GIS-based Analyses of Pressure-Fish Relationships in Austrian Rivers on Different Spatial Scales

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Abstract

Austria's rivers are influenced by many different anthropogenic alterations and partially show a risk of failing the quality objectives demanded by the Water Framework Directive (WFD). Especially hydro-morphological pressures (e.g. hydro peaking, impoundment, water abstraction, morphological alterations and barriers) have a high influence on rivers and their biocenoses. Although it is known that the composition of a fish assemblage or population can indicate hydro-morphological alterations, this relationship is mostly investigated on a local to reach scale, whereby influences of pressures surrounding the sample site in a wider range are not considered. A GIS-based analysis was performed to investigate the linkage of fish populations and hydro-morphological pressures on different spatial scales. The FAME- and EFIplus Index of 875 sample sites were used to investigate modifications of fish populations. Pressures possibly influencing these fish metrics were detected on 10 different spatial scales (local, 5 distance-buffers, service area (i.e. passable river segment), fish regions (i.e. longitudinal habitat classification), drainage area upstream and catchment) for each sample site. All pressures showed higher correlations for larger scales (25000m buffer, drainage upstream or catchment). While the selected indices were able to indicate impoundment and morphological alterations, hydro peaking and water abstraction could not be detected by the selected metrics. The results of this thesis represent a basis for further analyses and can be used to improve the formulation of suitable restoration measures.

Key words: Austria, GIS, fish indices, hydro-morphological pressures, spatial scales

Zusammenfassung

Österreichs Flüsse werden vielseitig anthropogen beeinflusst und weisen daher teilweise ein Risiko auf, die Zielvorgaben der Wasserrahmenrichtlinie (WRR) zu verfehlen. Insbesondere hydromorphologische Beeinträchtigungen (wie Schwall, Stau, Restwasser, morphologische Veränderungen und Querbauwerke) üben einen großen Einfluss auf Gewässer und deren Biozönosen aus. Auch wenn bekannt ist, dass die Zusammensetzung einer Fischgemeinschaft solche hydromorphologischen Beeinträchtigungen anzeigen kann, wird dieser Zusammenhang meist nur lokal erforscht, wobei Beeinträchtigungen mit größerer Entfernung zur Beprobungsstelle oft unberücksichtigt bleiben. Daher wurde eine GIS-basierte Analyse durchgeführt um den Zusammenhang von Fischgemeinschaften und hydromorphologischen Beeinträchtigungen auf verschiedenen räumlichen Maßstabsebenen zu untersuchen. Veränderungen der Fischgemeinschaft wurden mittels FAME- und EFIplus Index von 875 Beprobungsstellen gemessen. Beeinträchtigungen, die diese Indices beeinflussen können, wurden auf 10 unterschiedlichen räumlichen Ebenen je Beprobungsstelle ermittelt (lokal, 5 Entfernungspuffer, Service Area (d.h. passierbarer Flussabschnitt), Fischregionen (d.h. longitudinale Habitateinteilung), Einzugsgebiet flussauf der Beprobungsstelle und gesamtes Einzugsgebiet). Die Indices reagierten bei größeren räumlichen Skalen (25000m, Einzugsgebiet flussauf oder gesamtes Einzugsgebiet) stärker auf die Beeinträchtigungen. Während die gewählten Indices auf Stauhaltungen und morphologische Veränderungen reagierten, wurden Schall und Restwasser nicht von ihnen angezeigt. Die Ergebnisse dieser Masterarbeit sollen eine Basis für weitere Analysen bilden und können in weiterer Folge zur Formulierung geeigneter Restaurationsmaßnahmen herangezogen werden.

Schlüsselwörter: Österreich, GIS, Fischindizes, hydro-morphologische Beeinträchtigungen, räumliche Maßstabsebenen

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1. Introduction

1.1 General Introduction

Austrian streams and their aquatic organisms are influenced by many different parameters. Although mainly natural parameters (e.g. geology, climate, bioregion) characterize and influence a river's appearance, nowadays also human induced parameters (e.g. hydro peaking, impoundment, water abstraction, morphological alterations or connectivity disruptions) play a more and more important role in aquatic ecology. While it is common practice to include natural parameters of different spatial scales into studies investigating fish communities (JUNGWIRTH et al., 2003), anthropogenic induced alterations and pressures are mostly considered on a local to reach scale. However, the influence of these pressures on different spatial scales is still unexplored. To know which anthropogenic induced parameters influence aquatic organisms and on which spatial scale is crucial for the design of effective restoration measures. Therefore it is very important to investigate the relationship between local fish communities and pressures on different spatial scales.

A GIS-based analysis using data from the NGP (Austria's national water management act, BMLFUW, 2009) was performed to investigate the pressures of 1697 fish sample sites on 10 different spatial scales (local, 250m, 500m, 2500m, 5000m, 25000m, service area, drainage area upstream, catchment) within Austria. Furthermore, 41 metrics and 2 fish indices were mostly available for 875 of the 1697 sample sites. Different statistical analyses were performed to gain insights into the relationship between fish metrics and anthropogenic induced instream pressures on different spatial scales.

The following chapters will give a more detailed introduction to this master thesis. These chapters start with a discussion about the relevance of different spatial scales. Furthermore a status quo of Austria's river network and its pressures is given. Also the legal thresholds for these pressures will be presented. After the presentation of the MIRR and the LANPREF project, an introduction of the analysed metrics and their related guilds is given.

The 10 spatial scales used in this thesis are termed as both scales and buffers.

1.2 A question of scale

"Local species richness is a function of many factors operating at multiple spatial and temporal scales." (ANGERMEIER and WINSTON, 1998)

The question of scale is very important for any study in aquatic ecology. JACKSON, PERES-NETO and OLDEN (2001) investigated factors influencing the fish community structure and found out that the chosen scale will determine the results of a study. Also SMILEY and DIBBLE (2008) investigated the influence of spatial scales and concluded that the spatial resolution can influence results and their interpretation. Therefore it is very important to define a suitable scale for each question of research. But who is to define this scale? Especially in environmental research it is very hard to draw a spatial line since nature is too complex to include all interacting factors.

On the one hand, the local scale is always influenced by a larger scale. On the other hand, large scales are put together from smaller scales. So no matter which scale is used, the borders remain unclear. In most cases also the question of time, money and data availability plays an important role. Involvement of large-scale variables might increase the costs and complexity of a survey which makes larger scales less desirable. Nevertheless many researchers hold the view that since the biotic composition results from hierarchical interacting factors, variables of different spatial scales need to be included (CORTES et al., 2009). Since the Water Framework Directive (WFD) postulates the investigation of biotic- and pressure variables, in the future, a consistent database containing the most important instream variables for Europe will be available, which could be used for further studies investigating effects on different spatial scales.

The question of scale is discussed in many different papers. Some studies investigate multiscale influences on the invertebrate community (DEATH and JOY, 2004; WEIGEL et al., 2003, PARSONS, THOMS and NORRIS 2004). Several other papers focus on the influence of landscape features (HOPKINS II and BURR, 2009; TOWNSEND et al., 2003; MOERKE and LAMBERTI, 2006; ROTH, ALLAN and ERICKSON, 1996; WANG, LYONS AND KANEHL, 2001) or environmental factors (SANTOUL et al., 2004; PONT, HUGUENY and OBERNDORFF, 2005; MARSH-MATTHEWS and MATTHEWS, 2000) on the fish community on different spatial scales.

In contrast, only a few analyses on different spatial scales recently exist for human pressures as connectivity disruption or habitat alteration. COTE et al. (2009) investigated the influence of habitat fragmentation due to barriers. According to their research, habitat connectivity is a central factor influencing biological communities whereby the first few added barriers have the highest influence on a river. Not only the number of barriers has to be considered, but

also their location is crucial. While barriers near a river mouth greatly influence diadromous species, barriers in the centre of a catchment mostly impact potamodromous species (COTE at al., 2009). Also RAEYMAEKERS et al. (2009) investigated the effect of barriers (i.e. water mills) and showed that they induced a loss of the genetic variation, whereby the impact of individual barriers increases with distance from the source and height of the barrier.

According to SPRINGE et al. (2006) macrophytes and fish metrics in contrast to macro-invertebrate metrics can be used to assess the ecological quality at the catchment scale. DESCHÊNES and RODRÍGUEZ (2007) conducted research about the relationship between brook trout density and instream habitat features using different scales (i.e. sections, reaches and streams) and found out that there is no single “best scale” for examining fish-environment relationships. Again the question of the most suitable scale depends on the question of research. While it is said that biotic processes as predation and competition are most important at local scales (TONN et al., 1990), regional factors tend to increase in importance if biotic interactions decrease (OBERDORFF et al., 1998). As mentioned before, it is known that special large-scale variables influence local conditions. Therefore even surveys investigating local habitats may include selected large-scale variables as e.g. climate, geology, hydrology, bioregions or fish regions (JUNGWIRTH et al., 2003). ANGERMEIER and WINSTON (1998) recommend the definition of buffers over a wide range of spatial scales. This advice seems very reasonable for investigations of the most appropriate scale and was therefore taken into account for the definition of the scales used in this thesis.

1.3 Status quo in Austria

The Water Framework Directive (WFD, EC, 2000) represents a Europe-wide instrument for the protection and restoration of aquatic resources and came into force in 2000. For Austria it was implemented as an amendment of the Austrian Water Act (WRG 1959) in 2003 (BMLFUW, 2010a). The directive defines environmental objectives for all European surface water bodies and the groundwater. The aim is to achieve at least a good ecological status for all surface- and groundwater bodies. Heavily modified water bodies have to achieve at least a good ecological potential. While an improvement is demanded for all water bodies with a worse ecological status than demanded, a deterioration of the environmental status of all water bodies is strictly forbidden. An important innovation is the new level of management as water bodies are managed on a cross-border catchment scale. The WFD postulates an inventory of all rivers until 2004/05. A monitoring programme (until 2006) should lead to appropriate measures (until 2009) which should be implemented by 2012. Finally the objectives should be accomplished by the year 2015. With appropriate excuse the extension of the deadline to the years 2021 or 2027 is possible (EC, 2000).

The pressures occurring in each water body were used to classify the rivers according to their risk of failing the objectives (no risk, risk or unknown risk) whereby the pressure with the highest risk was decisive. This evaluation was done until 2005 for the so called “report of the characterisation, impacts and economics analyses required by Article 5” (BMLFUW, 2005). The risk analysis for Austrian rivers showed that 52% are at high risk to fail the objectives of the WFD (high or good ecological status/ potential), 28% are out of risk and for 20% the risk is unknown. For the hydro-morphological pressures alone the percentages are 50% (risk), 17% (unknown risk) and 32% (no risk). The risk is due to barriers (>35% of rivers), morphology (>20%) and residual flow (>15%) while impoundment (>5%) and hydro peaking (<5%) occur more seldom. The high percentage of rivers at risk is due to the high amount of renewable energy produced by water power in Austria.

In addition, the NGP (National Water Resource Management Plan of Austria) is a tool for the realisation of the objectives and principles of the WFD. It has to be published every 6 years and includes significant alterations of water bodies. According to the NGP hydro-morphological alterations represent the most significant influences on Austrian water bodies beside physicochemical alterations. A pressure is then rated as significant, if it influences a water body to a degree where the objectives of the WFD might be failed. Therefore, thresholds were defined for each pressure (BMLFUW, 2009). The pressures are divided into 4 groups (BMLFUW, 2009):

- Physicochemical pollution (point source or diffuse source)

  Since the physicochemical alterations are not included in the subject of this thesis they won’t be further discussed here. Further information can be looked up in the NGP (BMLFUW, 2009).

- Hydro-morphological pressures

  They concern hydrological, morphological and connectivity alterations of a river.

  - Hydrology: hydro peaking, impoundment, water abstraction
  - Morphology: anthropogenic alteration of the structural characteristics of a water body (depth-width ratio, structure, substrate, flow velocities) in connection with river regulations, riverbank or riverbed construction, straightening or impoundment.
  - Connectivity: barriers disrupt the natural connectivity of rivers and side arms, whereby organisms (e.g. fishes) are hindered in their migratory behaviour, habitats are isolated and also the natural sediment transport is impaired.

- Other pressures: alien species, piscivorous predators (cormorant), climate change, ect.

According to NGP (BMLFUW, 2009), these pressures are not rated as significant for the deterioration of the environmental status of water bodies in Austria.

Water abstraction is a significant pressure, leading to a significant pressure for the river biocenosis if the river segment downstream of the abstraction is not sufficiently provided with water. Segments with undefined residual flow are also rated as significant pressure. According to the NGP (BMLFUW, 2009) 9.9 percent of Austria's river network is impacted by water abstraction. This percentage is higher for areas belonging to the Rhine catchment (27.9%) and lower for areas belonging to the Elbe catchment (2.8%) whereas it reflects the percentage of the Danube catchment (9.5%). A river is evaluated with a high risk of failing the objectives, if the residual flow is below a certain threshold or a minimum discharge value is absent, while unknown residual flows were rated as unknown risk (BMLFUW, 2009).

Hydro peaking occurs, if the natural discharge and its natural fluctuations are changed and the discharge is controlled by anthropogenic induced fluctuations. Hydro peaking can occur downstream of run-of-river- as well as storage-power plants, showing short term water level fluctuations. It is most common in alpine regions at storage power plants. The intensity is measured as a ratio between flush and down surge, whereby a ratio higher than 1:5 or unknown is rated as risk. For large rivers the presence of hydro peaking per se leads to an evaluation of risk. According to the NGP, 2.5 percent of Austria's river network is impacted by hydro peaking. This percentage is higher for the Rhine catchment (9.1%) whereas it is absent in the Elbe catchment (BMLFUW, 2009).

The morphological condition of a river is mostly influenced by flood protection, rural areas and infrastructure, water power plants, shipping and agriculture. Also impoundment is rated as a morphological pressure since it leads to modifications of the flow (reduction of flow velocity) and morphological parameters (shore, river bed). For large rivers (>100km^2 catchment) impoundments with a length of more than 500m are rated as significant while this threshold is reduced to 100m for small rivers (<100km^2 catchment). A risk to fail the objectives depends on the number of impoundments as single impoundments were rated as unknown risk while chains of impoundment were rated as risk (BMLFUW, 2009).

For morphological condition, the percentage of morphology status class 3 to 5 was used to evaluate the risk. About 3.5 percent of Austria's river network is impacted by impoundment (Danube 3.6%, Rhine 0.8% and Elbe 2.3%) while 26.3 percent suffer from other morphological alterations (BMLFUW, 2009).

Barriers represent a lateral (e.g. side arms or tributaries) and longitudinal disruption of the natural river continuum. They can occur due to water power plants, water abstraction, flood protection or river bed stabilization and prohibit the migration of aquatic organisms (e.g.

fishes) and the transport of sediments, thereby leading to habitat fragmentation. Certain species might be prohibited to reach their reproduction habitats, whereby genetic exchange is prevented. On a long term this can lead to a decrease or loss of these species. Especially migratory species (potamodromous and anadromous) are impacted by barriers. It depends on a barrier's height in relation to the present fish region, in terms a barrier is a significant pressure (BMLFUW, 2009). According to the NGP there are 28848 barriers in Austria, which account for 0.9 barriers per km of Austria's river network (1.3 for Rhine and 0.8 for Elbe catchment). Their risk is evaluated according to their number per river and their altitude (BMLFUW, 2009).

1.4 Legal background

The "quality-objectives statutory order" (QZV Ökologie OG, 2010) is a legal frame developed from the NGP and lists quality components for the evaluation of running waters. These are divided in biological, hydro-morphological and physicochemical components. Biological quality components are represented by phytoplankton, macrophytes and phytobenthos, the benthic invertebrate fauna and the fish fauna.

Hydrology, morphology and river connectivity are used to describe the hydro-morphological quality while temperature, oxygen conditions, acidification and nutrients describe the physicochemical conditions (QZV ÖKOLOGIE OG, 2010). Additional, chemical threshold values are listed in the QZV CHEMIE OG (2006) but usually these demanded values are met in Austria. Table 1 lists the quality components reacting to hydro-morphological pressures.

Table 1: Hydro-morphological pressures and reacting quality components according to (QZV Ökologie OG, 2010), x = high significance; (x) = low significance).

	Reacting quality components			
Pressures	hydro-morphology	macrophytes	benthic invertebrate fauna	fish fauna
morphology	x	(x)	(x)	x
water abstraction	x	(x)	(x)	x
hydro peaking	x	(x)	(x)	x
impoundment	x	(x)	x	(x)
barriers	x		(x)	x

As it can be seen in Table 1, the fish fauna reacts significant to most above listed pressures. Although impoundment affects the fish fauna, this correlation shows a low significance (x). In this case hydro-morphological components or the benthic invertebrate fauna would be more suitable.

Nevertheless in this thesis only the fish fauna is taken into account. The evaluation of the fish fauna in Austrian rivers is usually expressed by the Fish Index Austria (FIA), which reflects species composition, age structure, fish regions index and biomass. The worst of those factors is decisive. The criteria are closer described in Annex F of the QZV ÖKOLOGIE OG (2010). In this thesis the FAME and EFIplus Index were used instead of the FIA since these indices were already calculated for most of the sample sites. Thereby the adaptability of FAME and EFIplus Index for Austria can be examined.

Section 2 of the QZV Ökologie OG (2010) contains the hydro-morphological quality objectives which have to be fulfilled to gain a high or good hydro-morphological status. The objectives relevant for this thesis are listed below:

To achieve a **high hydro-morphological status** the objectives 1 to 4 have to be fulfilled.

1) The water abstraction is small which means less than 20 percent of the annual discharge. If the months
   - October to March show less discharge than the average discharge for winter months or
   - April to September show less discharge than the annual average discharge

   the water abstraction threshold is set to less than 10 percent of the natural lowest discharge per day (NQ_t).
2) There are no anthropogenic induced level fluctuations with hydro peaking symptoms.
3) Anthropogenic reductions of the mean flow velocity per cross section appear only sporadically and show short lengths.
4) The connectivity of the river shows only slight anthropogenic modifications, but is still undisturbed allowing the migration of native aquatic organisms and the natural transport of sediments.

To achieve at least a **good hydro-morphological status** objectives 5 to 6 have to be met.

5) The minimum discharge at all times is
   - higher than the natural lowest discharge per day
     - ($NQ_{residual\ flow} \geq NQ_{t\ natural}$)
   - at least a third of the natural mean discharge per year (for rivers, where the natural lowest discharge per day is smaller than a third of the natural mean discharge per year)
     - $NQ_{residual\ flow} \geq ⅓\ MJNQt_{natural}$
   - at least the half of the natural mean discharge per year (for rivers, where the mean discharge is smaller than 1 m^3/s and the natural lowest discharge per day is smaller than the half of the natural mean discharge per year)

- $NQ_{residual\ flow} \geq ½\ MJNQt_{natural}$

6) Furthermore the discharge shows natural dynamic fluctuations.
   - Anthropogenic discharge fluctuations have to be separately evaluated for large rivers. All other rivers show no hydro peaking ratio higher than 1:3 and at least 80 percent of the river bed are covered by water at all times.
   - Anthropogenic reductions of the mean flow velocity per cross section to less than 0.3 m/s (for mean discharge) appear only sporadically and on short segments.
   - Anthropogenic barriers in fish-bearing rivers are passable the whole year and the habitat connection is only slightly modified.

1.5 The MIRR project

The MIRR project (SCHMUTZ et al., 2007a, http://mirr.boku.ac.at/) is a **M**odel-based **I**nstrument for **R**iver **R**estoration and includes the development of a strategic instrument for the evaluation of restoration measures at Austrian rivers. Since only a few restoration measures have been implemented in Austria so far and no statistic significant conclusions can be drawn, in this project the assumption is used that, if a pressure is removed, the rivers shows the opposite reaction as previously observed by the implementation of the pressure (see Figure 1) (SCHMUTZ et al., 2007b).

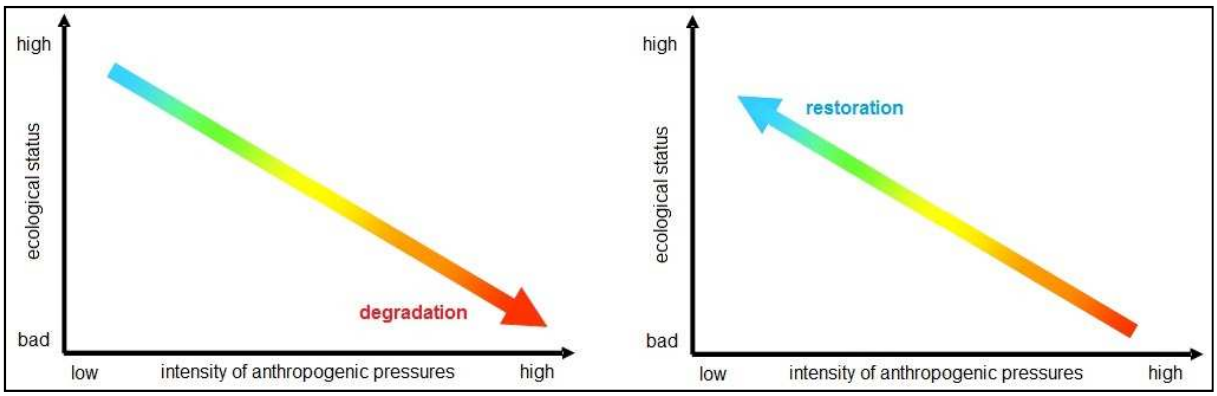


Figure 1: MIRR approach (adapted from SCHMUTZ et al., 2007a).

According to this theory the removal of a pressure leads to an unimpacted/ less impacted status again. The study used a similar approach as it is used in this thesis. Therefore the methodology and its results will be briefly described here.

In the MIRR project pressure data within Lower Austria were used to analyze their relationship to fish, whereby the sample sites were divided into less and stronger impacted sites. At the beginning of the project a criteria list for a detailed description of the pressures was formulated, based on experience and literature research. These criteria were evaluated

at a local scale (sample site) and for defined buffers around the sites. The spatial scales were defined as buffer circles with different distances to the sample sites (see chapter 3.1.2.2). The reaction of the fish population was measured by fish metrics developed according to the FAME approach (see chapter 1.7.2), whereby metrics for rhithral and potamal were developed separately. In sum 10 fish metrics were developed (one for each pressure (5) in potamal and rhithral rivers). The metric with the highest deviation from the expected value (for less impacted sites) was used to define a so called combined fish index (SCHMUTZ et al., 2007a).

The results of the MIRR project indicated that the fish metrics showed the strongest reaction to single pressures of land use and connectivity disruption in potamal rivers while the weakest response occurred for water abstraction and connectivity disruption in rhithral rivers. A strong correlation could be found for the proportion of impounded river sections within 10km river length, insufficient morphological conditions within 5km river length, the dimension of impoundments and the number of barriers per fish region. As expected multiple pressures had additive effects. Also a strong dependency on the spatial scale was found out, whereby stronger impacting pressures (e.g. land-use or morphology) were related to larger spatial scales (e.g. 10km). Only if those pressures were below a special threshold at the large scale, pressures of smaller scales (e.g. ratio of impounded length to MQ) became more important (SCHMUTZ et al., 2007a).

Table 2 shows the reaction of different metrics to pressures in rhithral and potamal rivers according to the MIRR project.

Table 2: Observed metric reaction in the MIRR project (SCHMUTZ et al., 2007a)

↑ fragmentation rhithral	↑ smaller fish species (<15cm) ↑ tolerant species (<15cm) ↓ potamodromous species
↑ fragmentation potamal	↑ tolerant species ↓ salmonids ↓ intolerant species ↓ insectivorous species
↑ regulation rhithral	↑ smaller fish species (<15cm) ↑ omnivorous species ↓ intolerant species (<15cm) ↓ potamodromous species ↓ salmonids

↑ regulation potamal	↓ intolerant species ↓ brown trout
↑ water abstraction rhithral	↑ short-lived species ↑ small species ↑ tolerant species ↓ intolerant species
↑ water abstraction potamal	↑ omnivorous species ↑ biomass of intolerant species
↑ impoundment rhithral	↓ total number of species ↓ density of brown trout ↓ biomass of intolerant species ↑ tolerant species
↑ impoundment potamal	↓ intolerant species ↓ insectivorous species ↓rheo-lithophilic species ↓ benthic species

The project also comes to the conclusion that metrics concerning the biomass are more suitable since they are less susceptible to natural variations than density metrics. Also fish metrics in potamal rivers showed a stronger reaction to pressures for both, less and stronger impacted sites, than metrics of the rhithral rivers. The above described fish index (combined fish index) used in the MIRR project was not able to differentiate between less and stronger impacted sites (SCHMUTZ et al., 2007a).

