamics of pike ecology
**Centrality (importance)**

- Angling Pressure
- Riparian Vegetation
- Submerged Vegetation
- Refuge
- Spawning Habitat
- Stocking Adult
- Stocking Juveniles

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Centrality (importance)
Angling Pressure
Riparian Vegetation
Submerged Vegetation
Refuge
Spawning Habitat
Stocking Adult
Stocking Juveniles

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Functional Differences

Scenario 1: Decrease Angling Pressure
Scenario 2: Increase Riparian Vegetation
Scenario: Decrease Angling Pressure

- adult pike population
- adult stocked pike
- juvenile stocked pike
- prey fish
- other predatory fish
- algae
- depth of water body
- spawning grounds
- juvenile wild pike
- riparian plants
- benthic invertebrates
- zooplankton
- cormorant
- submerged aquatic plants
- plant nutrients
- turbidity of water
- refuge
- surface area of water body
- angling pressure
- low specialized non-pike angler
- high specialized non-pike angler
- low specialized pike angler
- high specialized pike angler

The diagram shows the changes in various biotic and abiotic factors due to decreased angling pressure. The y-axis lists different environmental and population factors, while the x-axis represents the change in abundance or impact. The bars indicate the relative abundance or impact under different scenario conditions, allowing for a visual comparison of the effects of decreased angling pressure on the ecosystem.
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<thead>
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<th>Surface Area of Water Body</th>
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<th>Turbidity of Water</th>
<th>Plant Nutrients</th>
<th>Cormorant</th>
<th>Submerged Aquatic Plants</th>
<th>Zooplankton</th>
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<th>Algae</th>
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<th>Prey Fish</th>
<th>Juvenile Stocked Pike</th>
<th>Adult Stocked Pike</th>
<th>Adult Pike Population</th>
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**Scenario: Decrease Angling Pressure**

- **Lowly Specialized Pike Anglers**
  - Indicate the largest increase in pike populations compared to others
  - Indicate increase in juvenile wild pike
Scenario: Decrease Angling Pressure

Highly Specialized Pike Anglers

- Indicate the lower increase in pike populations compared to others
- Indicate decrease in adult stocking
- Indicate a decrease in cormorant

- Low specialized non-pike angler
- High specialized non-pike angler
- Low specialized pike angler
- High specialized pike angler

Surface area of water body, refuge, angling pressure, turbidity of water, plant nutrients, cormorant, submerged aquatic plants, zooplankton, benthic invertebrates, riparian plants, juvenile wild pike, spawning grounds, depth of water body, algae, other predatory fish, prey fish, juvenile stocked pike, adult stocked pike, adult pike population.
Scenario: Increased Riparian Vegetation

- adult pike population
- adult stocked pike
- juvenile stocked pike
- prey fish
- other predatory fish
- algae
- spawn grounds
- depth of water body
- cormorant
- benthic invertebrates
- zooplankton
- submerged aquatic plants
- riparian plants
- juvenile wild pike
- angling pressure
- turbidity of water
- plant nutrients
- refuge
- surface area of water body

Legend:
- low specialized non-pike angler
- high specialized non-pike angler
- low specialized pike angler
- high specialized pike angler
Highly Specialized Pike Anglers

- Indicate large increases in other ecological factors (zooplankton, benthic invertebrates, increase in prey fish)
Conclusions

Differences in understanding of pike ecology are dependent on both specialization and species choice

Less variation than expected in structural measures (self-selected sample? standardizing the mental modeling activity?)

Structural differences revealed themselves more clearly in dynamic functional analysis (i.e. focus on the importance of angling pressure and riparian vegetation)

Future research: looking to explain policy preferences by mental model structure and function
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Thanks to all German angling associations and angling clubs for participation!

Thank you for your attention!