1.6 The LANPREF project

This thesis is dedicated to the LANPREF project (landscape – pressure – fish – cascades) of the IHG (Institute of Hydrobiology and Aquatic Ecosystem Management, BOKU, Vienna). It started in 2009 and is funded by the FWF (Austrian Science Fund) (LANPREF PROJECT, 2009). Although it is a well known fact that environmental conditions across the landscape influence river networks and their biota, investigations usually focus on the biotic response to local instream conditions only. But human actions can influence a river's habitat, water quality and the biota in numerous and complex ways, not only local but also at a broader scale (ALLAN and JOHNSONS, 1997; STRAYER et al., 2003; TOWNSEND et al., 2003). The fish community can be threatened by landscape processes (e.g. agriculture, urban areas), hydrological impacts as impoundment (MCALLISTER et al., 2001; REID, 2004), water abstraction (ARTHINGTON and PUSEY, 2003; PYRCE, 2004) or hydro peaking (HOUSE, 2001;

HALLERAKER et al., 2003; FLODMARK, VOLLESTAD and FORSETH, 2004) as well as morphological alterations like channelization (AARTS, VAN DEN BRINK and NIENHUIS, 2004) or river bed degradation (BRAVARD et al., 1997; RAAT, 2001). Furthermore fish communities suffer from the disruption of longitudinal (RIEMAN and DUNHAM, 2000) or lateral (TOCKNER, SCHIEMER and WARD, 1998; BUIJSE et al., 2002; HUGHES and ROOD, 2003) connectivity.

LANPREF is an approach to combine investigations of both the landscape processes (different land-use patterns) and instream pressures (hydro peaking, impoundment, water abstraction, morphological alterations and barriers) on different spatial scales. Especially the linkage between multiple, interacting factors make it difficult to identify clear relationships between human interferences and the biotic reactions. Furthermore the roles of local versus larger spatial scales and cross-border pathways are still unclear and have to be explored (LANPREF PROJECT, 2009).

The approach started with examining the land-use patterns and instream pressures separately at different spatial scales. Therefore two master theses were created, of which one handles the land-use patterns (JUEN, in preparation) while this one deals with instream pressures. In a further process the results of these theses will be combined to evaluate interactions on multiple spatial scales (LANPREF PROJECT, 2009).

1.7 Index of biotic integrity and ecological guilds

The Index of Biotic Integrity (IBI) was developed by KARR (1981) for the use in warm water streams (U.S. EPA, 2010). According to KARR (1997)

"Biotic integrity is based on the premise that the status of living systems provides the most direct and effective measure of the integrity of water."

The term "biotic integrity" is measured as a population's deviation from its expected composition without impacts, thereby indicating the "integrity of a river". At the beginning the IBI was composed out of 12 single metrics (guilds) whereby each metric was evaluated with 5 points if it met the expectations for an undisturbed community and 1 point if it was similar to the expected values for a significantly disturbed community. The functionality of the IBI approach became very popular and was adapted for many different regions and ecosystems. Although the multi-metric structure persisted, the metrics differed in composition and number as well as the evaluation method varied from the original version. (U.S. EPA, 2010). As mentioned in SCHMUTZ et al. (2007b) the large scale natural variability in fish communities make it difficult to develop an IBI for large regions, including many different ecoregions. The FAME- and the EFIplus Index are two Indices of Biotic Integrity were especially designed to

cover a wide spatial range (Europe). They were used in this thesis and will be described in the following chapters.

1.7.1 Ecological guilds

Ecological guilds are characterized by similar strategies for resource use or a similar lifestyle concerning reproduction, feeding or migration (SCHIEMER and WAIDBACHER, 1992). They usually also show the same reaction to environmental changes. Hence, they can be used to evaluate river segments (JUNGWIRTH et al., 2003).

Species sharing the same function in a biocenosis (trophical guild, reproduction guild or migration guild) are defined as functional guilds while species using the same habitats (even for different purposes) are defined as structural guilds (SCHIEMER and WAIDBACHER, 1992). The metrics used in this survey are based on the guilds listed in Table 3. Their reaction to increasing, anthropogenic pressures is indicated by arrows in the right column (↑ = increase, ↓ = decrease).

Table 3: Fish guilds used in this thesis (description adapted from HOLZER (2008), according to the EFIPLUS CONSORTIUM, s.a.).

Guild	Name	Description	
current	rheophilic	Fish prefer to live in a habitat with high flow conditions and clear water.	↓
reproduction	lithophilic	Fish spawn exclusively on gravel, rocks, stones, rubbles or pebbles. Hatchlings are photophobic.	↓
	phytophilic	Fish deposit eggs in clear water habitats on submerged plants.	↑
	rheopar	Fish prefer to spawn in running waters.	↓
feeding habitat	benthic	Fish prefer to live near the bottom from where they obtain food. They usually do not go to the surface for feeding purposes.	↓
feeding	insectivorous	Adult diet consists of more than 75% insects. Individuals have a terminal or supraterminal mouth; take aerial, drifting or swimming insects and invertebrates. The largest and most diverse trophic guild. Combinations with other modalities are possible, if justified.	↓
	omnivorous	Adult diet consists of more than 25% plant material and more than 25% animal material. Species are typical generalists. Combinations with other modalities are possible, if justified.	↑
migration	diadromous	Migrate between sea and freshwater (long distance).	
	- long catadromous	Refers to fish that have lived their early life in fresh water – feeding and growing – and at maturity migrate down rivers to spawn in the sea.	↓
	- long anadromous	Refers to fish that live as older juveniles and sub-adults in the sea but at maturity migrate up rivers to spawn.	↓

	potamodromous	Species migrate between river zones or more than 5-10 km (more than a river segment).	↓
sensibility	tolerant	Species are in general tolerant to the usual national water quality parameters.	↑
	intolerant	Species are in general intolerant to the usual national water quality parameters.	↓
	O_2 tolerant	Species are tolerant against low oxygen concentration. Concentrations of 3 mgL^{-1} or less can be coped with.	↑
	O_2 intolerant	Species are intolerant to low oxygen concentrations. Their physical constitution requires concentrations of more than 6 mgL^{-1}.	↓
	habitat tolerant	Fish species that do not react too sensitive to degradation of their habitat.	↑
	habitat intolerant	Fish that cannot compensate any degradation of their habitat.	↓

In general, when sampling a site the size and species of each fish is noted. Using a length-weight regression a representative weight can be defined for each individual. This information is used to calculate the density of individuals and biomass and for each species. Since each species belongs to one or more guilds the collected data can be used to calculate the biomass, density or number of species per guild.

The following chapters describe the fish metrics used in this survey.

1.7.2 FAME Index (European Fish Index) and metrics

When the WFD came into force, most EU member states did not have fish-based assessment methods compliant to WFDs requirements. Therefore the FAME project (FAME CONSORTIUM, 2004, http://fame.boku.ac.at/) was funded by the European Commission (EC) under the 5th framework programme to implement a standardised fish-based method for assessing the ecological status of European running waters. The result was the European Fish Index (further called FAME Index) which evaluates a sample site by comparing its actual condition with a reference condition (IBI) thereby building an EQR (Ecological Quality Ratio) value. This quotient gains a value between 0 and 1 whereas a high ecological status is expressed as 1 and a bad ecological status as 0 (QZV ÖKOLOGIE OG, 2010). To be more precisely the FAME Index compares predicted and observed values of ten defined metrics (see Table 4). Six of those metrics are based on abundance while the other 4 are based on density (FAME CONSORTIUM, 2004). Only those metrics were chosen, which could be predicted by environmental descriptors and showed the ability to differentiate between various levels of human pressures (PONT et al., 2006).

The predicted metric values are based on observations of unimpacted or slightly impacted reference sites. To determine the reference conditions of a sample site ten environmental factors (as e.g. altitude, slope, catchment size etc.) and three sampling variables (i.e. fished area, sampling strategy and fishing method) were taken into account. The deviation of this reference condition is determined by the residuals of multilinear regression models (FAME CONSORTIUM, 2004):

$$residual\ metric\ value = metric_{observed} - metric_{predicted}$$

Since the metrics are based on different units they are standardised by the following formula, where σ is the standard deviation of the reference site's residuals (FAME CONSORTIUM, 2004):

$$\frac{residual}{\sigma}$$

In a next step the values are transformed into probabilities for sites to be a reference site (i.e. an unimpacted site). This transformation ensures that all values range from 0 to 1 and that they show the same response (e.g. decrease) to human pressures. In a final step the index scores were grouped to status classes. The class boundaries are based on observations of different combinations and degrees of human pressures and their dedicated index value (FAME CONSORTIUM, 2004). Table 4 lists the FAME metrics, their description and reaction to human pressure. Since the metrics are transformed to show the same reaction to pressures, both, the reaction of guilds and the reaction of calculated metrics are shown. At the bottom of the table the values for the transformation of the FAME Index into the FAME status classes are given.

Table 4: FAME metrics and their response to human pressures (↑ = increase, ↓ = decrease) according to FAME CONSORTIUM (2004).

guilds	**metric name**	**reaction to increasing human pressure**	
trophic level		guild	metric
1. density of insectivorous species	P-INSE	↓	↓
2. density of omnivorous species	P-OMNI	↑	↓
reproduction strategy			
3. density of phytophilic species	P-PHYT	↑	↓
4. relative abundance of lithophilic species	P-LITH	↓	↓

physical habitat			
5. number of benthic species	P-BENT	↓	↓
6. number of rheophilic species	P-RHEO	↓	↓
general tolerance			
7. relative number of intolerant species	P-INTO	↓	↓
8. relative number of tolerant species	P-TOLE	↑	↓
migratory behaviour			
9. number of species migrating over long distances	P-LONG	↓	↓
10. number of potamodromous species	P-POTA	↓	↓
$\boldsymbol{FAME\ Index = \sum_{x=1}^{10} metrics_x}$	FAME Index		
FAME status classes	FAME Status	high	0.669 – 1.000
		good	0.449 – 0.669
		moderate	0.279 – 0.449
		poor	0.187 – 0.279
		bad	0.000 – 0.187

The results of the FAME models observed a high variability within the guilds, which can be attributed to the different ecological requirements of individual species (SCHMUTZ et al., 2007b).

1.7.3 EFIplus Index and metrics

Since the testing of the FAME Index showed some limitations, a new, more accurate and pan-European fish index was developed in the project EFIplus (http://efi-plus.boku.ac.at) and named EFIplus Index. For this approach two different indices, one for salmonid dominated and one for cyprinid dominated rivers were created. Each of those indices is composed of two single metrics. The site classification (salmonid or cyprinid) is based on seven environmental variables (EFIPLUS CONSORTIUM, 2009).

Table 5 lists the definition and reaction of the single EFIplus metrics. Since both, guilds and metrics are expected to decrease with increasing pressures, the reaction is indicated only once (↓).

Table 5: Description of EFIplus metrics according to EFIPLUS CONSORTIUM (2009).

Index	Metric name	Description		reaction
Index 1 (salmonid river type)	Ni.Hab.Intol.150	Density of individuals with length ≤ 150 mm that belong to species intolerant to habitat degradation.		↓
	Ni.O2.Intol	Density of oxygen depletion intolerant species.		↓
Index 2 (cyprinid river type)	Ric.RH.par	Richness in number of species of rheopar reproduction habitat species.		↓
	Ni.Litho	Density of species with lithophilic reproduction habitat.		↓
EFIplus-Index	Salm.Fish.Index			
	Cypr.Fish.Index	$= \frac{Ric.RH.par + Ni.Litho}{2}$		$= \frac{Ni.Hab.Intol.150 + Ni.O2.Intol}{2}$
EFIplus-Class		Wading	Boating	
	Class 1	0.939 – 1	0.917 – 1	0.911 – 1
	Class 2	0.655 – 0.939	0.562 – 0.917	0.755 – 0.911
	Class 3	0.437 – 0.655	0.375 – 0.562	0.503 – 0.755
	Class 4	0.218 – 0.437	0.187 – 0.375	0.252 – 0.503
	Class 5	0 – 0.218	0 – 0.187	0 – 0.252

Again the values have been standardized to vary between 0 and 1 and to decrease by human pressure. An undisturbed site should show a value of 0.80. Higher values indicate a very good situation. Lower values are grouped in Index classes as shown in Table 5 (EFIPLUS CONSORTIUM, 2009).

1.7.4 Selected metrics from the EFIplus database

The 27 selected metrics from the EFIplus database were chosen since they showed already strong reactions in former projects (MIRR, FAME, EFIplus) and to be able to compare real measurements with modified metrics like the FAME- and EFIplus single metrics. The selected metrics are based on 4 guilds. The arrows indicate the guild's reaction to increased pressures.

- lithophilic (LITH, ↓)
- omnivorous (OMNI, ↑)
- potamodromous (POTAD, ↓)
- rheophilic (RH, ↓)

For each guild different metrics have been calculated (see Table 6).

Table 6: Description of selected metrics from the EFIplus database (x is a placeholder for each guild).

Name of fish metric	**Description of fish metric**
N_sp_all	Total number of species (N_{sp})
n_sp_Repro_LITH n_sp_Atroph_OMNI n_sp_Mig_POTAD n_sp_Hab_RH	Number of species per guild (N_x)
perc_nha_Repro_LITH perc_nha_Atroph_OMNI perc_nha_Mig_POTAD perc_nha_Hab_RH	Proportion of species per guild $= N_{x_{pct}} = \frac{N_x}{N_{sp}}$
Density_sp_all	Total density of all species per hectare (D_{sp})
n_ha_Repro_LITH n_ha_Atroph_OMNI n_ha_Mig_POTAD n_ha_Hab_RH	Density per guild and hectare (D_x)
perc_sp_Repro_LITH perc_sp_Atroph_OMNI perc_sp_Mig_POTAD perc_sp_Hab_RH	Proportion of density per guild $= D_{x_{pct}} = \frac{D_x}{D_{sp}}$
Biom_sp_all	Total biomass of all species per hectare (B_{sp})
kg_ha_Repro_LITH kg_ha_Atroph_OMNI kg_ha_Mig_POTAD kg_ha_Hab_RH	Biomass per guild and hectare (B_x)
perc_kgha_Repro_LITH perc_kgha_Atroph_OMNI perc_kgha_Mig_POTAD perc_kgha_Hab_RH	Proportion of biomass per guild $= B_{x_{pct}} = \frac{B_x}{B_{sp}}$

2. Data availability

The general database for this survey consists of several shape files generated for the NGP (Austria's national water management plan) by the Federal Ministry for Agriculture, Forestry, Environment and Water Management (BMLFUW, 2009) of Austria. They contain general information about the river network in Austria, its morphological status and anthropogenic pressures. In addition the Institute of Hydrobiology and Aquatic Ecosystem Management (IHG) at the University of Natural Resources and Applied Life Sciences (Vienna) provided a dataset with biological information investigated at several sampling sites at Austrian rivers. Since most files were projected in MGI-Austria-Lambert shape files with another geographic coordinate system were transformed to achieve a uniform database. The files used in this survey will be described in the following section.

2.1 Surface water bodies

The surface-water-body shape file (*owk_fg.shp*: BMLFUW, 2009) provides information about the water network in Austria. The segments are grouped due to their catchment size (<10 km^2, 10 km^2 or 100 km^2). Additional data inform about the river type of each segment (e.g. main stream, tributary stream). To avoid a fragmented river network, straight lines are formed where a river flows through a lake. Although these segments contain no information about the river network itself they hold the river segments together. Since Austria produces a high amount of energy with waterpower plants, not all lakes are natural. Some are artificial due to dams. While some of Austria's federal states (Salzburg, Tyrol and Vorarlberg) handled all lakes the same others made a distinction between natural and artificial lakes. This is demonstrated by the fact, that some federal states coded artificial lakes as lake segments while others coded them as river segments. This inconsistency has to be considered when the data are used.

2.2 Routes

The route shape file (*routen_aktuell.shp*: BMLFUW, 2010b) is very similar to the surface-water-body shape file, but it does not stop at the borders of Austria. In contrast to the surface-water-body shape file it contains the names of the rivers. Each object represents one whole river.

2.3 Lakes

Although lakes are not of special interest in this thesis it is necessary to take them into account since rivers might flow through them. As described before, the information about lakes is also present in the surface-water-body shape file. But since these files are not consistent between the federal states, it is helpful to have additional information. Therefore two shape files with information about the lakes in Austria were used. The first shape file (*seen_aktuell.shp*: BMLFUW, 2009) includes information about position, size and name of a lake. Additionally it lists the names of the rivers that flow into and out of the lake. Since the first shape file contains both natural and artificial lakes, a second shape file (*Geometrie_echte_Seen*) was produced by the Institute of Hydrobiology and Water management (IHG). This shape file contains only natural lakes. However, in this survey artificial lakes are handled as river segments.

2.4 Fish regions

According to QZV ÖKOLOGIE OG (2010) a fish region represents the longitudinal classification of running waters, which is based on sequences with changing biocenoses. Biocenoses change their composition according to river characteristics like slope, altitude, water temperature or discharge (HUET, 1949). This change allows a longitudinal classification of the river network into so called fish regions. Each fish region defines key species and accompanying species. Key species are species with relative high abundance in the respective fish region, while accompanying species show a medium relative abundance for the same region (QZV ÖKOLOGIE OG, 2010). Eight fish regions are occurring in this thesis. Their key species are shown in Table 7

Table 7: Fish regions

fish regions	**eponymous specie**
epirhithral	upper trout region
metarhithral	lower trout region
hyporhithral small	grayling region
hyporhithral large	
epipotamal small	barbel region
epipotamal medium	
epipotamal large	
metapotamal	bream region

The fish region shape file (*fischregionen.shp*: HAUNSCHMIDT, VERNIER and LINDNER, 2004) contains information about rivers with a catchment between 10 and 100 km^2 and is shown in Figure 2. For grey segments, no data about the fish region are available.

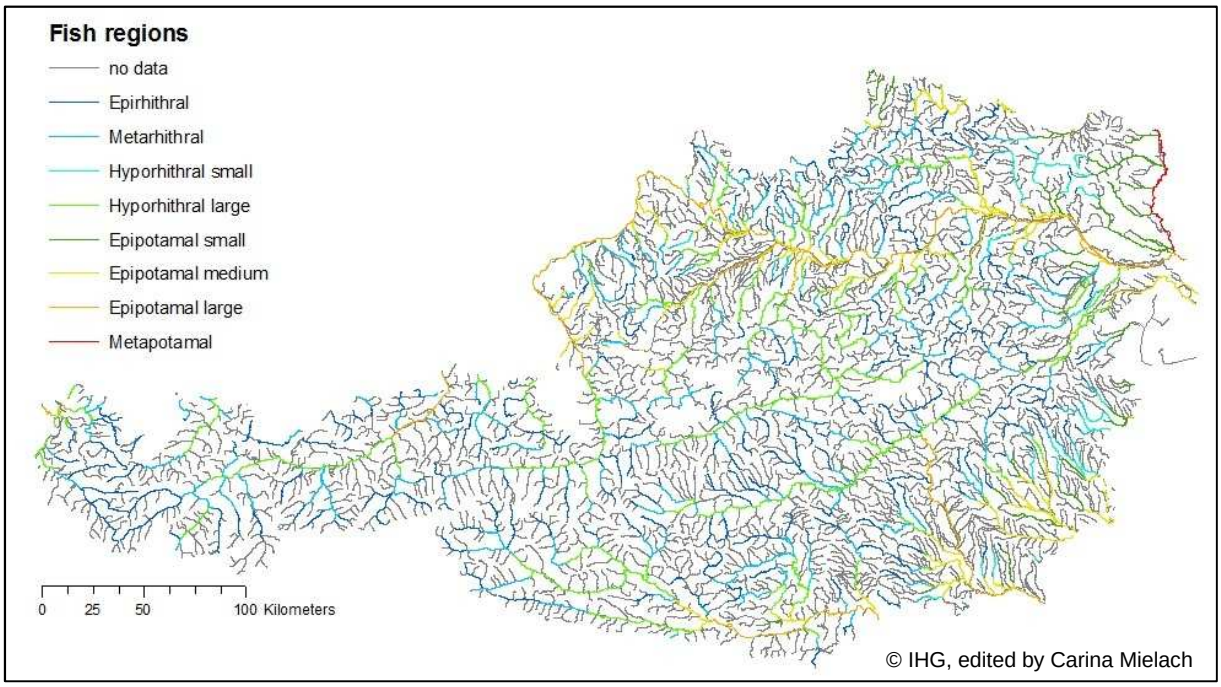


Figure 2: Fish regions according to HAUNSCHMIDT, VERNIER and LINDNER (2004).

2.5 Primary Catchments

"For any point along a water course, and for any other point in the landscape, a catchment (or watershed or drainage basin) can be defined" (RODHE and KILLINGTVEIT, 1997).

Rain reaching the surface seeks its way downhill (either above or below surface) until it reaches a water body. The area draining into the same river is defined as the river's catchment (RODHE and KILLINGTVEIT, 1997). Usually the borders between catchments show a higher elevation than their surrounding area. Catchments of single rivers can be combined to larger areas representing the catchment area of a whole river network. The smallest unit of interest is the primary catchment (PC). A PC is either the catchment of one single river without any confluents or the area between two confluent river segments.

By using a digital terrain model it is possible to calculate these PCs and their river segments. The CCM (Catchment Characterisation and Modelling) River and Catchment database (version 2.0) developed at the Joint Research Centre of the European Union in Ispra, Italy (VOGT et al. 2007) serves as reference network and for catchment delineation in this thesis. CCM is a project in accordance with the WFD, which postulates river management on a

catchment level. To support this management, a pan-European database of river networks and catchments was generated (VOGT et al., 2007). Figure 3 shows exemplary the upper catchment of the river Triesting and its calculated PCs and river segments.

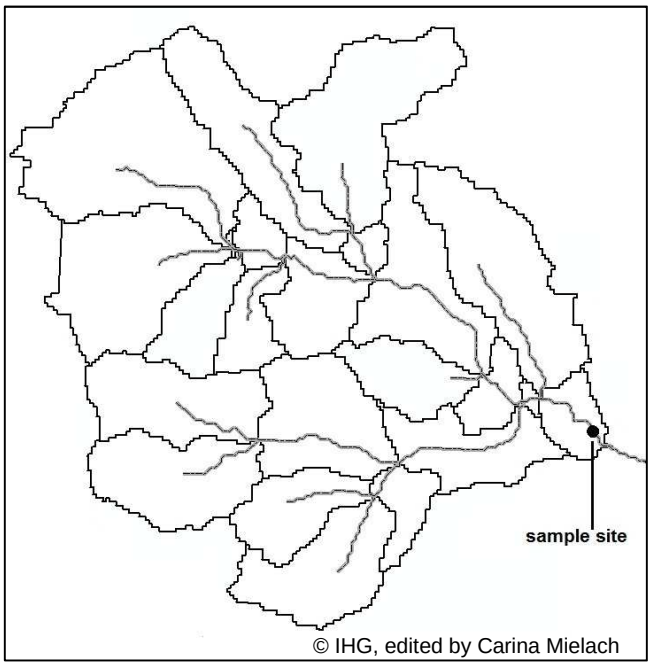


Figure 3: Primary Catchments (Exemplary Upper Triesting).

Each PC carries a distinctive code (*WSO1_ID*) and a code of the next downstream PC (*NextDownID*). A specially programmed script adapted from BADY and TRAUTWEIN (2007, unpublished) was used to calculate the upstream catchment for any desired fish sampling point by using the information of primary catchments (see chapter 2.5). The script starts with the PC containing the sample site and searches for other PCs referring to it as *NextDownID*. This procedure is repeated until no more upper PCs are present.

2.6 Morphological status

The morphological status is an evaluation of the water body in terms of anthropogenic modification. The river characteristics are rated as being natural or anthropogenically modified ranking from 1 (no alterations) to 5 (very high alterations). Table 8 shows the five morphological status classes and their definition.

Table 8: Definition of morphological status classes.

Morphological status class	Definition
1	No or minor anthropogenic alterations
2	Slight alterations
3	Moderate alterations
4	High alterations
5	Very high alterations

The morphology shape file (*morph_Stau_RW_merge.shp* (IHG) is a modification of *morph_v6.shp*: BMLFUW) and can be seen in Figure 4.

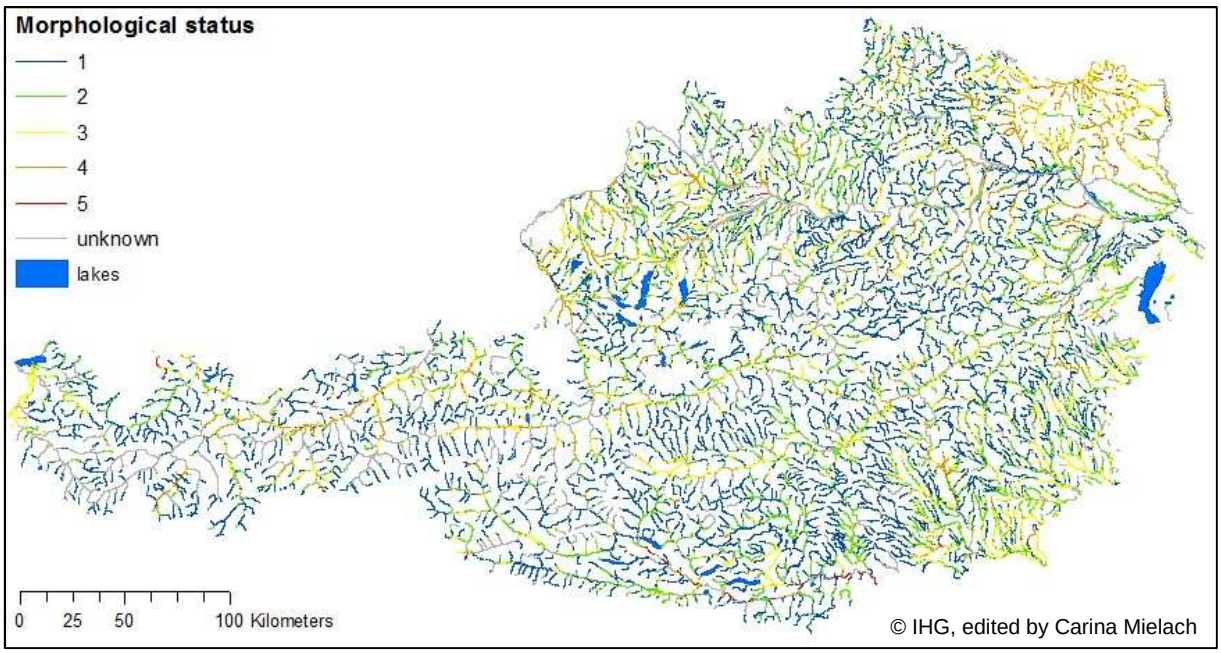


Figure 4: Morphological status of Austrian rivers according NGP (BMLFUW, 2009).

In addition, Figure 5 shows the percentage of each status class on the total river network of Austria. It is calculated as length ratio between each morphological status class and the total length. No morphological status was defined for 19 percent of the river network (class unknown or “0”). According to the NGP (BMLFUW, 2009) about 26.3 percent of Austria’s river network are morphologically impacted. Summing up the percentages for morphology status class 3 to 5 (i.e. impacted) in Figure 5 results in 22.2 percent of morphologically impacted river segments. So the NGP results and the calculated results for this thesis differ slightly.

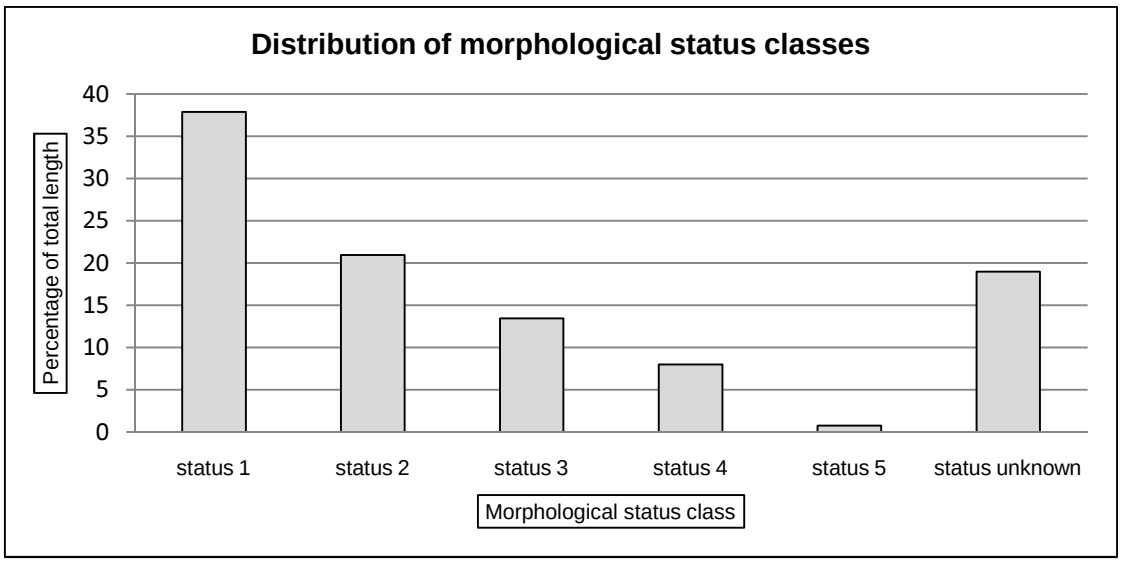


Figure 5: Distribution of morphological status classes according NGP (BMLFUW, 2009).

In order to determine the morphological status of a river segment by a single value, a morphological index was created. Its calculation will be described in chapter 3.2.3.

2.7 Barriers

Barriers can be either passable or impassable for fish or other aquatic organisms. If they are impassable they disrupt the longitudinal or lateral connectivity and thereby cause habitat fragmentation (RIEMAN and DUNHAM, 2000).

According to the barriers shape file (*querbauw_v6.shp*.: BMLFUW) there are 55040 barriers in Austria's river network at which a proportion of 60 percent is impassable for fish. Table 9 shows the percentage for each barrier type.

Table 9: Distribution of barrier types in percent according to NGP (BMLFUW, 2009).

	all barriers	**power plants**	**others**	**natural barriers**	**type unknown**
impassable	60.5	5.2	46.2	8.1	0.9
passable	39.5	0.8	38.4	0.3	0.1
sum	100.0	6.0	84.6	8.4	1.0

Since the type of barrier is less important than its passability there was only made a distinction between passable and impassable barriers in this thesis. Barriers represent a special problem since they can't be simply transformed into percentage values as other longitudinal pressures (e.g. water abstraction). The total amount of barriers is an improper

measure since the number will simply increase with an increasing scale. A possibility to calculate information related to percentages is to presume the highest number of barriers per scale as 100 percent, while no barriers represent zero percent. Other values can then be calculated as a proportion. Another possibility would be to calculate the number of barriers per unit of length (e.g. 1000 meters). But thereby a barrier at each end of a buffer would be wrongly presumed. Since all those calculations might distort the true situation a new buffer was invented using impassable barriers as delineation (see chapter 3.1.2.3). It is very likely that barriers surrounding the sample sites have the greatest influence. Barriers further away do not directly influence the local fish population and may only influence the hydro-morphological situation. Since this information is also included in other pressure shape files this solution was evaluated as suitable.

Nevertheless the information about total number of barriers is very important for restoration measures. It is not very beneficial if an impassable barrier is upgraded with a fish ladder if the next impassable barrier is very close. If such restoration measures are undertaken they should involve the whole river (or a greater section of the river). The amount of impassable barriers is an important criterion when selecting a river for restoration.

2.8 Hydro peaking

Hydro peaking is a pressure caused by reservoir power stations which are used to cover peak demands. The intermittently processing of the reservoir water results in a flush in the downstream river segment whereas impacted river segments suffer from residual or no flow when no energy is produced. The ecosystem has to undergo regular flow fluctuations. Times with very high discharge are followed by periods of no or sparse residual flow. This phenomenon is not only local but extends over a longer section of the river until it is absorbed by flowing retention. Therefore the influence on aquatic organisms occurs in a long distance. During flush juvenile fish might seek shelter in shallow areas close to the shore. As the water level quickly declines, these fishes might be trapped in troughs and die (JUNGWIRTH et al., 2003).

According to the hydro peaking shape file (*schwall_v6.shp*: BMLFUW, 2009) about 2.5 percent of Austria's river network are affected by hydro peaking. This value matches with the percentage stated in the NGP. In addition this shape file also contains information about the peeking ratio, but since this information is only known for 38 percent it's not taken into account. Figure 6 shows the affected river segments and their percentage of Austria's river network.

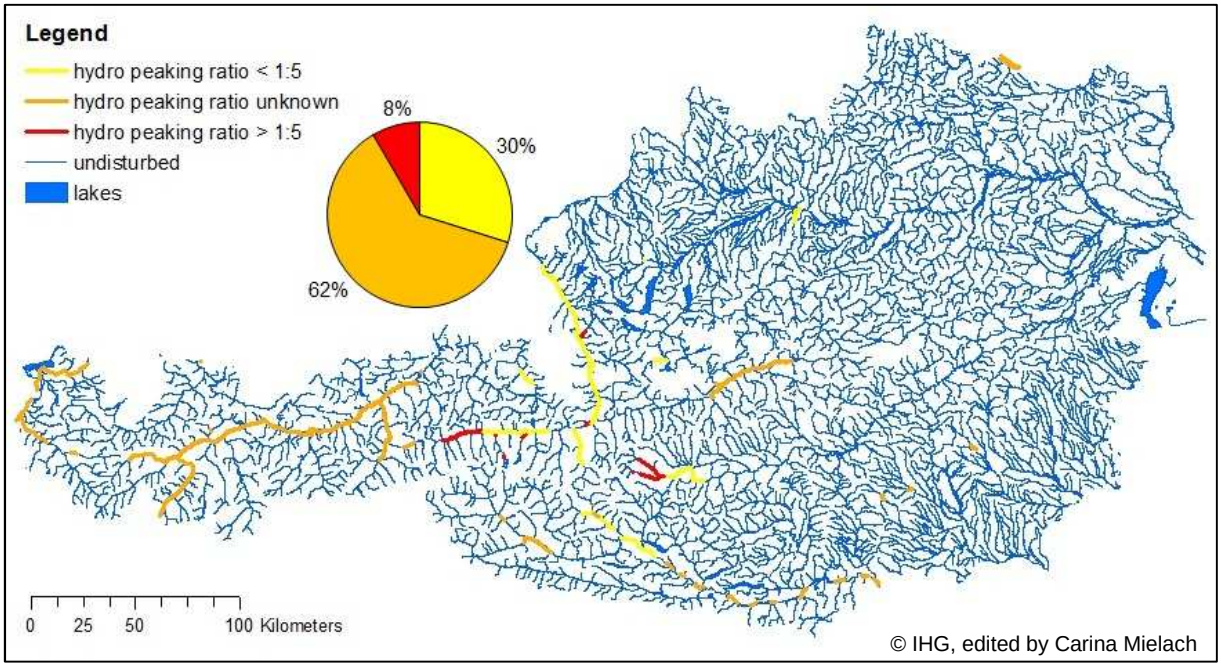


Figure 6: Austrian water bodies affected by hydro peaking according NGP (BMLFUW, 2009).

2.9 Impoundment

Impoundments mainly occur at run-of-river- and storage power stations. At run-of-river power plants a continuous processing of the discharge without storing occurs. Therefore especially potamal rivers can show very long impounded sections, suffering from a reduction of dynamic processes (as e.g. flow velocity). While siltation occurs upstream of the power station, the downstream section suffers from river bed deepening (JUNGWIRTH et al., 2003). Impounded sections influence fish by loss of fluvial habitat, embeddedness of substrate or altered channel form (REID, 2004).

In contrast to run-of-river power stations, storage power stations show very large impoundments, which are comparable to lakes. The reservoir might even show thermal stratification and mixing cycles. The lowering of the water level can destroy the benthos population and might kill fish due to stranding. Downstream of the dam the river suffers from residual flow and hydro peaking. Especially reservoir flushing (to flush fine sediments out of the reservoir) causes devastating consequences (JUNGWIRTH et al., 2003).

The impoundment shape file (*stau_v6.shp*: BMLFUW, 2009) divides the impacted sections into two pressure-groups due to their length. The first group is defined by less than 100 meters length in small rivers (10 km^2 catchment) or less than 500 meters in larger rivers (100 km^2 catchment). If the lengths exceed the above stated values they belong to pressure-group two which is rated as significant pressure. According to shape file impoundment the

percentage of impounded segments in Austrian rivers is about 3.8. This value is very similar to the percentage mentioned in the NGP (see chapter 0). Affected segments and percentage per pressure group are shown in Figure 7.

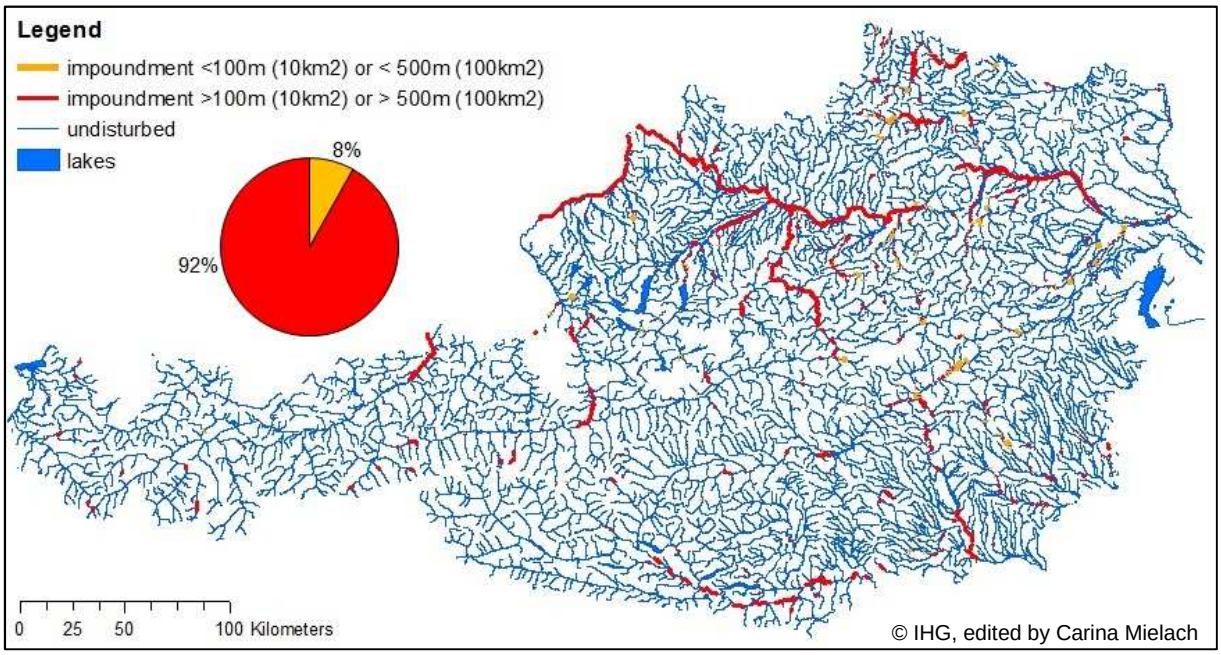


Figure 7: Impounded river sections in Austria according NGP (BMLFUW, 2009).

Since the length of the impounded segments is anyway calculated as a percentage of each scale and most of the segments (92%) are rated as significant pressure, no distinction between the two pressure groups was made.

2.10 Water abstraction

This pressure occurs in connection with diversion water power plants, which branch off a proportion of the river's water to lead it to the power station, for example via a pressure pipe. The water remaining in the river is called residual flow and often shows annual fluctuations (JUNGWIRTH et al., 2003). The affected river segments suffer of a decrease in channel maintenance flow (REID, 2004). Usually an appropriate amount of residual water should be specified for those river segments to ensure the functionality of the local ecosystem (JUNGWIRTH et al., 2003). Unfortunately the discharge left in those segments is not always chosen adequately so far. However, the NGP contains a first definition of thresholds for water donations (Q_{dot}) in Austria, they are listed in the "quality-objectives statutory order" (QZV Ökologie OG, 2010), see chapter 1.4 for details.

Unfortunately the water abstraction shape file (*restw_v6.shp*: BMLFUW, 2009) only includes segments rated either as significant (52 percent) or unknown (48 percent) pressure. The significant pressure is defined as a residual flow lower than the MJNQt. Figure 8 displays the affected segments and their percentage of the river network. According to the shape file about 9.1 percent of the river network suffers from this pressure. This value is slightly lower than the percentage mentioned in the NGP (i.e. 9.9%, see chapter 1.3).

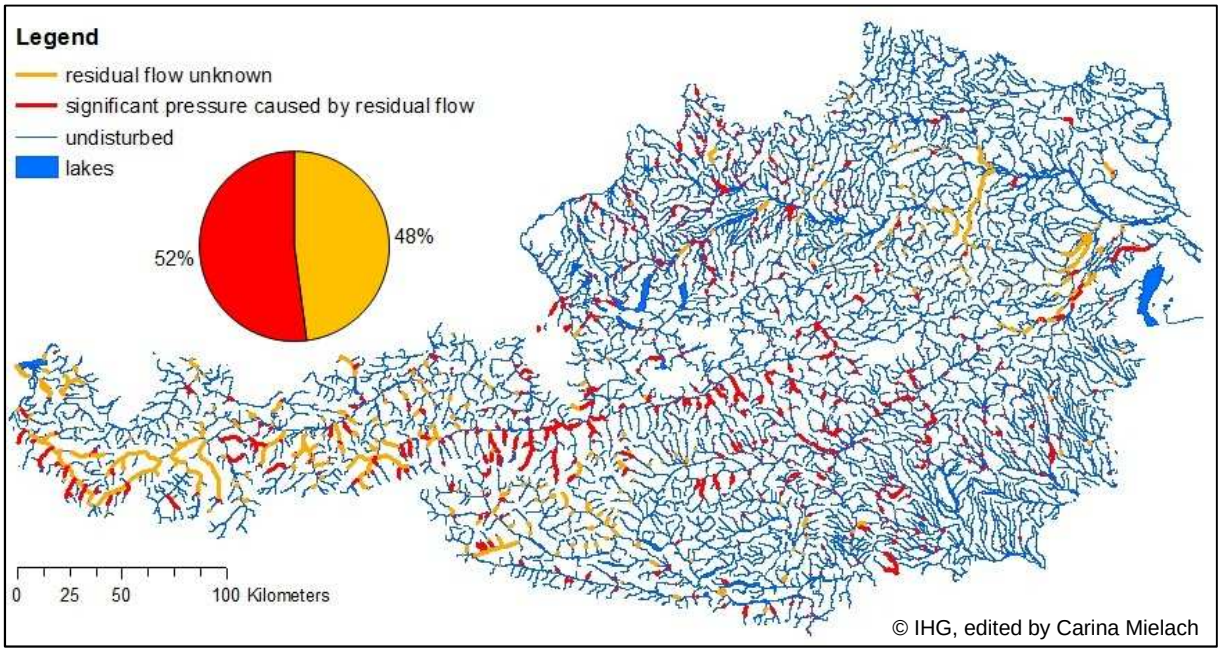


Figure 8: Water abstraction in Austrian rivers according NGP (BMLFUW, 2009).

2.11 Sample Sites

In sum 1697 sample sites in Austria were taken into account for the generation of related pressures. 518 are GZÜV sites (Gewässerzustandsüberprüfungs-VO), 874 are out of the EFIplus database (EFIPLUS CONSORTIUM, 2009) and 305 are other sample sites from the IHG database. Each site was given a code beginning with the letters AT (for Austria) followed by the first 4 letters of the river name and the altitude of the sample site. For instance ATSALZ390 is a site at river Salzach with an altitude of 390 meters above sea level. This ensures that each site and measurement has a unique code. Figure 9 shows all 1697 sites, their origin and location.

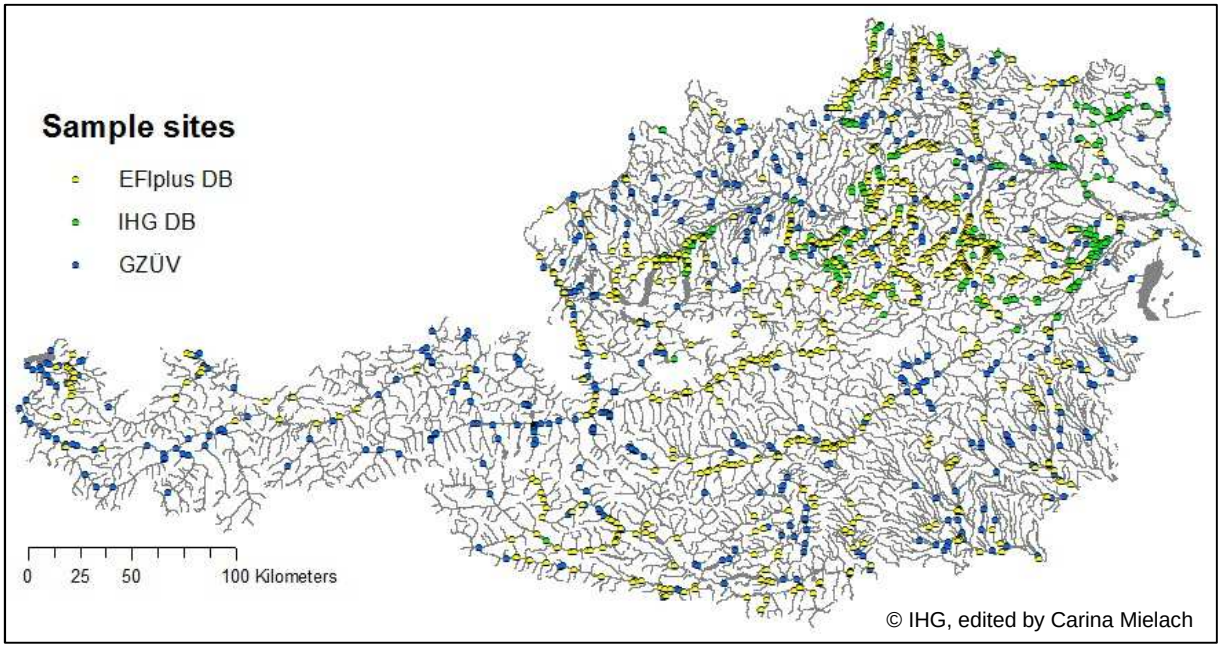


Figure 9: Sample sites in Austria

Since the fish metrics (see chapter 1.7) already were calculated for 875 sample sites, only these were taken into account. Nevertheless the pressures were evaluated for all sites and most scales (see chapter 3.1.2). Figure 10 shows the percentage of each morphological status class and pressure for all sites (1697) and sites with fish metrics (875) as well as their distribution in Austria's river network.

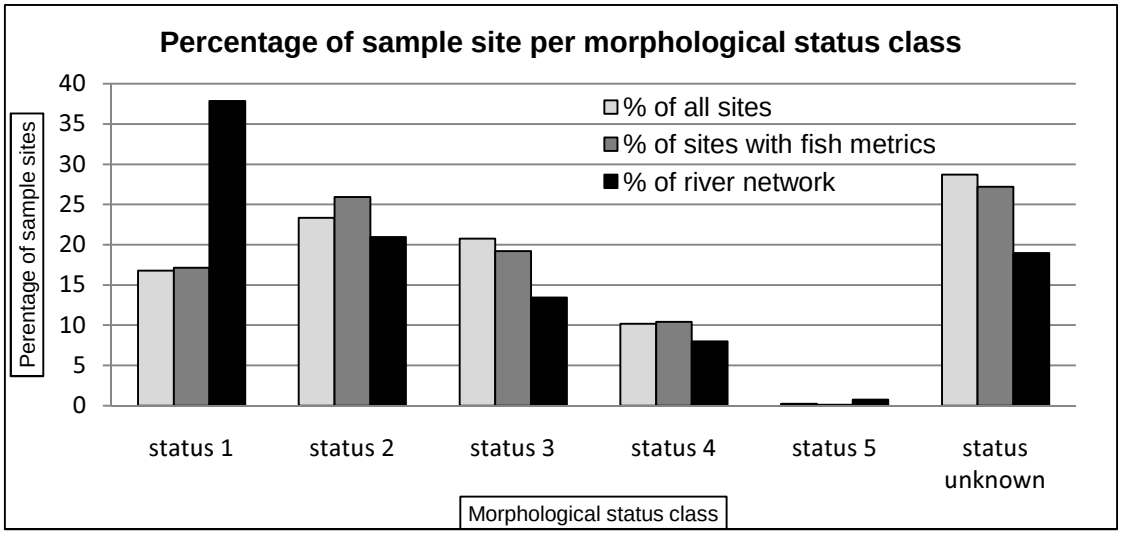


Figure 10: Morphological status of sample sites

It can be seen that although 38 percent of the river network are rated with status 1 only 17 percent of the sites achieve this status. This indicates that the morphological status class 1

might be underestimated. However more than 25 percent of the sites lie within undefined segments which make up only 19 percent of the river network.

Figure 11 shows the percentage of sample sites per pressure. The black bar indicating the pressure percentage in the river network is always lower than the bars representing the sample sites. This means the sample sites are more often placed in influenced than uninfluenced segments and that pressures are overrepresented by the sample sites.

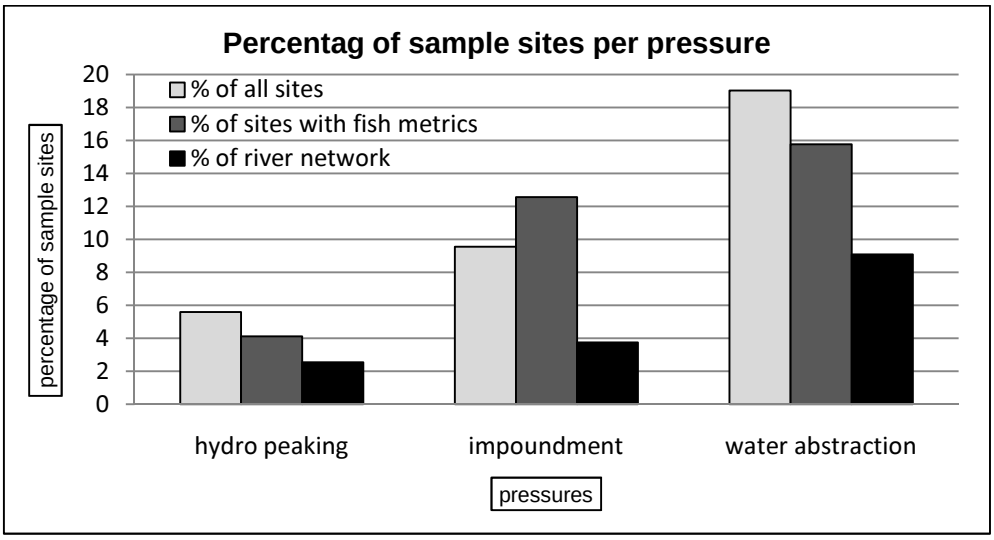


Figure 11: Pressures at sample sites

3. Methodology

3.1 ArcGIS©

ArcGIS© is a software product developed by the Environmental Systems Research Institute (ESRI). The program includes several tools. Therefore ESRI provides a very useful Desktop Help (9.2) with tutorials and instructions on how to use them. For this study ArcGIS© 9.3 was used.

3.1.1 Tools

Since shape files represent independent datasets without connections to each other ArcGIS© provides a variety of different tools to connect the containing information. In the following section the tools used for this thesis are described.

3.1.1.1 Spatial Join

The “Spatial Join” tool (Analysis Tools – Overlay – Spatial Join) creates a table-join in which fields from one layer’s attribute table are appended to another layer’s attribute table based on the relative locations of the features in the two layers (ESRI, 2007). The table is written into a new shape file that includes the information of both input files.

It is possible to choose between two different join operations. The first method joins one element of the first layer to one element of the second layer. The second method joins one element of the first layer to one or more elements of the second layer. Depending on the definition the tool joins objects that intersect, contain each other or are closest to each other. Usually all fields from the input layers will be put together in the output table. But there is also the possibility to choose only the fields of special interest. By doing so the result is clearly arranged and redundant information can be avoided.

In this thesis the tool was used for joining each pressure layer to the sample sites layer. The resulting attribute table included the information about the sample sites as well as the chosen information about each pressure. Thereby it was possible to determine local pressures.

3.1.1.2 Intersect

The tool “Intersect” (Analysis Tools – Overlay – Intersect) computes a geometric intersection of the input features. Features or portions of features which overlap will be written to the output shape file (ESRI, 2007). Figure 12 shows an example of the intersect tool. The sample sites and catchments represent the input features. The output shape file includes the information for each sample site within (or at the border) of those catchments as well as the

catchment information. Thereby the number and attributes of sample sites per catchment can be evaluated.

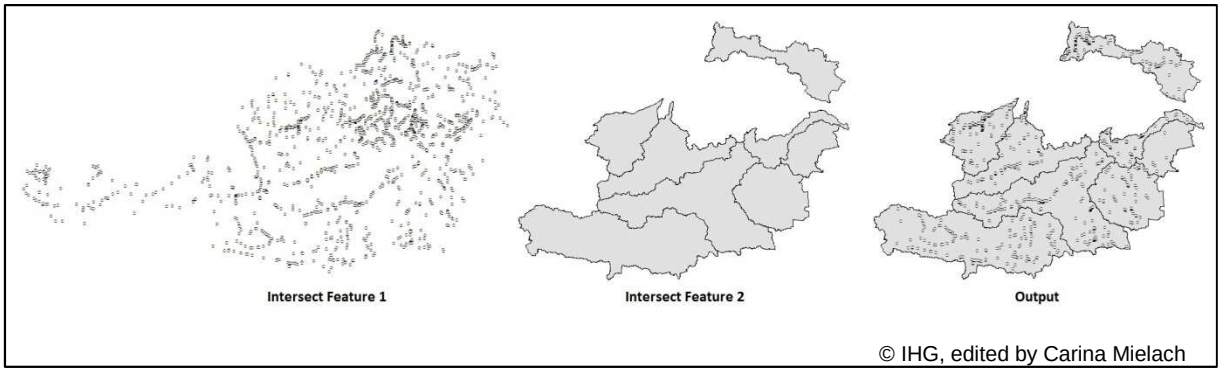


Figure 12: Example for application of tool “Intersect“.

In most cases the pressures of a buffer were identified by intersecting the pressure shape file with the buffer shape file. The pressure shape files are cut at the border of the buffer shape file. The output table includes an entry for each pressure segment within a buffer. For the example in Figure 12 this would mean that the attribute table shows one entry for each point and that each entry will include the catchment information.

3.1.1.3 Network Analyst

The Network Analyst is an extension of ArcGIS© and is used to conduct network-based spatial analyses. With this extension it is possible to calculate vehicle routing problems, logistics, closest facilities or to create service areas (ESRI, 2007). In this survey the Network Analyst was used to create a service area surrounding the sample sites (see chapter 3.1.2.3). To do so the extension was ordered to start at a given point and to go in all directions for a fixed distance. The resulting segments represented one service area.

3.1.1.4 Clip

The “Clip” tool (Analysis Tools – Extract – Clip) is used to extract input features that overlay the clip features (ESRI, 2007). It simply uses the clip feature as a cookie cutter which clips the input feature at its border. No information is shared in this process. The output shape file keeps the same information as before and only the geometry of the layer is modified. Figure 13 shows an example. The route shape file represents the input file while a shape file with Austria’s border is the clip feature. The output is a clipped route file with no additional information but a changed geometry.

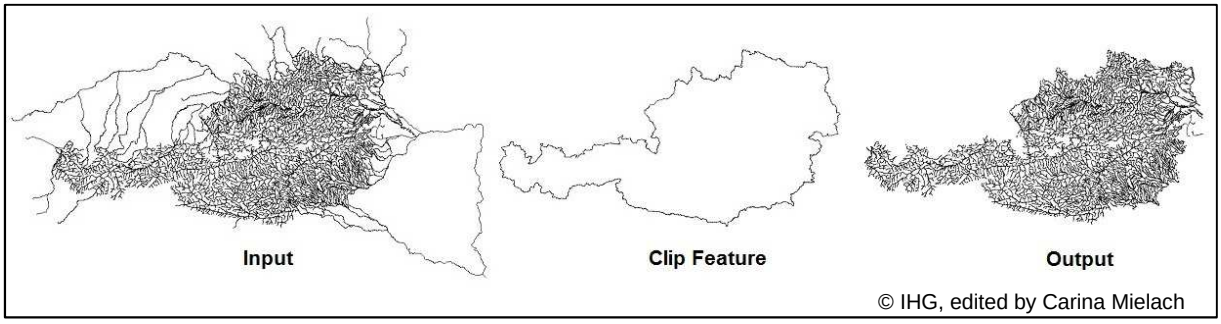


Figure 13: Example for application of tool “Clip”.

3.1.1.5 Buffer

The “Buffer” tool (Analysis Tools – Proximity – Buffer) applies a buffer to an existing layer. The size of the buffer can be entered in the dialog box. The input feature may be a point, line or polygon. Figure 14 shows a buffered river segment as an example.

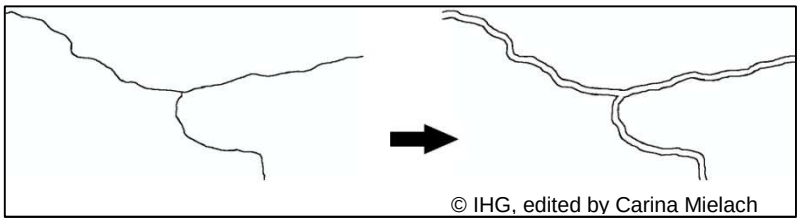


Figure 14: Example for application of tool “Buffer”.

3.1.1.6 Merge

The tool “Merge” (Data Management Tools – General – Merge) combines input features from multiple input sources (same data type required) into a single, new output shape file (ESRI, 2007). Figure 15 shows an example. The input consists of three separate shape files (features). Since all of them include polygons representing catchments they should be combined into one single shape file. This can be achieved by merging them. The attribute table of the output shape file then shows an entry for each catchment.

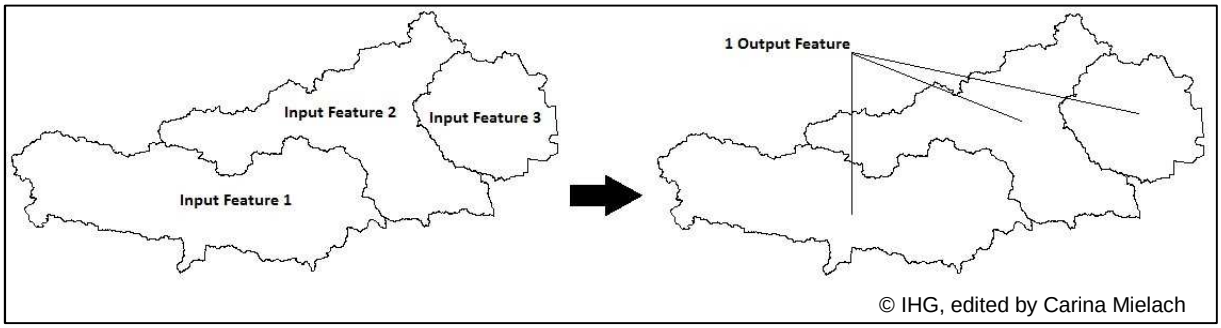


Figure 15: Example for application of tool “Merge”.

3.1.1.7 Dissolve

The “Dissolve”-tool (Data Management Tools – Generalizations – Dissolve) aggregates features based on specified attributes (ESRI, 2007). Figure 16 shows sub-catchments of the Danube. Assumed that the attribute table of this feature includes a column with the name of the superior catchment (i.e. Danube) and this field is chosen to dissolve this layer then all single catchments would be dissolved to one new feature (in this case the Danube catchment) with only one single entry in the attribute table.

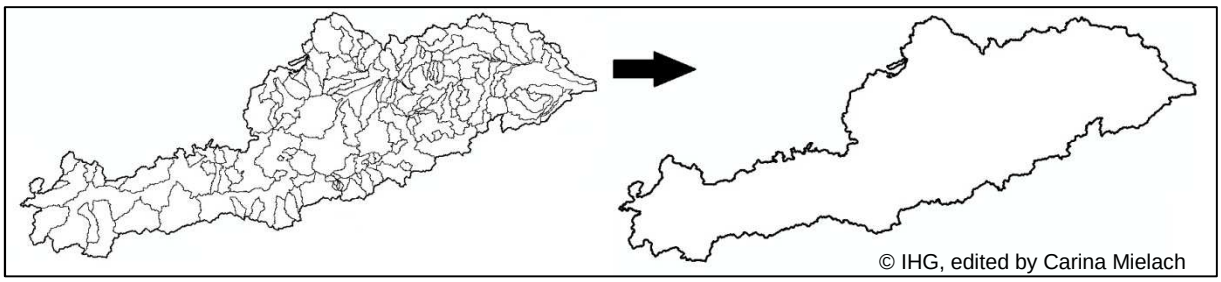


Figure 16: Merge

3.1.1.8 Caclulate Geometry

The tool is available in the Attribute table. It can be selected by right-clicking a column and choosing “Calculate Geometry”. Depending on the object lengths, areas or coordinates can be calculated.

3.1.1.9 Create Layer from selected features

If one or more objects from an attribute table (or in the map) are selected it is possible to right-click the layer, go to “Selection” and “Create Layer from Selected Features”. Then a virtual shape file is added to the map and saved within the Arc Map document (mxd). It includes only the selected objects with all parameters from the input shape file. Contents of the virtual shape file are read from the original source and the new selection is not physically stored on the hard disk.

3.1.2 Generation of Spatial Scales

To investigate the relationship between fish and anthropogenic pressures different spatial scales have to be taken into account. Since it is not known at which scale the greatest influence occurs many different scales were discussed according to their importance and feasibility. While some of the scales are simply based on distance to sampling points others were selected due to local conditions or habitat areas. As mentioned in one of the introducing chapters (0) the selected scales should cover a wide range of different scales. Therefore after professional discussion and literature review the following 10 scales were chosen.

3.1.2.1 Local scale

The local scale plays an important role since it is the location where the samples were taken. Pressures at this scale shape the local habitat and have a great influence on the existing fish stock. A negative aspect of this scale is therefore that the river network surrounding the site is not taken into account.

The pressures at local scale were investigated by simply joining the sample sites to the pressure files using the spatial join-tool (see chapter 3.1.1.1). A problem occurred due to the fact that the points representing the sample sites are not always located exactly on the lines representing the river network. The greatest distance between sample site and river network is 14.5 meters. To account for this inaccuracy the search radius in the Spatial Join dialog box was set to 14.5 meters. By doing so another error arises. Assuming that a site is located in an impounded river segment and very close to the causing dam it will be correctly joined to the impoundment file. In addition it might be joined to the hydro peaking or water abstraction file downstream of the dam if the distance is smaller than 14.5 meters. Figure 17 visualizes the above described example. The site is within an impounded river segment but the distance to the other pressures is very small. All three pressures will be joined to the site. The two incorrect pressures have to be deleted by hand.

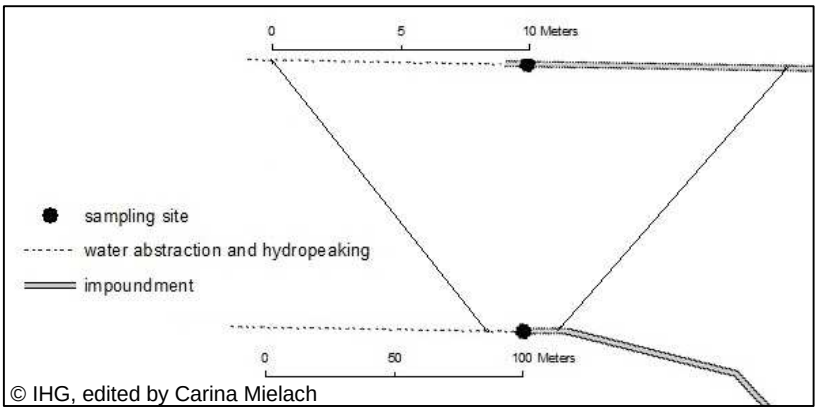


Figure 17: Example for a local error.

Also a site that is exactly located on the river network might be joined to a pressure file on the same river segment although the site is not located in this pressure area. Therefore all results with distances greater than 1 m were checked for plausibility and wrongly joined objects were deleted from the attribute table of the resulting layer.

Usually the pressure values are calculated as percentage of the total buffer length but since the buffer length is zero, the calculation is not possible at this scale. However, the pressures

were valued with 1 if the pressure occurs and 0 if the pressure does not exist. For later analyses this means that either 0 or 100 percent values exist at this scale.

3.1.2.2 Distance Buffers

The distance buffers for this investigation were adopted from the MIRR project where circles with diameters of 1, 5 and 10 kilometres were calculated (SCHMUTZ et al, 2007a). The buffers in this thesis were built a little different since the distance was not applied as linear distance but as distance measured along the river network. These segments were not restricted to be at the same river but could lead in all possible river segments. To cover a greater range two more buffers with the length of 0.5 kilometres and 50 kilometres were selected. So in sum 5 different distances were used (see Table 10).

Table 10: Buffer scales calculated for this thesis.

buffer	distances up- and downstream	MIRR project
1	250 m	-
2	500 m	1 km
3	2500 m	5 km
4	5000 m	10 km
5	25000 m	-

Figure 18 shows a visualization of the five buffers as an example (the buffers are numbered as listed in Table 10). Since the biggest buffer (5) is very long it was not drawn to its full extent in the illustration (indicated by arrows).

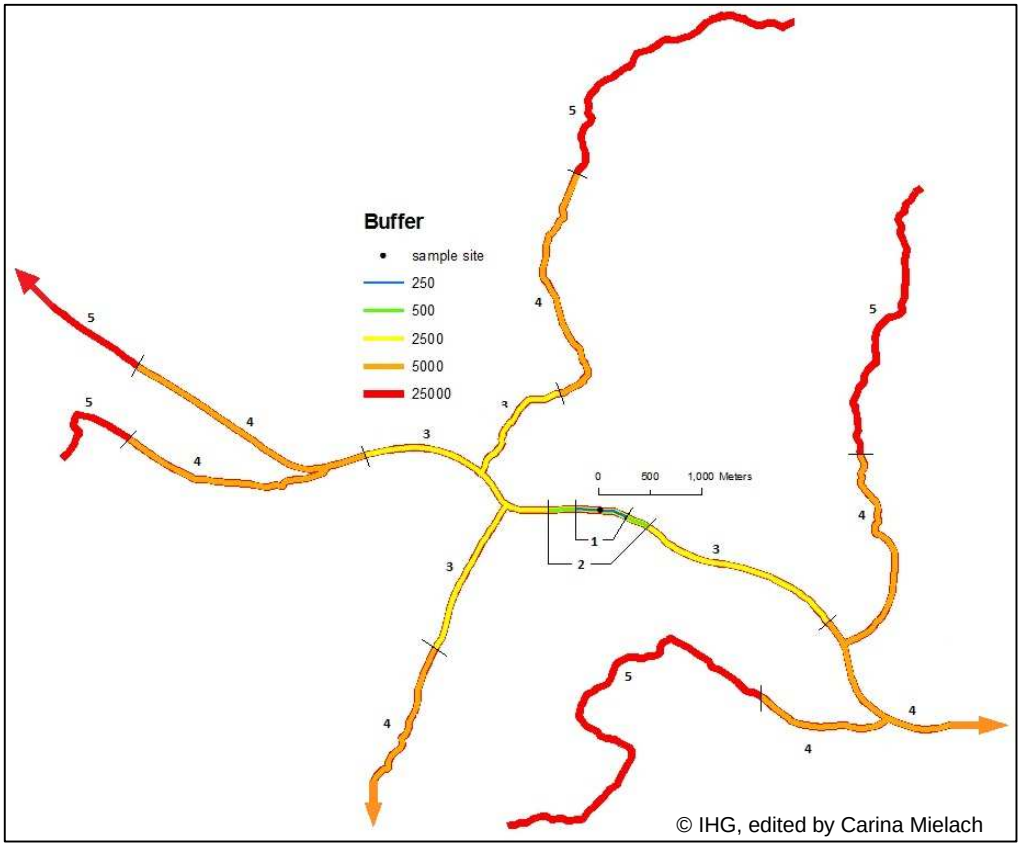


Figure 18: Visualization of Buffers (ATINN_595).

Although the buffer distances used are always the same the resulting routes might have different lengths in sum. Smaller values might occur if the distance to the spring is shorter than the used buffer while bigger values arise if the river network shows many branches (see Figure 19).

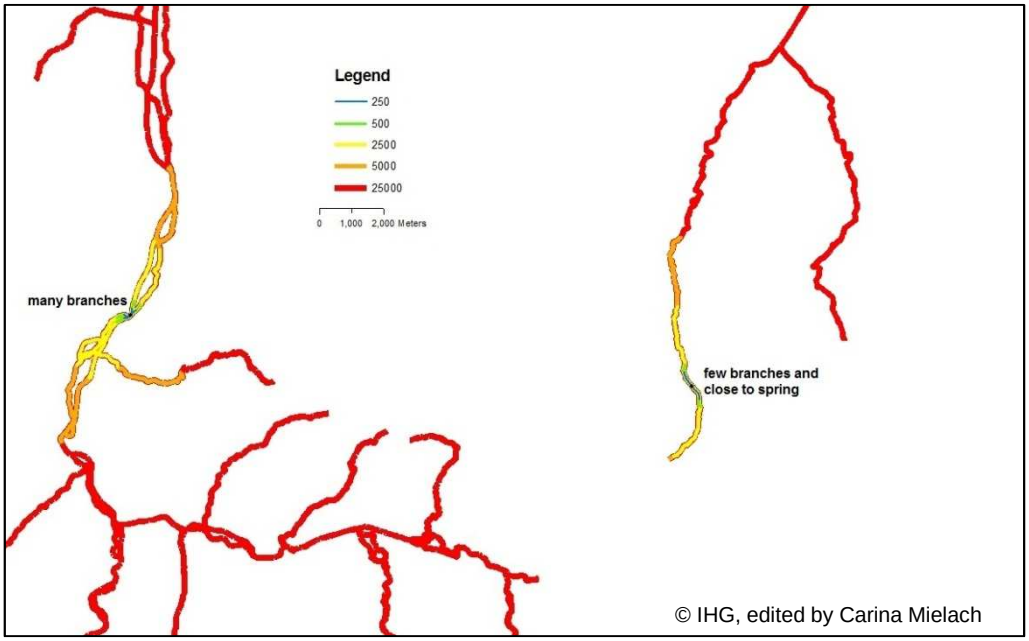


Figure 19: Visualization of buffer length differences.

In contrast to the MIRR project, each buffer was used for each site regardless of the underlying catchment size. The buffers were named due to their distance from the site.

To identify the above described buffers the route file was edited with the network analyst using the sampling sites as starting points. The resulting attribute table showed an entry for each polyline containing the name of the site and the length of the buffer. Since the route file exceeds the Austrian border, segments outside of Austria had to be clipped. Therefore a polygon with Austria's shape was used, which was generated based on a shape file showing Austria's federal states (*laender_at_project.shp*: IHG). Again the accuracy of the polygon and the accuracy of the river network differed slightly. By using the original polygon some border-rivers might be trimmed wrongly. To avoid this, a buffer of 50 meters was aligned to the Austrian polygon before using the clip tool.

Since the length of the buffers does not coincide with the length of the pressure shape files the tool "Intersect" was used. This tool cuts the selected pressure shape files at the edges of the buffer and generates new segments. The resulting attribute table contains information about the associated site and the relevant pressure. To calculate the new length of the segments the tool "Calculate Geometry – Length" was used.

3.1.2.3 Service Area

The service area (SA) buffer was especially designed for the LANPREF theses. The buffer was named "service area" since it represents the area fish can freely use for migration. Impassable barriers were employed to delineate the relevant area. Barriers classified as passable (due to their physical properties or a fish migration ladder) were not taken into account. The SA was chosen since it stands for the area fish might not be able to leave. This means if a pressure limits the environmental condition of this buffer fish are not able to overcome it by migration into undisturbed areas.

Another important factor demanding the SA buffer is the limitation of habitat availability and genetic exchange between populations within and outside the SA, as it might weaken the population within a service area in the long term.

At the beginning the route shape file was dissolved to one single feature (polyline) by using the dissolve tool. In a second step a special script (Split lines at points: ESRI, 2008) was imported and embedded in ArcGIS©. This script was written to cut lines at defined points. Therefore a point layer and a line layer have to be chosen. In this case a file containing all impassable barriers and the dissolved route file were used. The script was able to cut the line at most points. Unfortunately the route shape file was also cut at points where two lines met (confluenting river segments). To find the wanted service area, each sample point had to be allocated and all relevant segments had to be selected by hand. This means starting from the

sample site the river network was followed in all directions until an impassable barrier appeared. Figure 20 shows two examples for such service areas. The Figure points out that the SAs can differ by length.

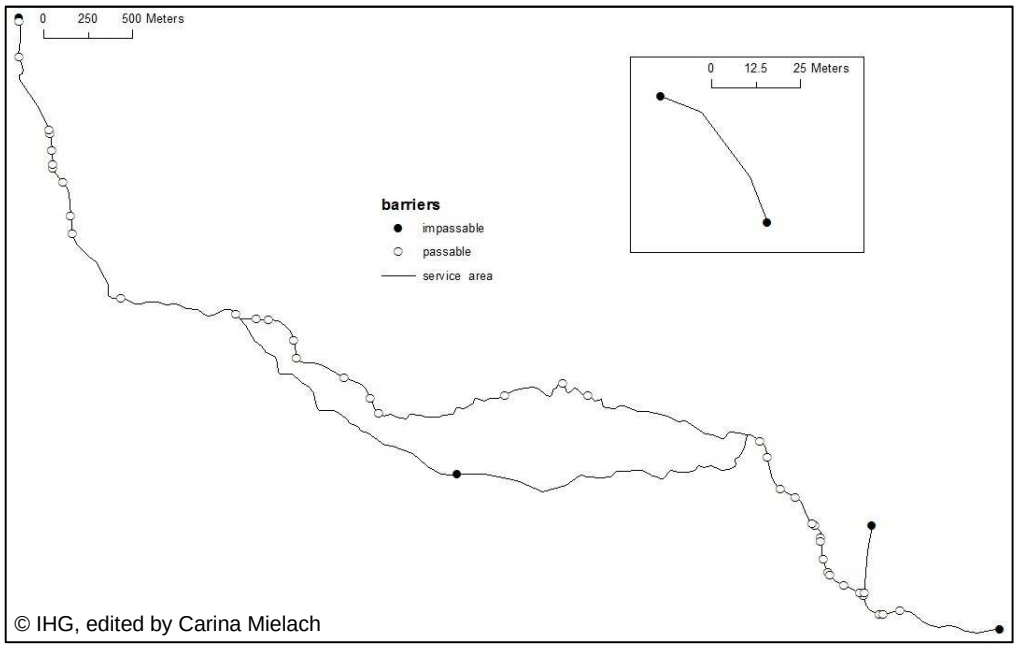


Figure 20: Examples for a small and a large service area.

A new column was added to the route attribute table to provide an identical code for all segments belonging to the same service area. This procedure was executed for each service area. When all relevant segments were coded the route file was dissolved using the code column. As a result each service area was represented by one single entry in the attribute table. Since this process is very time-consuming the service area was only defined for sample sites with available fish metrics (i.e. 875).

3.1.2.4 Fish region

As it is known from HUET (1949) species have different requirements regarding water temperature, flow or habitat selection. Therefore the fish region was chosen since it describes preferred habitats of certain species.

To establish this buffer the fish region shape file (*Fischregionen.shp*: HAUNSCHMIDT, VERNIER AND LINDNER, 2004) was dissolved by the field *FISHREGIO*. To avoid a single object per fish region, multipart features were checked. This ensures that each group of connected segments is dissolved to one object. Unfortunately the resulting objects contained only the main river and confluents were drawn as separate object (see Figure 21). So once again it was necessary to code connected objects by hand and to dissolve them to one single object.

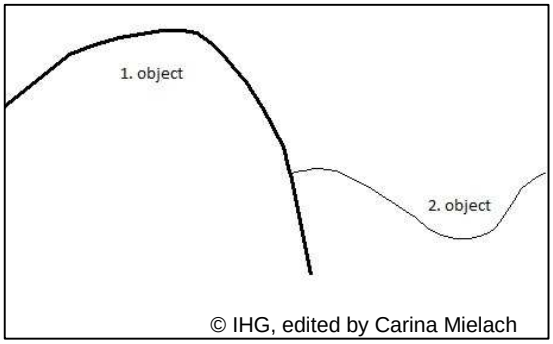


Figure 21: Separate objects.

The fish region buffer does not have exactly the same geometry as the other shape files (i.e. pressures) since it was generated on a different basis for an earlier project. To identify the relevant pressures for each object a buffer of 50 m was attached to the fish region buffer. This ensures that no important data get lost. On the other hand it generates a small error by gathering data at the end of each segment. Assuming that the borders of the buffer are not always set within an accuracy of a meter this error was rated as acceptable.

Figure 22 shows the separate course of the fish region shape file and the route shape file as well as the created buffer.

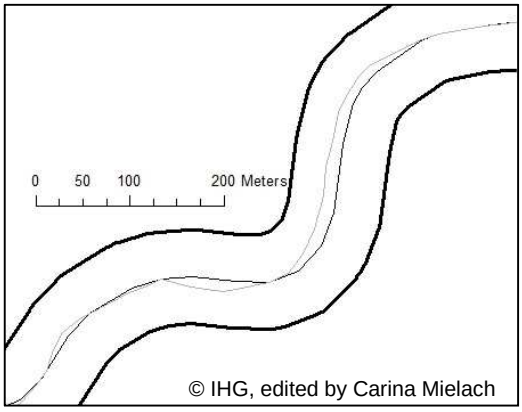


Figure 22: Fish region buffer.

Since the fish regions are only available for rivers with a catchment larger than 100 km^2 (see chapter 2.4) this scale couldn't be defined for all sites. Anyway it is available for 1467 of the total 1697 sample sites.

3.1.2.5 Drainage Area Upstream

The calculation of the drainage area upstream (DU) is based on primary catchments (see chapter 2.5). The DU for each sample site was calculated starting from the corresponding

PC. To identify PCs including sites the two layers were spatially joined. Since the PCs and their river segments were calculated automatically they do not always exactly match with the true situation. Especially the calculated river segments differ from the real river network. Due to this error the sample sites might be joined to a wrong PC. It was assumed that the EFIplus sites were in right position so all other sites (766 sites with “no” in column *efi-site*) were checked for accuracy. This happened by zooming to each relevant site, checking it for the position in the right PC and if necessary moving it into the right PC. In sum 94 sites had to be adjusted. The pressures per PC were determined by intersecting the pressure shape files with the PC shape file. The selected PCs may not always be within Austria but this does not matter for the resulting values since PCs outside of Austria do not contain countable information. It just has to be mentioned that pressures beyond the Austrian border cannot be taken into account. For example the upper catchments of Danube and March river are missing while the catchments of Inn and Thaya are partially outside of Austria.

During the data analysis it was detected that not all EFIplus sites were joined to the correct PC. Hence for 72 sample sites a wrong DU was calculated. These sample sites were therefore not included in the statistical analyses. Attribute tables of PC and pressure intersection were exported to a MS Access© database. The further approach of catchment attribute aggregation is described in chapter 3.2.1.

3.1.2.6 Catchment

In contrast to the DU buffer the catchment buffer represents the whole river catchment. The advantage of this buffer is that pressures downstream of a sample site are also considered. However it has to be mentioned that the position of the site in the catchment (e.g. when close to spring or river mouth) is not taken into account. The catchment buffer is a very specific buffer, as it was defined to be the largest of all ten buffers. Catchments were only generated for rivers containing one or more sample sites. In this case the sample sites were distributed over 337 rivers. Since some of the rivers showed very small catchments only those possibly exceeding the 25000m buffer were generated in ArcGIS©.

A MS Access© database was built to identify a catchment for each site that is still longer than the 25000m buffer in its longitudinal extent (see chapter 3.2.2). To identify the catchment of a river a special script embedded in ArcGIS© (SCHMUTZ, 2007a) was used. By selecting the PC at the outlet of a river all PCs upstream were selected. The catchment buffer generation started with the Danube catchment which was defined to end at the March outlet at the Austrian border. Then the catchment buffer of Inn and Rhine were formed. Using the tool “Create layer from selected features” (see chapter 3.1.1.9) a new shape file was generated for those rivers. Each of those shape files was dissolved to one single object (see chapter

3.1.1.7). Furthermore, catchments were delineated for those sites not yet covered by one of the above mentioned catchments. To be able to dissolve them a new column was added to the attribute table and all PCs belonging to the same catchment were coded equally. If there was a site located in the tributary another sub catchment was delineated. This step was repeated another time. Furthermore only the biggest remaining catchments were subdivided.

Some additional catchments were generated although the associated river included no samples sites. This happened if a site was located on a river too small (< than 25000m buffer) to have its own catchment but the river it drained into showed no sample site itself. Figure 23 visualizes such an “intermediate” catchment.

Here the river Kleinkirchheimerbach (Seebach) and its tributaries are represented by the whole Lieser catchment although the river Lieser itself doesn’t include a sample site.

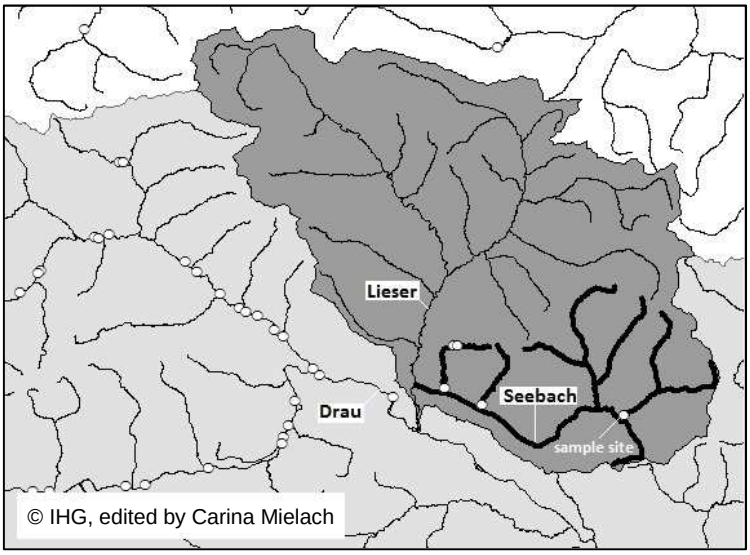


Figure 23: Example for an intermediate catchment.

Again the tool “dissolve” was used to generate the catchments shown in Figure 24. In sum 198 catchments were delineated but not all of them were taken into account for the pressure evaluation (see chapter 3.2.2). The bluish area shows the Danube catchment with the Inn catchment (light blue) as a subdivision. Catchments of the first step are delineated with a stronger black line than those of the following rounds.

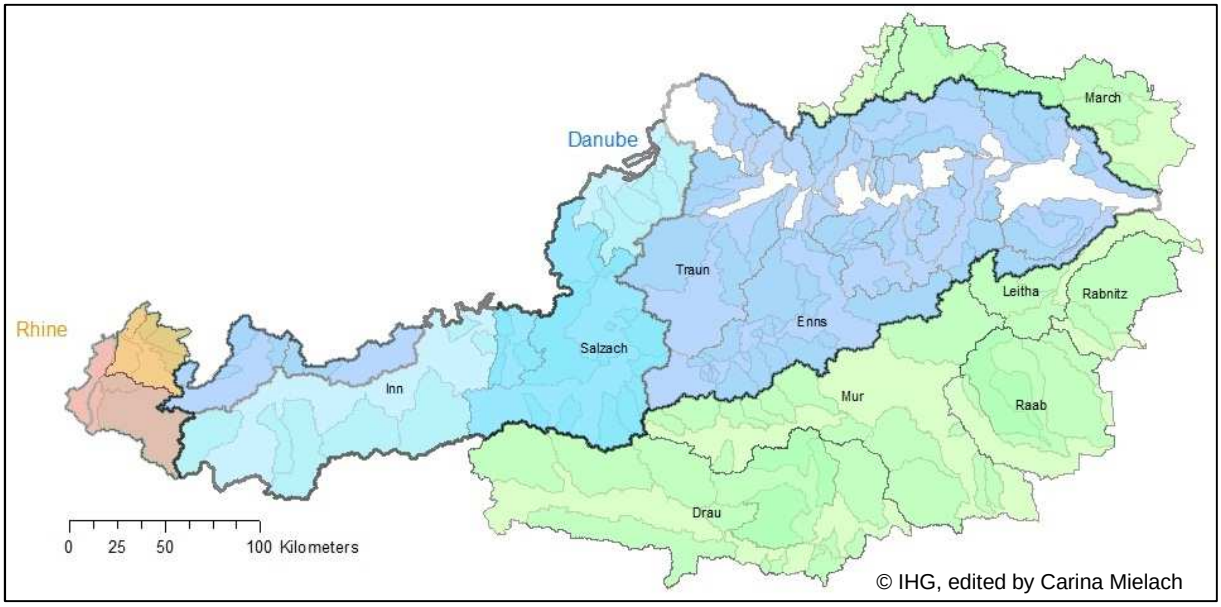


Figure 24: Generated catchments for Austrian sampling sites.

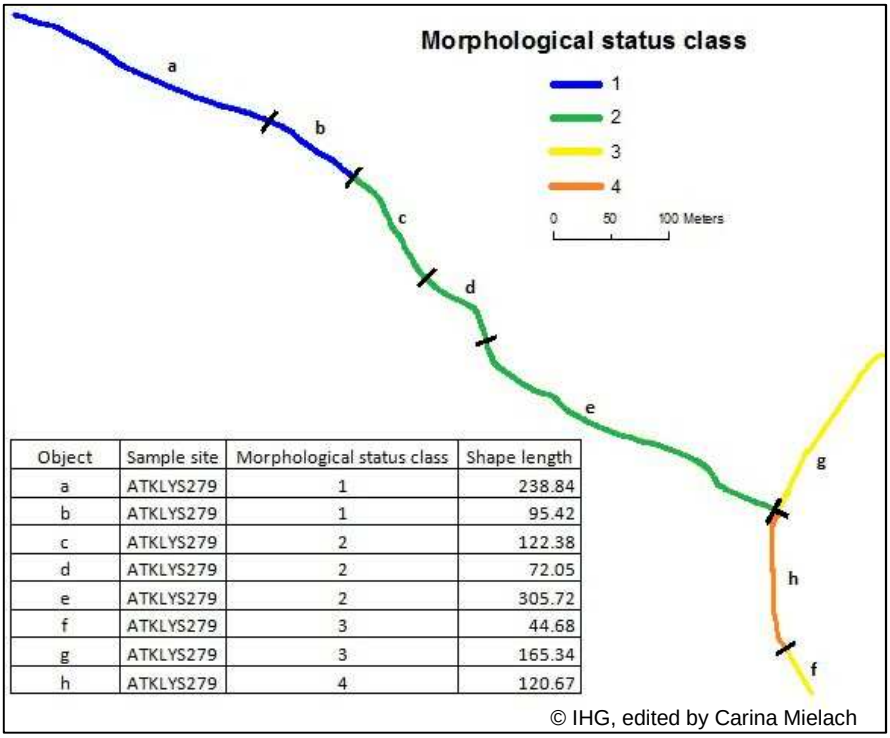
3.1.3 ArcGIS Output

After data processing, the following shape files were available for each scale:

- Generated scale
- Join of scale and site
- Intersect of scale and morphology
- Intersect of scale and barriers
- Intersect of scale and hydro peaking
- Intersect of scale and impoundment
- Intersect of scale and water abstraction
- Intersect of scale and lakes (Geometrie_echte_Seen)

The length was calculated for the buffer-, pressure- and lake shape files (see chapter 3.1.1.8). In general the buffer shape files include one single object for each sample site (except of the DU scale: different calculation approach, see chapter 3.1.2.5). This means the attribute table of a scale shows one entry per sample site. By intersecting those scale shape files with the pressure shape files they are fragmented to single pieces again. This happens due to the fact that the connected shape files change their characteristics (e.g. status class for morphology) or are only sporadically present (e.g. hydro peaking).

The example in Figure 25 shows the 500m buffer for the site ATKLYS279. As it can be seen the buffer is composed of single fragments.



Object	Sample site	Morphological status class	Shape length
a	ATKLYS279	1	238.84
b	ATKLYS279	1	95.42
c	ATKLYS279	2	122.38
d	ATKLYS279	2	72.05
e	ATKLYS279	2	305.72
f	ATKLYS279	3	44.68
g	ATKLYS279	3	165.34
h	ATKLYS279	4	120.67

Figure 25: Example for fragmented scale.

Each of those fragments is described by an entry in the attribute table. The fact that even segments with the same morphological status class are divided is to be explained by the outdoor recording method.

To calculate the length of each attribute per buffer the shape files were exported to a MS Access© database.

3.2 MS Access©

MSAccess© 2007 is a software for data management. Imported tables can be connected by equal fields (primary keys) building the basis for queries where tables can be updated or new tables can be created. The program can also be used to calculated new attributes. The following chapters describe the three databases produced during this thesis. The first database (PC_pressures) was used to identify the PCs for the DU buffer, the second database (Catchments) was used to select the appropriate catchment for each sample site while the third database (Pressure_database) was developed to connect the created tables of all buffers.

3.2.1 Generation of DU scale

After the determination of pressures for all PCs (see chapter 3.1.2.5) the attribute tables were exported to an MS Access© database called "*PC_pressures*". They were combined into one table so that each row represented one PC. The columns contained length measurements of the river segment (total length), the pressures as well as the number of barriers. An additional column informed whether a PC contained a site or not. The database included another table with the information about the next downstream PC (NextDownID). The phyton script used for the DU calculation was adopted from BADY and TRAUTWEIN (2007, unpublished) and had to be adjusted and rewritten. It accessed the above described database by an ODBC (Open Database Connectivity). The script works as follows: It searches the first PC with a sample site in it. Then it selects all upstream primary catchments. When all PCs are selected it sums up the lengths and numbers as ordered and inserts the calculated values in a text file. Then it searches for the next PC containing a site and repeats the procedure until all PCs including a site are dealt with. The result is a text file where the input variables are summed up per DU. Since the sample sites were already spatially joined to the PCs (spatial join between PC shape file and sample site shape file in ArcGIS©) the resulting DU parameters only had to be connected to the according sample sites.

3.2.2 Generation of catchment scale

The generation of the catchment scale was partly performed in the MS Access© database and therefore it is given an extra chapter here.

The database "*Catchments*" consists of three tables named *Catchment*, *Superior Catchment* and *Length Comparison.*

The table *Catchment* listed 347 river names in column 1 (337 rivers with sample sites on it plus 10 intermediate catchments, see Figure 23) and the catchment the rivers were assigned to in column 2 (see Table 11). This table shows if a river is represented by its own catchment (e.g. Sanna) or a superior catchment (e.g. Rosanna). The evaluation if a catchment buffer was bigger than the 25000m buffer was roughly estimated. To be sure to take all necessary catchments into account a catchment buffer was generated if the size in comparison to the 25000m buffer was not clearly assessable.

Table 11: Extract from MS Access© table *Catchment.*

1	2
Rosanna	Sanna
Sanna	Sanna
Trisanna	Sanna

In a second table called *Superior catchments* all 347 rivers were listed again. In the following columns the names of superior catchments were entered. Table 12 shows an extract of this table (e.g. the Bruckbach drains into the Oichten which drains into the Salzach ect.).

Table 12: Extract from MS Access© table *Superior catchments*.

1	2	3	4	5
Reitbach	Oichten	Salzach	Inn	Danube
Eugenbach	Fischach	Salzach	Inn	Danube

The table *Length comparison* was produced to compare the river length of the catchment buffer to the river length of the 25000m buffer. The length for each buffer was calculated using the route shape file length (intersect between buffer and route shape files). Since sites within the same catchment buffer may show different positions and therefore have different 25000m buffer lengths, the length difference was calculated per site and not per catchment buffer. Therefore the *Site code* had to be included in this step. Table 13 shows an extract of the described table.

Table 13: Extract from MS Access© table *Length comparison.*

SITE_CODE	river	initial catchment	New catchment	25000m length	catchment length	new catchment length	difference	new difference
ATREIT404	Bruckbach	Oichten	Salzach	121862	43527	1925857	-78335	1803995
ATFICH408	Fischach	Fischach	Salzach	259105	80137	1925857	-178968	1666752
ATFISC413	Fischach	Fischach	Salzach	249323	80137	1925857	-169186	1676534
ATFISC420	Fischach	Fischach	Salzach	229421	80137	1925857	-149284	1696436
ATEUGE507	Eugenbach	Fischach	Salzach	155383	80137	1925857	-75246	1770474
ATOICH389	Oichten,	Oichten	Salzach	216083	43527	1925857	-172556	1709774
ATOICH390	Oichten,	Oichten	Salzach	197122	43527	1925857	-153595	1728735

The Bruckbach was initially assigned to the Oichten-catchment buffer. The subtraction of the *25000m length* (i.e. length of 25000m buffer for this sample site) from the *catchment length* resulted in a negative value in column *difference*. This indicates that the catchment buffer of the Oichten is smaller than the 25000m buffer and therefore does not fulfil the requirements defined for the catchment buffer. Table 12 and Table 13 were connected to perform an update query where the name of the next superior catchment was entered into the column *new catchment*. This query was used for all sample sites with a negative *difference*. Then a *new Difference* was calculated between the *new Catchment* and the *25000m Length*. This step was repeated until only positive values were left in the column *new difference*. Then the

attributes of the finally assigned catchments (in sum 104) were transferred to the sample sites.

3.2.3 Generation of MS Acess© database

As explained before the generated shape files were exported from ArcGIS© to the MS Access© database. Using different queries the required parameters were calculated for each scale and site. They are listed in Table 14.

Table 14: MS Access© table content.

Information about the sample site		
SITE_CODE	Name of sample site	
General lengths		
totleng_scale	total length of the relevant scale per site	
leng_lake_scale	total length of river segments coded as real lake	
leng_scale	total length of scale without lake segments = $(totleng_scale) - (leng_lake_scale)$	
Morphology		
leng_scale_1-5	total length of classified morphology (class 1 to 5) per scale = $\sum_{i=1}^{5} morph_scale_i$	
leng_scale_0-9	total length of morphology (class 0 to 5, 9) per scale $= \sum_{i=1}^{5} morph_scale_i + morph_scale_0 + morph_scale_9$	
morph_scale_0	length of morphological class 0	
morph_scale_1	length of morphological class 1	
morph_scale_2	length of morphological class 2	
morph_scale_3	length of morphological class 3	
morph_scale_4	length of morphological class 4	
morph_scale_5	length of morphological class 5	
morph_scale_9	length of morphological class 9	
perc_scale_0+9	percentage of morphological classes 0 and 9	$= \frac{morph_scale_i}{\text{leng_scale_1-5}}$
perc_scale_1	percentage of morphological class 1	
perc_scale_2	percentage of morphological class 2	
perc_scale_3	percentage of morphological class 3	
perc_scale_4	percentage of morphological class 4	
perc_scale_5	percentage of morphological class 5	
Index_scale	morphological index = $\sum_{i=1}^{5} (perc_scale_i \cdot i)$	
code0_scale	perc_scale_0 < 0.33 → 1 (high reliability) perc_scale_0 between 0.33 and 0.66 → 2 (medium reliability) perc_scale_1 > 0.66 → 3 (low reliability)	
Barriers		
barr_scale_nopass	number of all impassable barriers	
barr_scale_pass	number of all passable barriers	
barr_scale_KW1	number of passable barriers caused by water power plants	
barr_scale_KW2	number of impassable barriers caused by water power plants	
barr_scale_Nat5	number of passable natural barriers	
barr_scale_Nat6	number of impassable natural barriers	

Other pressures		
hpeak_scale	total length of hydro peaking sections	
imp_scale	total length of impounded sections	
watab_scale	total length of water abstraction sections	
hpeak_scale_perc	percentage of hydro peaking section of total	$= \frac{pressure_scale}{leng_scale}$
imp_scale_perc	percentage of impounded section of total	
watab_scale_perc	percentage of water abstraction section of total	
Pressure combination		
label_scale	the label is a 4-digit code informing about the pressures present in the buffers of each sample sites (more information concerning the label is given in chapter 5.7)	
(The word "scale" is a placeholder for all considered scales (= local, 250, 500, 2500, 5000, 25000, SA, fish region, DU and catchment)		

One of the above listed parameters is the morphological index mentioned in chapter 2.6. Since the buffers may include many segments with different morphological status classes the morphological index represents one way to combine these classes to a length weighted mean value. Segments with an unknown morphological status cannot be taken into account for this calculation since they might distort the result by lowering the value. In the NGP shape file morphology, the morph_scale_0 as well as morph_scale_9 indicate missing data. Therefore these values are summed up to one parameter (perc_scale_0+9).

At first the percentage ($perc_scale_i$) of each status $i = 1,..,5$ was calculated as length ratio.

$$\frac{morph_scale_i}{\text{leng_scale_1-5}} = perc\ scale\ i$$

Then the percentages (ranking from 0 to 1) were entered into the following formula:

$$Morphological\ Index = \sum_{i=1}^{5} (perc_scale_i \cdot i)$$

E.g. a buffer with 50% status 1, 30% status 2 and each 10% status 3 and 4 receives an index of 1.8.

$$0.5 \cdot 1 + 0.3 \cdot 2 + 0.1 \cdot 3 + 0.1 \cdot 4 = 1.8$$

Since segments with unknown status are not taken into account a code was established to give approximate information about the percentage of these segments. The code ranks from 1 to 3. Buffers with less than 33 percent undefined morphological status length are coded with 1 indicating a high reliability. Buffers with more than 33 and less than 66 percent are coded with 2 indicating a moderate reliability while buffers with more than 66 percent are coded with 3 (low reliability). Assumed a buffer has a total length of 100 metres including 35 metres of status class 1, 25 metres of status class 2 and 40 meters with an unknown status,

the morphological index will be calculated only for the evaluated length (60 meters) as follows:

$$\frac{35}{60} \cdot 1 + \frac{25}{60} \cdot 2 = 1.42.$$

Since the length with unknown status represents 40 percent of the total buffer length the result (1.42) shows a medium reliability.

Since only values between 1 and 5 are allowed in the column Index all zero values were replaced by NULL values. This is important for further analyses in SPSS©. Values of zero might be rated as an actual value while NULL values represent the lack of data. On the other hand if a pressure attribute of hydro peaking, impoundment or water abstraction was NULL (i.e. no data) it was replaced by a zero value indicating that the pressure is not present.

When all parameters were calculated for each site and scale they were connected to each other. Therefore the attribute table of the sample sites shape file was also imported to MS Access© and worked as a hub. Finally the tables were also connected to the fish metrics. Figure 26 shows the connections between the database tables. Since the arrow between the fish metrics and the sample sites shows no direction, only sites present in both tables will be transferred to a new created table.

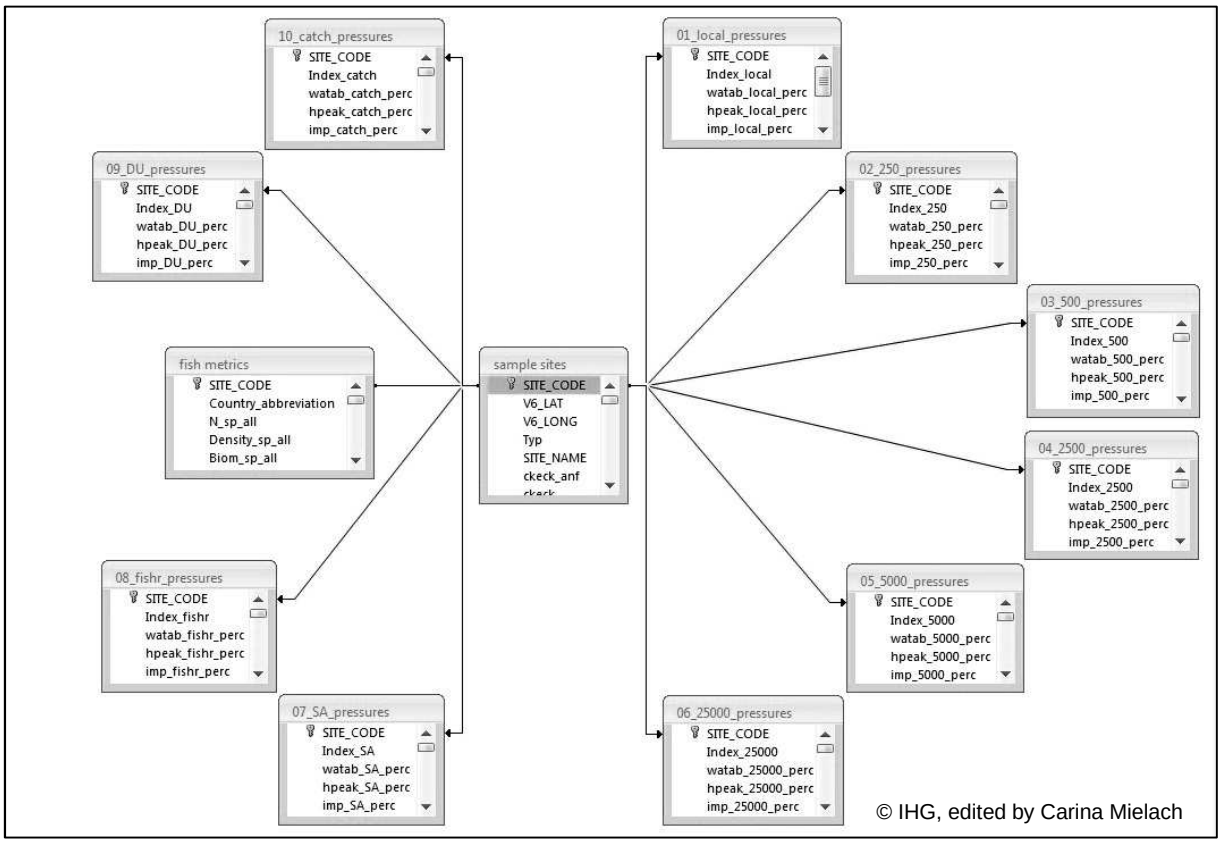


Figure 26: Connections of generated tables in the MS Access© database.

By using further queries, new tables showing the parameters for each pressure-group were built.

- Morphology all
- Barriers all
- Hydro peaking all
- Impoundment all
- Water abstraction all

Those tables were exported to SPSS© for further analyses.

4. Descriptive analyses

In the following chapters the distribution of pressure data (morphology, hydro peaking, impoundment and water abstraction) is described. Most analyses were made for both, all sample sites (1697) and sample sites with available fish metrics (875).

Since only the sample sites with fish metrics available will be included in statistical analyses in chapter 0, these analyses will be paid more attention in this chapter. The descriptive analyses of all sample sites can be seen in Annex B. Nevertheless a comparison between all sample sites (1697) and sample sites with fish metrics will be shown.

As mentioned in chapter 3.1.2 the SA buffer was only calculated for those sample sites with fish metrics available (875 sample sites). The fish region buffer could only be calculated for those river segments with defined fish regions (1467 sample sites) and the DU buffer includes only data for 1625 sample sites. All other buffers include the above mentioned 1697 samples included in this survey.

4.1 Pressures

4.1.1 Buffer lengths

As mentioned in chapter 3.1.2 the buffer size can differ between single sample sites. The length buffers (250m, 500m, 2500m, 5000m and 25000m) depend on the position of the sample site on a river and the surrounding river network. The length of the SA buffer depends on the distance to the next impassable barriers in the river network while the length of the fish region buffer is defined by the length of each fish region. The length of the DU buffer is conditional to the position of the sample site within the catchment while the length of the catchment buffer depends on the catchment size of the associated river. Therefore, all these lengths can show a high variation. Table 15 shows the minimum and maximum values, as well as the mean and the standard deviation for the buffer lengths of each sample site. Since the local scale shows no length it is not included in this table. The greatest range can be detected for the DU and catchment buffer. But also the fish region-, 25000m- and SA buffer show a high variation.

Table 15: Descriptive statistics of the buffer length for sample sites with available fish metrics (875).

Descriptive statistics: buffer length (875)					
scale	N	minimum length [m]	maximum length [m]	mean length [m]	standard deviation
250	875	280	945	533	75
500	875	530	2,116	1,121	208
2500	875	2,609	14,805	6,955	1,914
5000	875	5,359	45,983	16,664	5,369
25000	875	35,712	423,658	168,954	65,192
SA	875	49	343,250	49,683	76,070
fishr	752	1,237	628,887	78,838	106,645
DU	803	87	15,851,302	276,516	704,996
catch	875	46,385	17,040,586	2,140,777	4,069,909

Figure 27 visualizes the length distribution of sample sites with available fish metrics and buffers. Since the differences of the single buffers are barely visibly in the big diagram, extracts with different scales (y-axis) have been included.

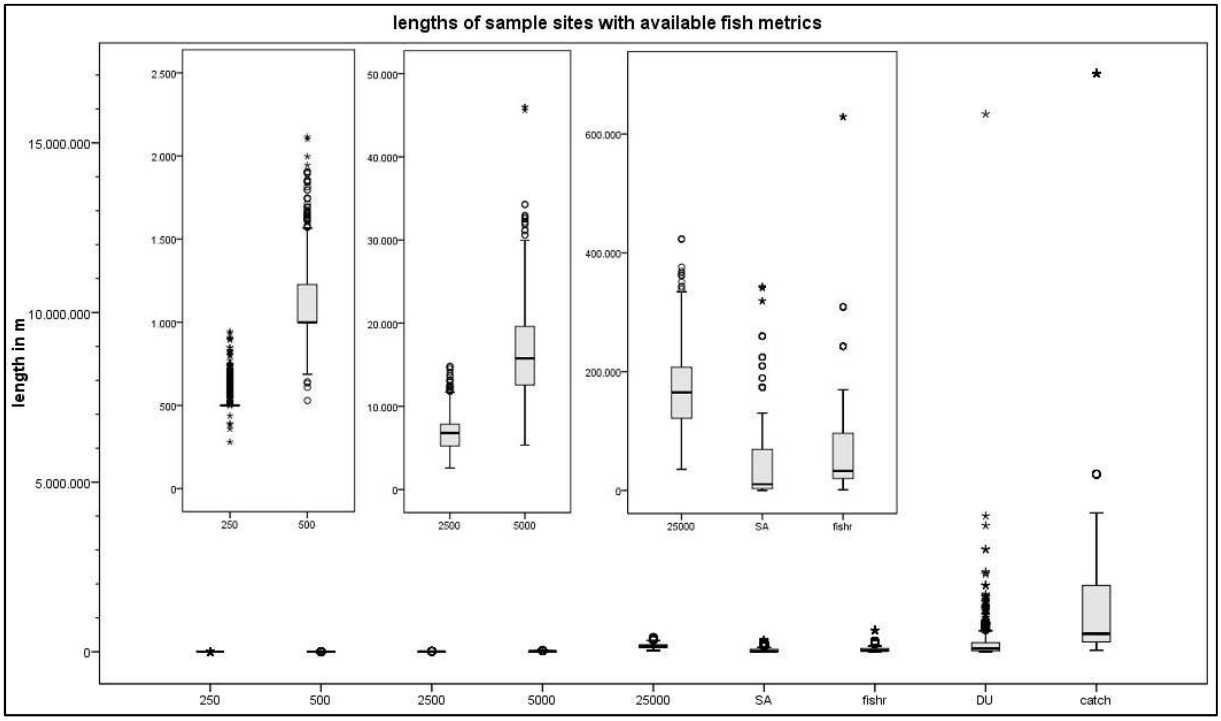


Figure 27: Box-plots showing the length distribution of sample sites with available fish metrics (875).

The maximum values for the DU- and catchment buffer (see Figure 27) are outliers. They represent one sample site of the buffer (sample site ATDONA163 at Danube) and 55 sample sites assigned to Danube's catchment buffer. Since the length of the distance buffers is used twice (up- and downstream) the resulting lengths are expected to have higher values as

initially indicated by their names. For example, for the 250m buffer a length of 500 (250m up- and downstream) is expected while the 500m buffer should show 1000m length. As it can be seen in Table 15 and Figure 27 this assumption is roughly met for the mean values of smaller scales (250m and 500m) while the means of larger buffers (2500m to 25000m) are higher than expected. As mentioned in chapter 3.1.2.2 larger scales include more side arms or tributaries and thereby achieve higher lengths than expected.

4.1.2 Morphological index

Since the morphological index can only be calculated if the buffer includes evaluated segments (i.e. segments with a morphological index between 1 and 5) it is not available for some sites and their buffers. If a buffer consists only of morphology class 0 (data missing) the index cannot be taken into account. Table 16 shows the number and percentage of sites with available morphological indices for all buffers.

Table 16: Descriptive statistics of morphological index for sample sites with available fish metrics (875).

Descriptive statistics: morphological index (875)									
scale	N	valid N	percent valid	N impacted	percent impacted	minimum morphological index	maximum morphological index	mean morphological index	standard deviation
Local	875	637	72.8	260	29.7	1.0	5.0	2.3	1.0
250	875	759	86.7	374	42.7	1.0	5.0	2.3	0.9
500	875	800	91.4	440	50.3	1.0	4.9	2.4	0.9
2500	875	855	97.7	520	59.4	1.0	4.2	2.3	0.7
5000	875	870	99.4	520	59.4	1.0	4.3	2.2	0.6
25000	875	875	100.0	394	45.0	1.0	3.7	2.0	0.3
SA	875	852	97.4	550	62.9	1.0	4.8	2.3	0.7
fishr	752	752	100.0	483	64.2	1.0	4.9	2.4	0.6
DU	803	802	99.9	167	20.8	1.0	3.5	1.8	0.4
catch	875	875	100.0	166	19.0	1.3	2.9	1.9	0.3

As it can be seen the number of sites with available morphological index rises with an increasing buffer size. As the length of the observed river segments increases it is more and more likely that an evaluated segment is included. Table 16 also includes maximum and minimum, arithmetic mean, standard deviation of the morphological index calculated from NGP data, percentage of sample sites with valid morphological index as well as the percentage of sample sites with a morphological index above 2 (percent impacted).

The box-plots in Figure 28 show the sites with available morphological index and its distribution. Obviously, range of the morphological index declines with increasing buffer size. This occurs due to the effect that extreme values like a morphological index of 5 barely

occurs at large scales, since many segments with different morphology class are combined to one single index.

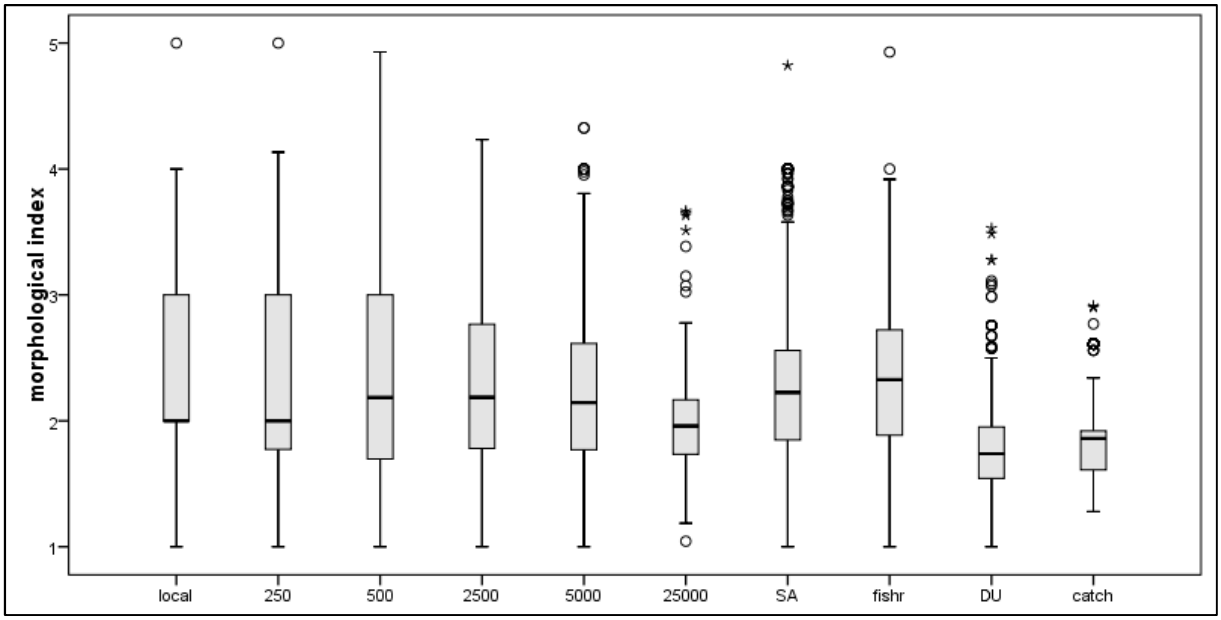


Figure 28: Box-plots showing the morphological index for sample sites with available fish metrics (875).

The percentages of sites with valid morphological index per buffer are higher for sample sites with fish metrics (875) in comparison to all 1697 sample sites (see Table B.2 in Annex B).

Since the values for the DU buffer are calculated automatically, they can show errors. Especially in small DUs segments not associated with the considered PCs might be included. This means that the calculated PCs might include river segments which do actually not belong to the PC and the calculated DU. Figure 29 visualizes the explained error.

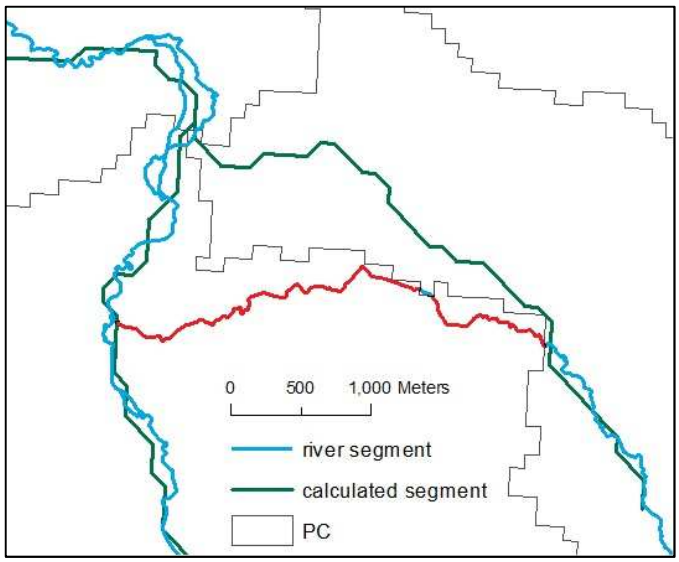


Figure 29: Possible errors that can occur at DU scale.

The green line represents the automatically calculated CCM segment while the blue line is the actual river network. The tributary is in the wrong PC for about 2 kilometers (see red line) until it flows in the PC it is actually assigned to. Such errors do not have a high influence in large DUs but they can affect the results of smaller DUs. Therefore the DU buffer has to be treated with caution.

Due to these possible errors, outliers (DU buffer: morphological index = 5) were checked for plausibility. E.g. the morphological index at the site ATMFKS161 represents such an extreme value (see Table B.2 in Annex B). It is located at the Marchfeldchannel which represents an artificial water body supplying water from the Danube to the Rußbach. The channel should protect the endangered groundwater and is also used for irrigation purposes (MARCHFELDKANAL, 2010). Since this river segment is artificial it is not represented by the automatically calculated river segments (see Figure 30: black line). The Marchfeldchannel has a morphological status of 0 (data missing) with the exception of a small segment evaluated with morphology class 5 (red object). Since the index is only calculated on available data and there is no PC upstream the whole DU buffer receives a morphological index of 5. Of course, this example shows an exceptional case but is able to display the possible generation of wrong data. Since there are no fish metrics available for this sample site it won't be included in further statistical analyses.

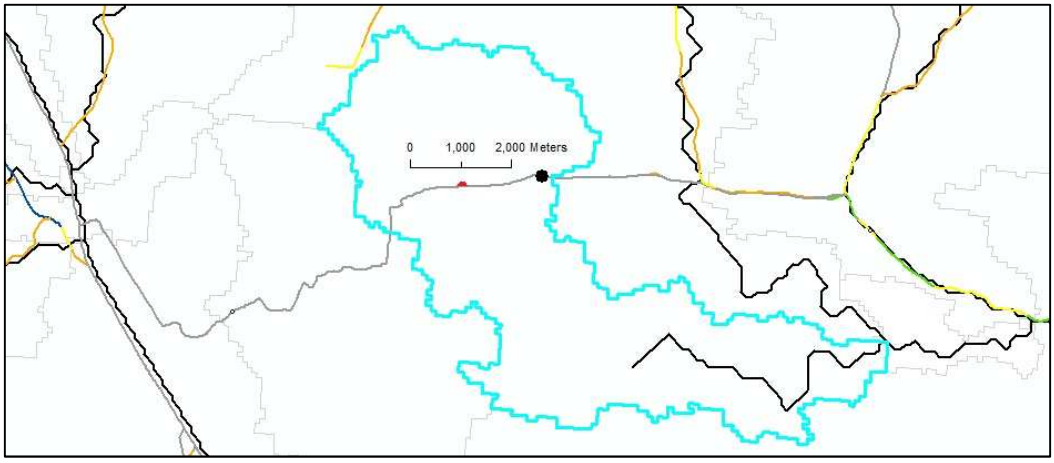


Figure 30: DU buffer at Marchfeldchannel.

4.1.3 Hydro peaking

In Table 17 the minimum and maximum percentage values, as well as the mean and the standard deviation investigated for hydro peaking according to the NGP classification are shown. The mean value doesn't show great differences between the different buffers and varies between 1 to 5 percent of buffer length. The big buffers (25000m, DU, catchment)

show slight lower values (1 to 3 percent) than the rest. Also the range between minimum and maximum value is the smallest at large buffers.

Table 17: Descriptive statistics of hydro peaking classification (NGP) for sample sites with available fish metrics (875).

Descriptive statistics: hydro peaking (875)							
scale	N	N with hydro peaking	percent with hydro peaking	minimum percentage	maximum percentage	mean percentage	standard deviation
Local	875	36	4.1	0.00	1.00	0.04	0.20
250	875	43	4.9	0.00	1.00	0.04	0.19
500	875	51	5.8	0.00	1.00	0.04	0.19
2500	875	65	7.4	0.00	1.00	0.04	0.17
5000	875	82	9.4	0.00	1.00	0.04	0.14
25000	875	189	21.6	0.00	0.52	0.03	0.07
SA	875	145	16.6	0.00	0.98	0.04	0.14
fishr	752	169	22.5	0.00	0.99	0.05	0.15
DU	803	156	19.4	0.00	0.31	0.01	0.03
catch	875	385	44.0	0.00	0.13	0.01	0.03

As mentioned in chapter 2.8 about 2.5 percent of the Austrian river network is impacted by hydro peaking. While the percentage of smaller buffers is higher, the percentage of larger buffers is smaller than this expected value. The 25000m buffer comes closest to the expected 2.5 percent.

Figure 31 visualizes the distribution of the hydro peaking percentage per buffer and impacted site. Since there are so many entries with 0 percent, the box-plots would barely be visible if all sample sites were included (see Figure A.1 in Annex A). Although the 0 values represent measured data the diagram includes only percent values higher than 0 (see Figure 31). The number of impacted sample sites can be seen in Table 17 (N with hydro peaking).

On the one hand the number of impacted sites increases with buffer size while on the other hand the hydro peaking percentage decreases with increasing buffer size (Figure 31). Of course also extreme values (e.g. 100% hydro peaking) are reduced with increasing buffer size.

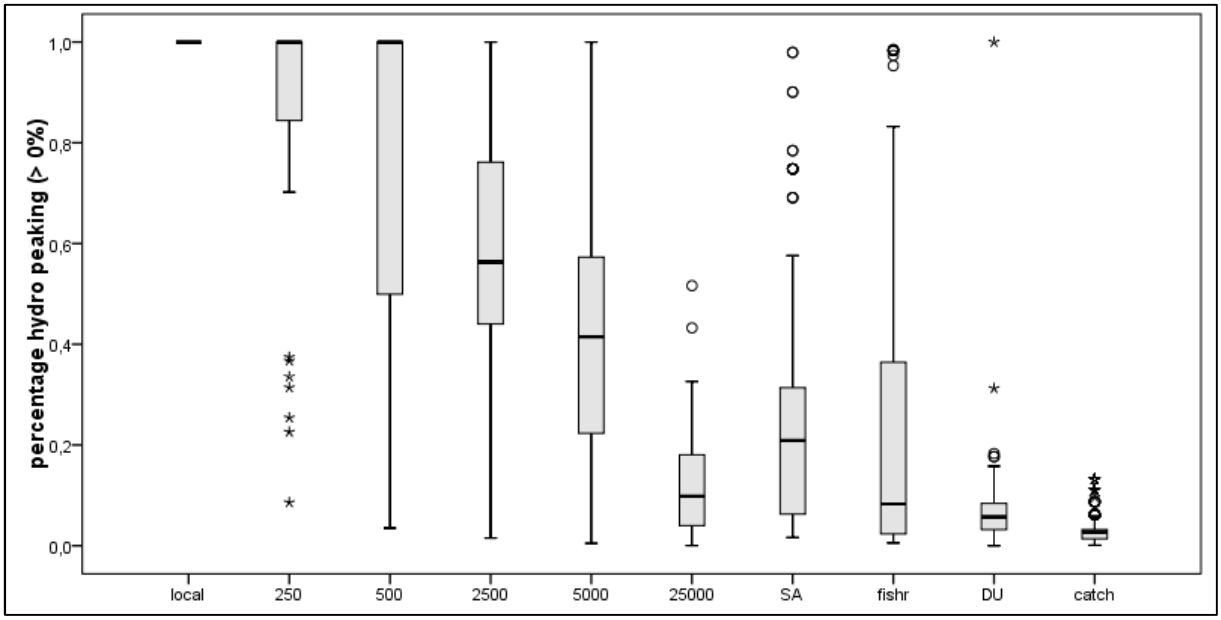


Figure 31: Box-plots showing the percentage of hydro peaking length (> 0 percent) per buffer for sample sites with available fish metrics (875)

The maximum and mean percentages as well as the standard deviation for all 1697 sample sites are higher than the values for 875 sample sites (see Table B.3 in Annex B). Figure 31 includes less outliers and extreme values than Figure B.4 in Annex B.

4.1.4 Impoundment

The NGP classification for impoundment shows higher mean values than for hydro peaking. Again the differences between the different buffers are small and only the DU and catchment buffer show lower values than the other buffers.

Table 18: Descriptive statistics of impoundment classification (NGP) for sample sites with available fish metrics (875).

Descriptive statistics: impoundment (875)							
scale	N	N with impoundment	percent with impoundment	minimum percentage	maximum percentage	mean percentage	standard deviation
local	875	110	12.6	0.00	1.00	0.13	0.33
250	875	175	20.0	0.00	1.00	0.11	0.27
500	875	223	25.5	0.00	1.00	0.10	0.24
2500	875	420	48.0	0.00	1.00	0.09	0.18
5000	875	537	61.4	0.00	0.96	0.08	0.15
25000	875	826	94.4	0.00	0.34	0.06	0.06
SA	875	552	63.1	0.00	1.00	0.09	0.18
fishr	752	596	79.3	0.00	0.63	0.11	0.14
DU	803	611	76.1	0.00	0.23	0.02	0.03
catch	875	806	92.1	0.00	0.11	0.03	0.02

The mean values for sample sites with available fish metrics (875) are up to 3 percent higher than the mean values for all 1697 sample sites. This indicates that these sample sites are more impacted by impoundment than all 1697 sample sites. Except for the fish region buffer the standard deviations are higher in comparison to all 1697 sample sites. Especially the smaller buffers overestimate the percentage of impounded river segments, which adds up to approximately 3.8 percent (see chapter 2.9). The DU- and catchment buffer come closest to this expected value.

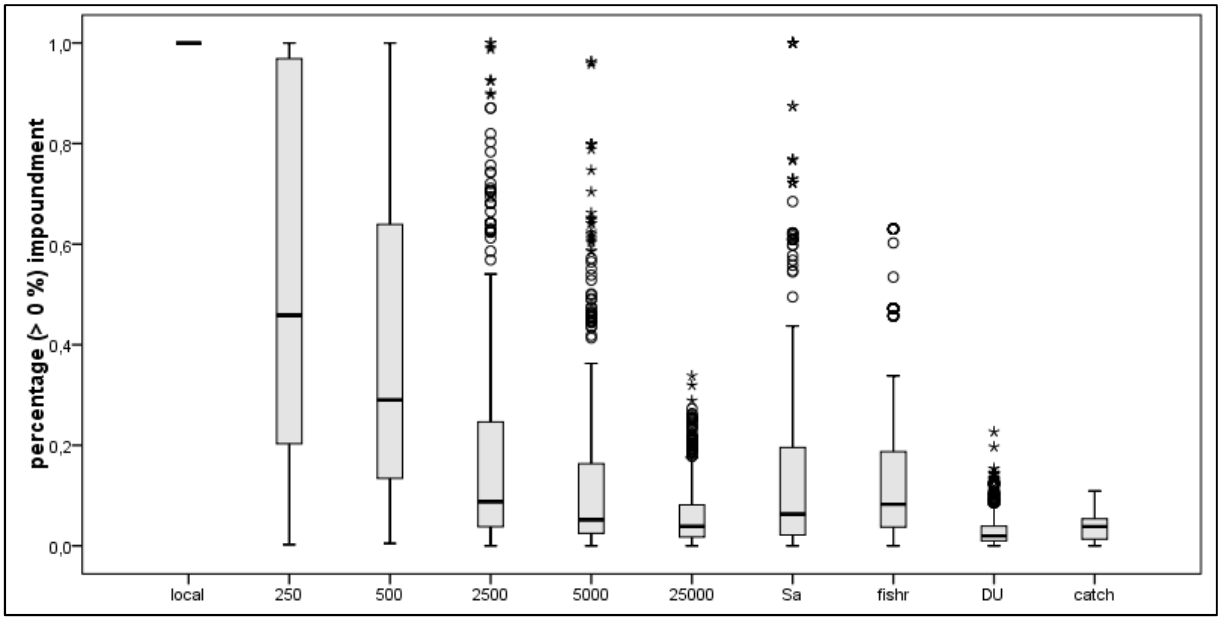


Figure 32: Box-plots showing the percentage of impoundment (> 0 percent) per buffer for sample sites with available fish metrics (875).

Again the percentage decreases with increasing buffer size. The catchment buffer shows only small percentages with no extreme values.

4.1.5 Water abstraction

The NGP water abstraction classification shows the highest mean percentage per buffer of impacted sample sites. As mentioned in chapter 2.10 the percentage of river segments impacted by water abstraction adds up to 9.1 percent. Thereby water abstraction shows the highest percentage of all pressures. The mean water abstraction percentages for sample sites with fish metrics are smaller than the mean for all sample sites (see Table B.5 in Annex B). On the other hand the standard deviation is lower in comparison to all 1697 sample sites. The expected value of 9.1 percent is almost achieved by the 25000m-, DU- and catchment buffer.

Table 19: Descriptive statistics of water abstraction classification (NGP) for sample sites with available fish metrics (875).

Descriptive statistics: water abstraction (875)							
scale	N	N with water abstraction	Percent with water abstraction	minimum percentage	maximum percentage	mean percentage	standard deviation
Local	875	138	15.8	0.00	1.00	0.16	0.36
250	875	211	24.1	0.00	1.00	0.14	0.30
500	875	256	29.3	0.00	1.00	0.13	0.26
2500	875	498	56.9	0.00	1.00	0.12	0.17
5000	875	649	74.2	0.00	1.00	0.11	0.14
25000	875	867	99.1	0.00	0.67	0.09	0.07
SA	875	602	68.8	0.00	1.00	0.11	0.21
fishr	752	694	92.3	0.00	0.99	0.15	0.17
DU	803	695	86.6	0.00	0.58	0.07	0.07
catch	875	875	100.0	0.01	0.41	0.08	0.05

The box-plots in Figure 33 include only those sample sites impacted by water abstraction (see Table 19). Again the percentage of impacted length decreases with increasing buffer size.

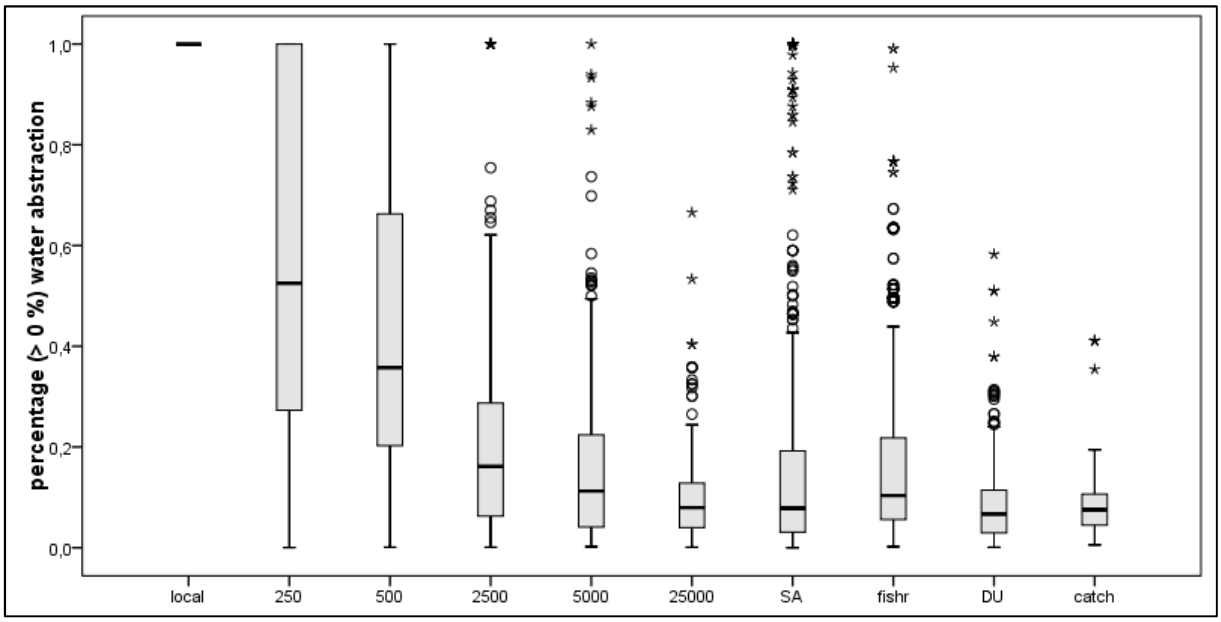


Figure 33: Box-plots showing the percentage of water abstraction (> 0 percent) per buffer for sample sites with available fish metrics (875).

4.1.6 Comparison of pressures

In comparison to impoundment and water abstraction, hydro peaking shows the lowest percentage of impacted sample sites per buffer while water abstraction shows the highest percentage. This reflects the actual distribution of these pressures within the Austrian river network (see chapters 2.8 to 2.10). Although pressure data are available for all sample sites Figure 34 visualizes only those with a pressure percentage higher than 0 (impacted buffer) or a morphological index higher than 2. Also the percentage of sample sites with available morphological index is given.

When comparing the pressure data of all sample sites with pressure data of sample sites with available fish metrics no great differences occur. Mostly the data become more compact (decrease of outliers, extreme values and standard deviation). Also the percentage of impacted sample sites shown in Figure 34 show no great differences in comparison to all 1697 sample sites (see Figure B.9 in Annex B).

As the buffer size increases the number of impacted sample sites (i.e. sample sites with pressure within the buffer) rises. On the other hand the mean percentage of each pressure declines at larger scales since extreme values (e.g. morphological index of 5 or 100 percent of impoundment) become rare for those buffers.

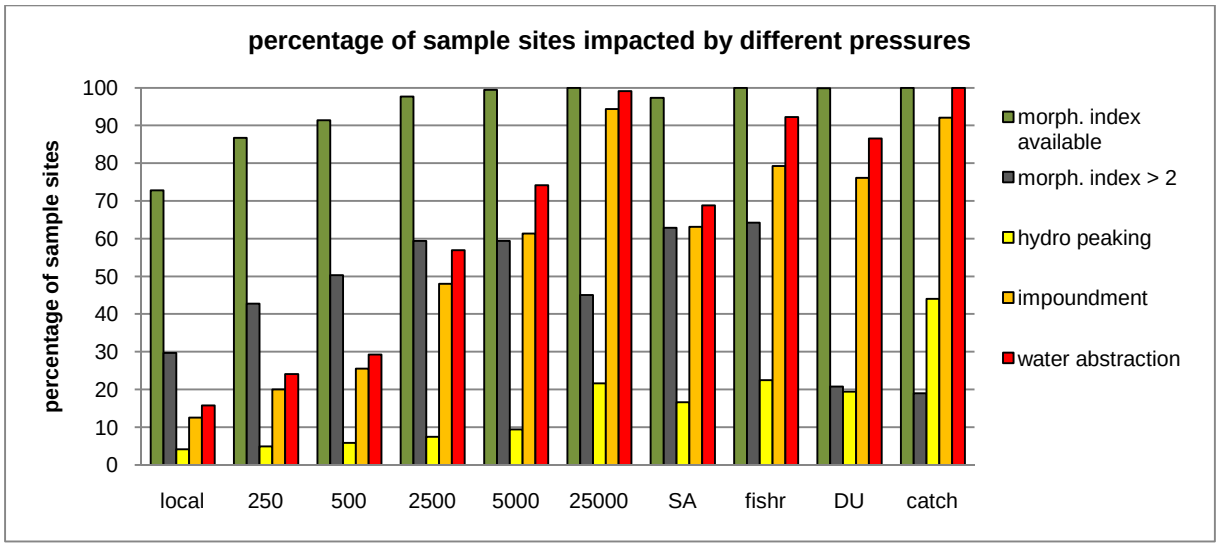


Figure 34: Percentage of sample sites impacted by different pressures.

4.2 Fish metrics and pressures

This chapter includes analyses related to fish metrics investigated for 875 sample sites and their pressures per buffer. Not all fish metrics are available for all sample sites but most of them are available for more than 800 sample sites. Exceptions to this are the EFIplus metrics, which are calculated for 597 sample sites only at the moment. Since the EFIplus Index distinguishes between salmonid and cyprinid river segments two of the single metrics for the EFIplus calculation are only available for 85 sample sites. This has to be taken into account when interpreting the results presented later.

Table C.1 (Annex C) lists all 41 single fish metrics as well as the FAME- and EFIplus Index and the number of sample sites they were calculated for. Additionally it shows the number of sample sites with fish metrics higher or equal to 0. This information is given since some of the later described analyses can only be calculated if all values are positive (i.e. above 0).

Since the data analysed in this thesis are mostly not normally distributed, the connection between fish metrics and pressures was partly analyzed by nonparametric tests. These tests do not analyze the investigated values themselves but transform them into ranks, whereby a normal distribution is not mandatory. The following chapters built the basis for some tests in chapter 0.

4.2.1 FAME Index and pressures

This chapter shows the mean values and mean ranks of the morphological index and the pressure percentages separated by FAME classes. Thereby it should be visible if the FAME Index is able to differentiate between low and high impacted sample sites. The mean values represent an arithmetic mean of all sample sites with available FAME classes. Furthermore the calculation is based only on sample sites with pressure data existing for each buffer. For example, if the fish region buffer is missing for a sample site all buffers attributed to this site will be excluded from the graphs below, although the data for all other buffers were calculated. This is due to the fact, that the following Figures built the basis for further analyses (Friedman test, Kendall's W, see chapter 0) which compare the buffers with each other. Thereby only data available for all 10 buffers are useful.

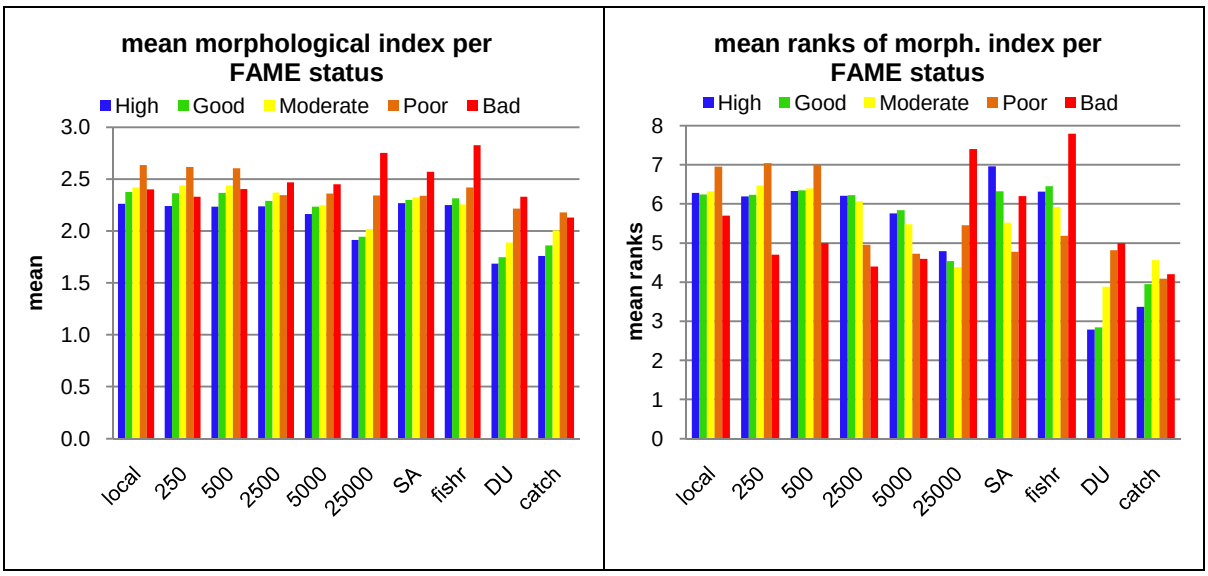


Figure 35: Mean values and mean ranks of the morphological index (per buffer and FAME status).

Figure 35 shows the mean values and mean ranks of the morphological index. The data base on 446 sample sites. This low number results out of the high number of missing values for the local buffer (morphology class 0, i.e. data missing) and the missing sample sites for the fish region- and DU buffer. In addition the FAME Index was only calculated for 800 sample sites. The calculation of data presented in this chapter is described in Table 20.

Table 20: Calculation of mean values and mean ranks.

morphological index	**local**	**250**	**500**	**2500**	**5000**	**25000**	**SA**	**fishr**	**DU**	**catch**
sample site 1	2.000	2.300	2.400	2.599	2.381	2.384	2.939	2.255	1.981	2.230
sample site 2	3.000	3.000	3.097	1.954	1.580	1.658	1.474	2.059	1.563	1.570
sample site 3	1.000	1.000	1.000	1.950	1.694	1.699	1.769	1.981	2.129	2.610
mean morphological index	2.000	2.100	2.166	2.168	1.885	1.914	2.061	2.098	1.891	2.137
ranks	**local**	**250**	**500**	**2500**	**5000**	**25000**	**SA**	**fishr**	**DU**	**Catch**
sample site 1	1	4	7	8	5	6	9	3	0	2
sample site 2	7	8	9	5	3	4	0	6	1	2
sample site 3	1	1	1	6	3	4	5	7	8	9
mean rank	3.0	4.3	5.7	6.3	3.7	4.7	4.7	5.3	3.0	4.3

Three sample sites and their morphological index per buffer are listed in the upper part of the table. The mean morphological index is calculated as:

$$mean\ morphological\ index = \frac{\sum_1^i morphological\ index_i}{i}$$

The smallest morphological index gains rank 0 while the highest morphological index gains rank 9. If two or more sample sites have the same morphological index (see sample site 3: local, 250m, 500m) the ranks are summed up (0 + 1 + 2 = 3) and are then divided by the number of sample sites (3 / 3 = 1). Finally the mean ranks are calculated as described for the mean morphological index. In case of the morphological index this calculation was done for all sample sites with the same FAME status.

Furthermore, Table 21 lists the number of sample sites per FAME status class. Status classes “poor” and “bad” are underrepresented while the status class “good” is represented by a high number of sample sites.

Table 21: Number of sample sites per FAME status class (for morphological index)

morphological index						
FAME status	high	good	moderate	poor	bad	sum
number of sample sites	57	323	50	11	5	446

The idea is that the FAME status class “high” shows the lowest morphological index and the FAME status class “bad” shows the highest morphological index. The other FAME status classes should follow this assumption, showing intermediate stages. As it can be seen in Figure 35 the lowest mean can always be found in the FAME status class “high”. Furthermore the highest mean always occurs in FAME status class “bad” or “poor”. The expected pattern can be seen at the 25000m-, SA- and DU buffer. The DU buffer shows the desired step-range since the FAME status classes “high” and “good” can be distinguished from the status class “moderate” while the status class “bad” and “poor” discern from all other status classes. Nevertheless it has to be taken into account that the last two FAME status classes (“bad” and “poor”) are represented by a low number of sample sites and therefore might be more inaccurate.

The mean ranks show a different picture than the mean morphological index. Here only the DU buffer shows the expected order.

The graphs were also created for sample sites where the morphological index shows a high reliability (i.e. less than 30 percent missing data within a buffer). The results are shown in Figure C.1 in Annex C. There the mean ranks show a similar pattern except for the FAME status class “poor” which includes higher values for the morphological index.

Since the length impacted by a pressure is expressed as percentage the lowest mean values are expected for FAME status class “high” or “good” while the highest mean percentage should occur at status classes “poor” and “bad”. Since 0 values represent real data here a

higher number of sample sites are included in the calculations (see Table 22). The high number of 0 values has to be taken into account when interpreting the mean values.

Table 22: Number of sample sites per FAME status class (for hydro peaking, impoundment and water abstraction).

Pressures (hydro peaking, impoundment, water abstraction)						
FAME status	high	good	moderate	poor	bad	sum
number of sample sites	70	446	77	18	20	631

As Figure 36 shows, the FAME status classes “bad” and “poor” are only occurring at the large buffers. This means that there is no hydro peaking present at the smaller buffers (local, 250m, 500m, 2500m, 5000m) for sample sites evaluated as “bad” or “poor”. The database shows that there are 34 sample sites with hydro peaking at the local scale but these entire sample sites are rated as “high” or “good”. Only the mean ranks of the catchment buffer show the usual picture.

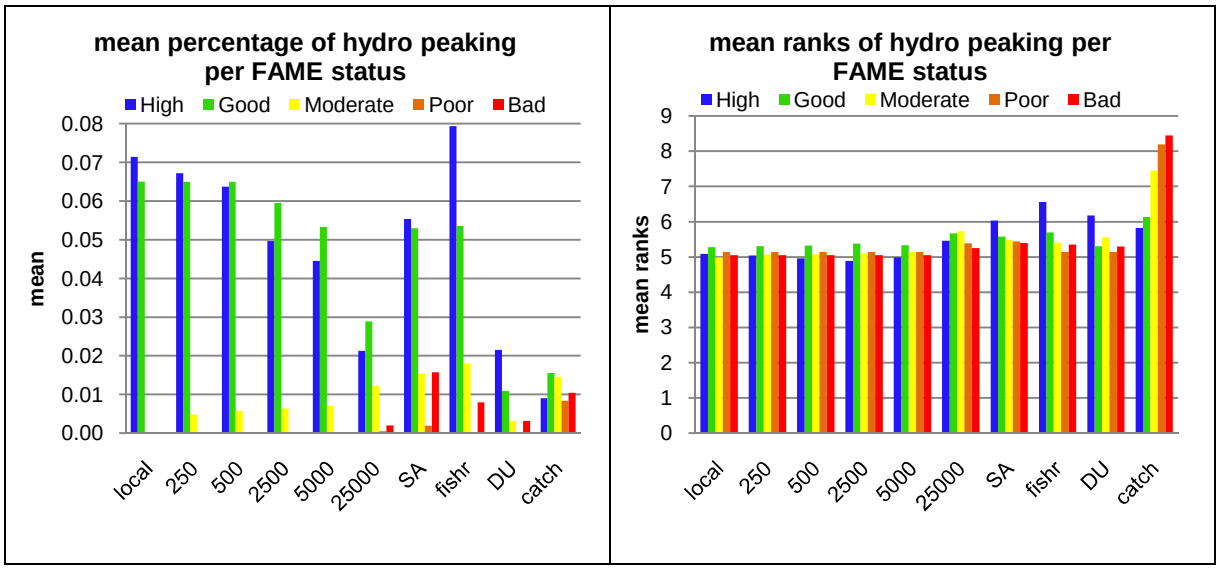


Figure 36: Mean values and mean ranks of percentage hydro peaking (per buffer and FAME status).

The expected difference of the mean percentage of impoundment per FAME status occurs at all buffers (see Figure 37). The local buffer shows the highest contrast between the single status classes while the catchment buffer barely shows differences. The mean ranks are in the expected order at the local, 250m- and 500m buffer. The large buffers (25000m and catchment) show even an inverse stratification with the highest mean ranks of impoundment at the FAME status class “high”.

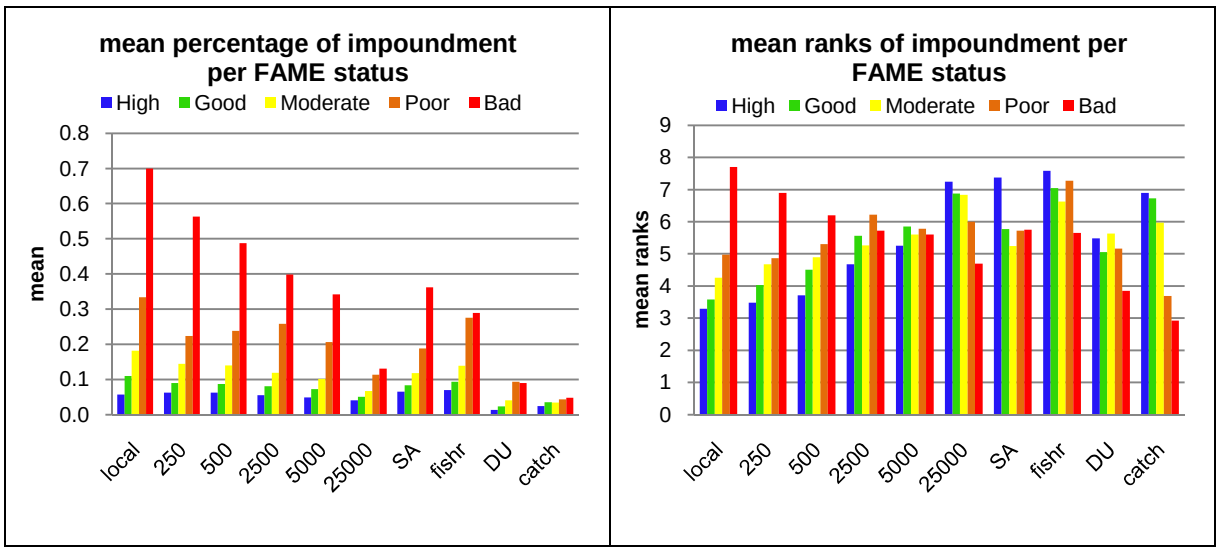


Figure 37: Mean values and mean ranks of percentage impoundment (per buffer and FAME status).

Figure 38 shows that the mean percentage of water abstraction per FAME status class as well as the mean ranks at all buffers do not differentiate as expected in the status classes.

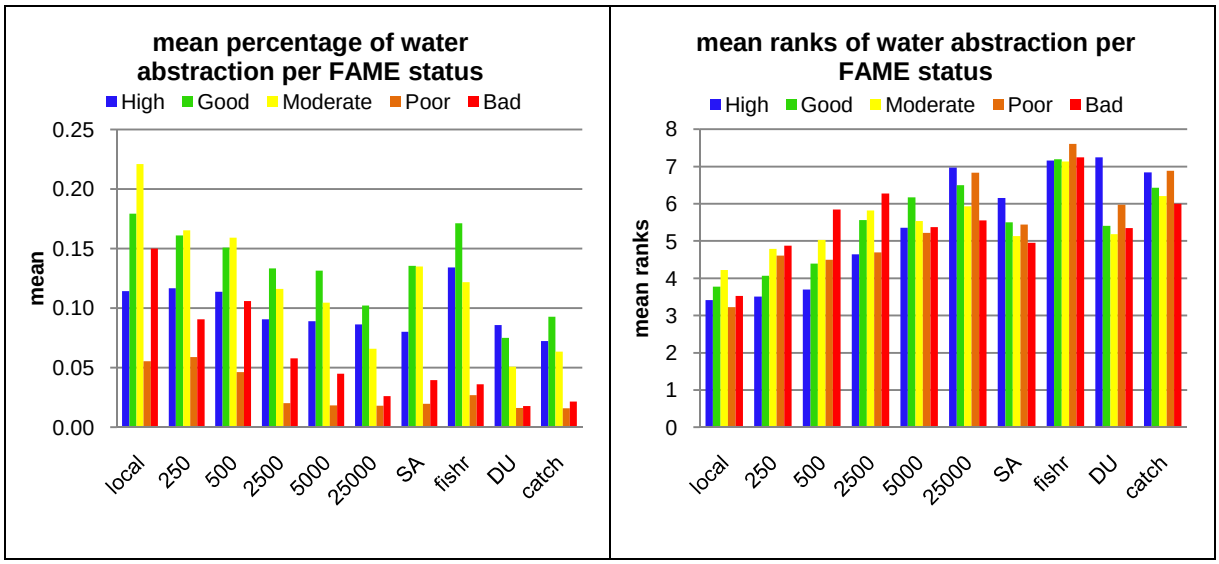


Figure 38: Mean values and mean ranks of percentage water abstraction (per buffer and FAME status).

Both the FAME status class “bad” or “poor” show the lowest mean percentage of water abstraction at all times. The mean ranks of the 250m buffer come closest to the expected stratification. Here at least the status classes “high” and “good” include the lowest ranks and are distinguishable from the other status classes.

The FAME Index was able to detect the morphological status and impoundment. Hydro peaking and water abstraction were not able to induce the predicted stratification of the FAME status classes.

4.2.2 EFIplus Index and pressures

Since the EFIplus Index represents an improvement of the FAME Index it is expected that the desired stratification between the EFIplus classes is met more often. The EFIplus recently only is calculated for 597 sample sites. However, Figure 39 bases on the morphological indices of 347 sample sites. The reasons for this low number were already mentioned in chapter 4.2.1. and can be explained by the high number of missing values for the local scale (morphology class 0, i.e. data missing), the missing sample sites for the fish region- and DU buffer and the low number of sample sites (597) the EFIplus Index was calculated for.

The number of used sample sites per EFIplus class for the morphological index is listed in Table 23.

Table 23: Number of sample sites per EFIplus class (for morphological index).

morphological index						
EFIplus class	1	2	3	4	5	sum
number of sample sites	58	140	86	43	20	347

Furthermore, Figure 39 indicates that EFIplus class 4 shows throughout the highest mean morphological index. Nevertheless the EFIplus class 5 sometimes shows even a lower morphological index than EFIplus class 1. The stratification of the EFIplus classes varies per buffer. Only the DU buffer shows approximately the expected layering. Although class 4 again exceeds class 5 the two highest EFIplus classes are distinguishable from classes 1 to 3. This picture changes for the mean ranks, where no consistent layering is identifiable.

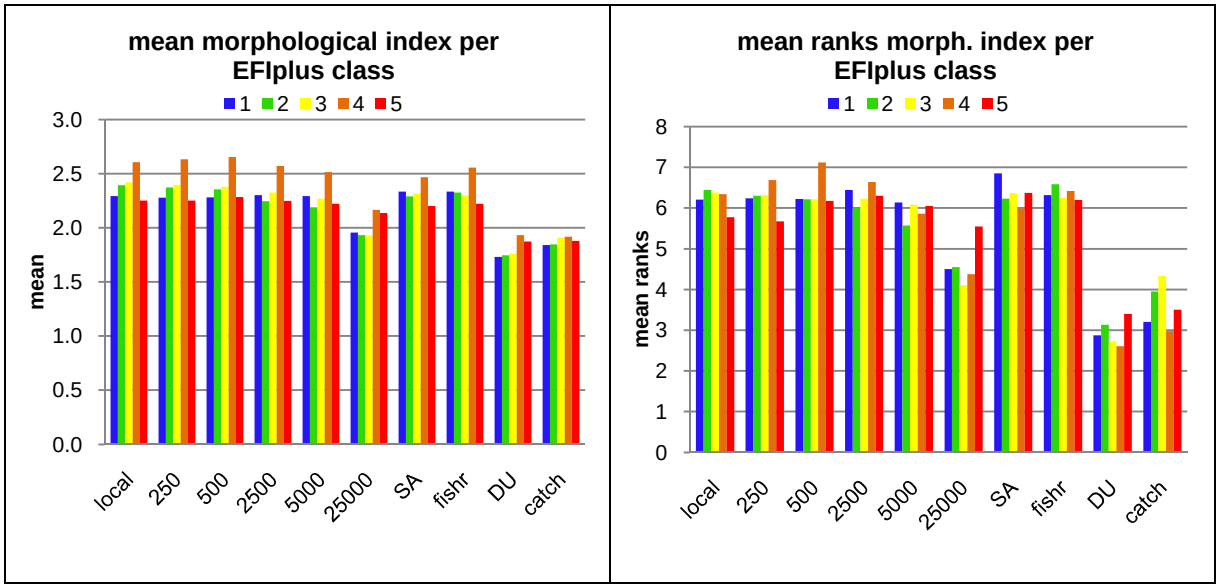


Figure 39: Mean values and mean ranks of morphological index (per buffer and EFIplus class).

Again the graphs were also made for sample sites showing a morphological index with high reliability (i.e. less than 30 percent missing data per buffer). The results are given in Figure C.1 (Annex C) which is very similar to Figure 39.

The graphs concerning the pressures hydro peaking, impoundment, water abstraction were based on the sample site numbers listed in Table 24.

Table 24: Number of sample sites per EFIplus class (for hydro peaking, impoundment and water abstraction).

Pressures (hydro peaking, impoundment, water abstraction)						
EFIplus class	1	2	3	4	5	sum
number of sample sites	78	209	118	72	26	503

The mean percentage of hydro peaking per EFIplus class (Figure 40) shows a similar picture as the mean percentage of hydro peaking for the FAME status classes.

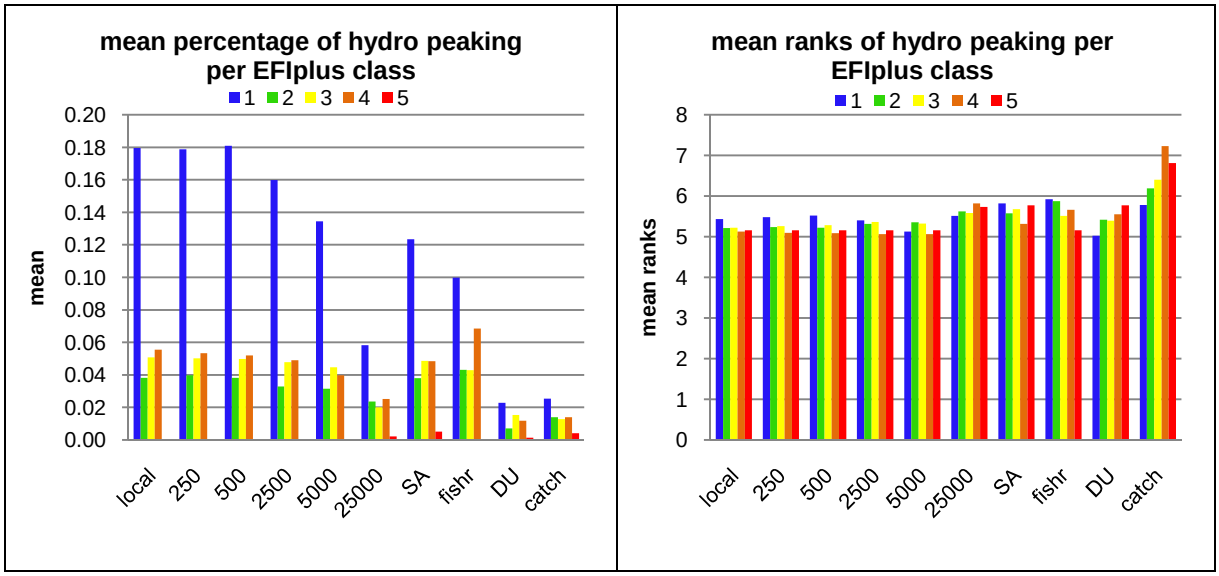


Figure 40: Mean values and mean ranks of percentage hydro peaking (per buffer and EFIplus class).

However, the EFIplus class 4 is present at all buffers while class 5 is mostly absent. Again the EFIplus class 1 achieves the highest percentage of hydro peaking but this time in all buffers. The DU- and catchment buffer present the predicted layering for the mean ranks. But only the catchment buffer is able to differentiate between low EFIplus classes (1, 2, 3) and high EFIplus classes (4, 5). However, also the EFIplus class 4 exceeds the EFIplus class 5.

At least for some buffers Figure 41 shows the expected distribution of the mean percentages for pressure impoundment.

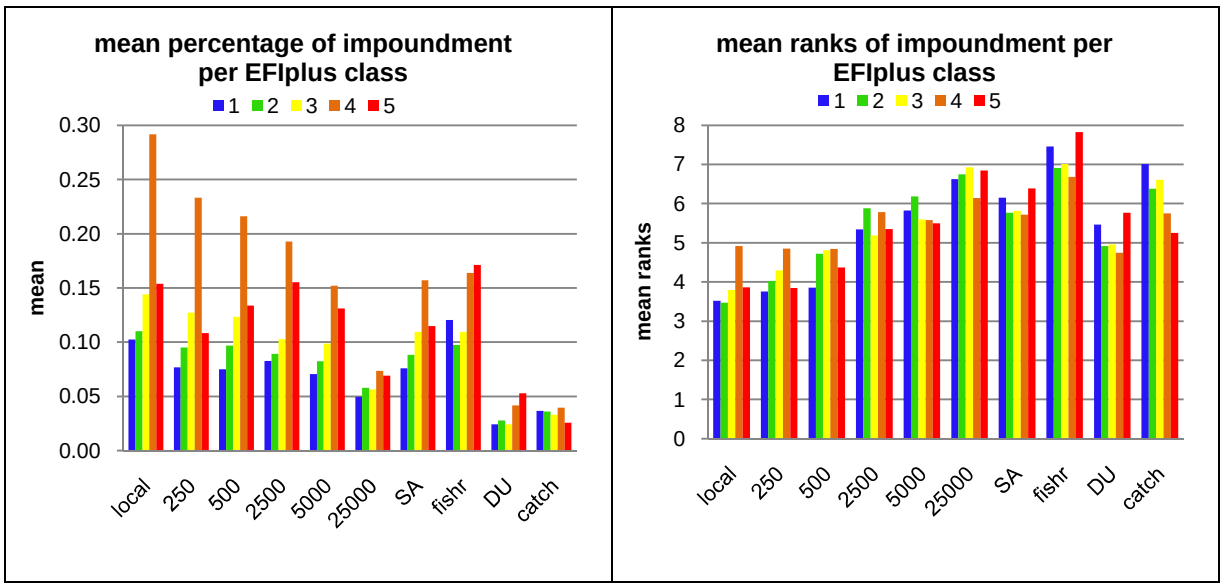


Figure 41: Mean values and mean ranks of percentage impoundment (per buffer and EFIplus class).

Nevertheless the layering based on the FAME status classes showed a higher agreement. Still the classes 4 and 5 show the highest percentage of impoundment. The mean ranks are not able to provide the expected pattern for any buffer.

The mean percentages of water abstraction (Figure 42) show even an inverse layering with the highest percentage of water abstraction in the EFIplus classes 1 and 2 while the other classes (3, 4 and 5) show lower percentages. Also the mean ranks do not present the expected distribution at any buffer.

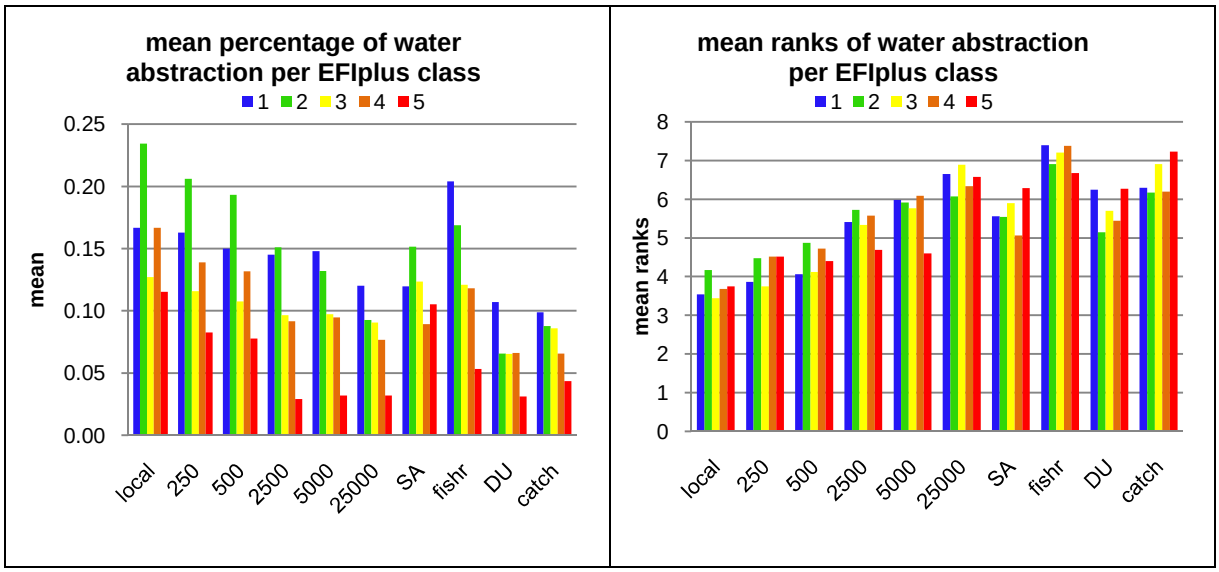


Figure 42: Mean values and mean ranks of percentage water abstraction (per buffer and EFIplus class).

5. Statistical analyses

The statistical analyses in this chapter investigate the connection of fish metrics and pressures at different spatial scales. Since the knowledge about the best suitable buffer is rare the first analyses were performed as an explorative data analysis. The hypotheses will be defined separately for each test and chapter.

5.1 Wilcoxon signed rank test

The Wilcoxon signed rank test is a non-parametric alternative to the student's t-test. Since the data do not show a normal distribution this test was used to compare two connected samples, in this case, two buffers. It calculates the difference between two buffers of the same sample site (i.e. difference of morphological index or percentage of pressure). The difference can show both positive and negative values. In a second step those differences are sorted starting by the lowest difference, whereby the sign is not taken into account. Then ranks are assigned to the differences. Further on the ranks of positive and negative differences are summed up separately. The lower value of the two rank-sums is compared to a critical value which depends on the sample size. If the value is smaller than this critical value the null hypothesis is rejected (SPSS INC., 2010a).

The null hypothesis is (e.g.):

H_0: The distribution of the morphological index is the same for buffer x and buffer y.

SPSS©18 was used to compare the morphological index of each buffer with the morphological index of each other buffer separately. The resulting p-values for the morphological index are listed in Table 25. If the p-value is below 0.05 the null hypothesis is rejected and the values of the two buffers differ significantly. P-values with a significance level of 0.05 are printed bold while p-values with a significance level of 0.01 are additionally highlighted in grey.

Table 25: Wilcoxon signed rank test for morphological index on different spatial scales.

	local	250	500	2500	5000	25000	SA	fishr	DU	catch
local	-	0.85	0.85	0.15	**0.00**	**0.00**	0.03	0.10	**0.00**	**0.00**
250		-	0.52	0.02	**0.00**	**0.00**	**0.00**	0.15	**0.00**	**0.00**
500			-	**0.00**	**0.00**	**0.00**	**0.00**	0.08	**0.00**	**0.00**
2500				-	**0.00**	**0.00**	0.13	0.04	**0.00**	**0.00**
5000					-	**0.00**	0.09	**0.00**	**0.00**	**0.00**
25000						-	**0.00**	**0.00**	**0.00**	**0.00**
SA							-	**0.00**	**0.00**	**0.00**
fishr								-	**0.00**	**0.00**
DU									-	**0.00**
catch										-

As it can be seen in Table 25 the 5000m, 25000m, DU- and catchment buffers differ from all other buffers. The local- as well as the 250m buffers are not significantly different from each other and they also do not differ from the 500m, 2500m and fish region buffers. Further differences can be seen in the table above.

Table 26 demonstrates that there is no buffer that differs from all other buffers when considering hydro peaking. Especially the small buffers (local to 5000m) show no significant differences among each other.

Table 26: Wilcoxon signed rank test for hydro peaking pressure on different spatial scales.

	local	250	500	2500	5000	25000	SA	fishr	DU	catch
local	-	0.22	0.12	0.38	0.66	**0.00**	**0.01**	**0.00**	0.02	**0.00**
250		-	0.07	0.72	0.53	**0.00**	0.02	**0.00**	0.16	**0.00**
500			-	0.66	0.26	0.04	0.12	**0.00**	0.54	**0.00**
2500				-	**0.00**	0.52	0.48	**0.00**	0.25	**0.00**
5000					-	0.13	0.06	**0.00**	0.02	**0.00**
25000						-	**0.00**	**0.00**	**0.00**	**0.01**
SA							-	0.22	**0.00**	0.66
fishr								-	**0.00**	0.63
DU									-	**0.00**
catch										-

The Wilcoxon test for impoundment (Table 27) shows that only the local and fish region buffers differ from all other buffers. But in general most buffers are only similar to one or two other buffers.

Table 27: Wilcoxon signed rank test for impoundment pressure on different spatial scales.

	local	250	500	2500	5000	25000	SA	fishr	DU	catch
local	-	**0.00**	0.02	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
250		-	0.21	0.46	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
500			-	0.44	0.73	**0.00**	**0.00**	**0.00**	0.14	**0.00**
2500				-	**0.00**	0.05	0.15	**0.00**	**0.00**	0.16
5000					-	0.10	0.25	**0.00**	**0.00**	0.01
25000						-	0.69	**0.00**	**0.00**	**0.00**
SA							-	**0.00**	**0.00**	**0.00**
fishr								-	**0.00**	**0.00**
DU									-	**0.00**
catch										-

The Wilcoxon test for water abstraction shows a similar picture. Again the local buffer differs from all other buffers (see Table 28).

Table 28: Wilcoxon signed rank test for water abstraction pressure on different spatial scales.

	local	250	500	2500	5000	25000	SA	fishr	DU	catch
local	-	**0.01**	**0.01**	0.05	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
250		-	0.02	0.32	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
500			-	0.76	0.02	**0.00**	**0.00**	**0.00**	0.56	**0.00**
2500				-	1.00	0.69	0.35	**0.00**	**0.00**	0.32
5000					-	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**
25000						-	**0.00**	**0.00**	**0.00**	**0.00**
SA							-	**0.00**	0.10	**0.00**
fishr								-	**0.00**	**0.00**
DU									-	0.00
catch										-

5.2 Friedman test

The Friedman test is the nonparametric alternative to the ANOVA with repeated measurements. It tests if three or more connected (paired) samples have been drawn from the same population. In this case it was used to analyze, if the buffer values (morphological index or percentage of pressures) differ within each FAME status class and EFIplus class. Thereby the test observes all 10 buffers at the same time. As soon as one buffer differs significantly from all other buffers the test is significant, meaning that the null hypothesis is rejected (SPSS INC., 2010a).

The null hypothesis is

H_o: The 10 buffer samples do not differ in their location within the FAME status classes and the EFIplus classes

For these analyses the mean ranks presented in chapter 0 were used.

The higher the differences between the mean ranks per buffer and FAME status class/ EFIplus class, the lower the p-value. Again a p-value below 0.05 leads to the rejection of the null hypothesis.

Table 27 shows the p-values for the Friedman test based on the FAME status classes. The results show that the buffers do not differ within the “poor” and “bad” status class for the morphological index. This can be explained due to the fact that these status classes are underrepresented. The p-values of the pressures are all below 0.05 which means that the buffer values (percentage of hydro peaking, impoundment and water abstraction) differ within each FAME status class.

Table 29: Friedman test for different pressure categories and the FAME Index (EFI).

Friedman test						
FAME status	morphological index		pressures			
				hydro peaking	impoundment	water abstraction
	N (446)	significance	N (631)	significance	significance	significance
high	57	**0.000**	70	**0.000**	**0.000**	**0.000**
good	323	**0.000**	446	**0.000**	**0.000**	**0.000**
moderate	50	**0.000**	77	**0.000**	**0.000**	**0.000**
poor	11	0.155	18	**0.000**	**0.045**	**0.000**
bad	5	0.547	20	**0.000**	**0.000**	**0.013**

Table 26 lists the same results for the EFIplus classes. Only the buffer percentages of hydro peaking show no significant differences within EFIplus class 1. All other p-values are below 0.05 leading to the rejection of the null hypothesis.

Table 30: Friedman test for different pressure categories and the EFIplus Index (EFIplus).

Friedman test						
EFIplus class	morphological index		pressures			
				hydro peaking	impoundment	water abstraction
	N (347)	significance	N (503)	significance	significance	significance
1	58	**0.000**	78	0.112	**0.000**	**0.000**
2	140	**0.000**	209	**0.000**	**0.000**	**0.000**
3	86	**0.000**	118	**0.000**	**0.000**	**0.000**
4	43	**0.000**	72	**0.000**	**0.000**	**0.000**
5	20	**0.003**	26	**0.000**	**0.000**	**0.000**

5.3 Kendall's coefficient of concordance (Kendall's W)

Kendall's W is a normalization of the Friedman statistic and is used for the assessment of agreement among ratings. If Kendall's W is 1 all ratings are unanimous. If it is 0 the ratings can be regarded as random (SPSS INC., 2010a).

In this case the values (morphological index/ pressure percentages) are ranked as described in chapter 0. These ranks representing the ratings are summed up to the mean ranks per buffer. The mean ranks of all buffers are compared with each other whereby Kendall's W expresses the percentage of unanimous ratings.

Assumed that the local pressures are most influencing we would expect that the morphological index shows the lowest values at the local scale and increases for other scales, since the effects of larger-scale pressures might decrease. If the compliance is low this would mean that the local morphological index in status class "high" is not always the lowest of all buffers or that its variation among the scales doesn't show a clear pattern repeated for each sample site.

Figure 43 shows Kendall's W for all pressures and each FAME status class. The highest values occur for hydro peaking in combination with status classes "poor" and "bad" (up to 50 %). This means that within these two categories the distribution of the lowest to the highest values is equal for about 50 percent of the sites. FAME status class "high" shows the highest Kendall's W for the pressure impoundment.

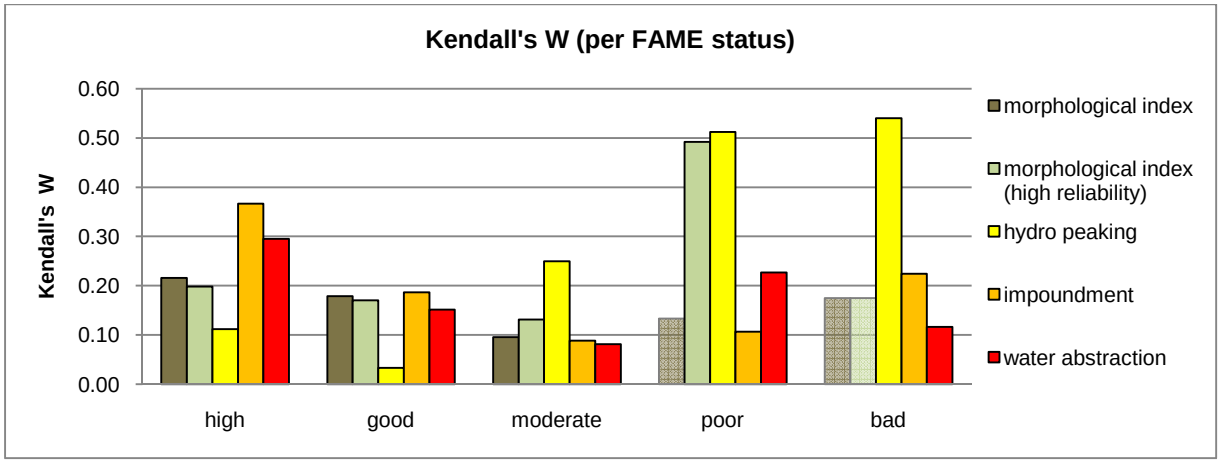


Figure 43: Kendall's W (per pressure and FAME status class).

Kendall's W is not significant for morphological index and FAME class "poor" and "bad" (shown transparent in Figure 43). But Kendall's W for the morphological index (high reliability) and status class "poor" is significant.

Looking at Figure 44 showing the EFIplus classes it can be seen that Kendall's W decreases for most pressures compared to the FAME Index. The morphological index shows higher values for EFIplus classes 3 and 4, although the morphological index (high reliability) decreases for EFIplus class 4. This time only hydro peaking in combination with EFIplus class 1 is not significant.

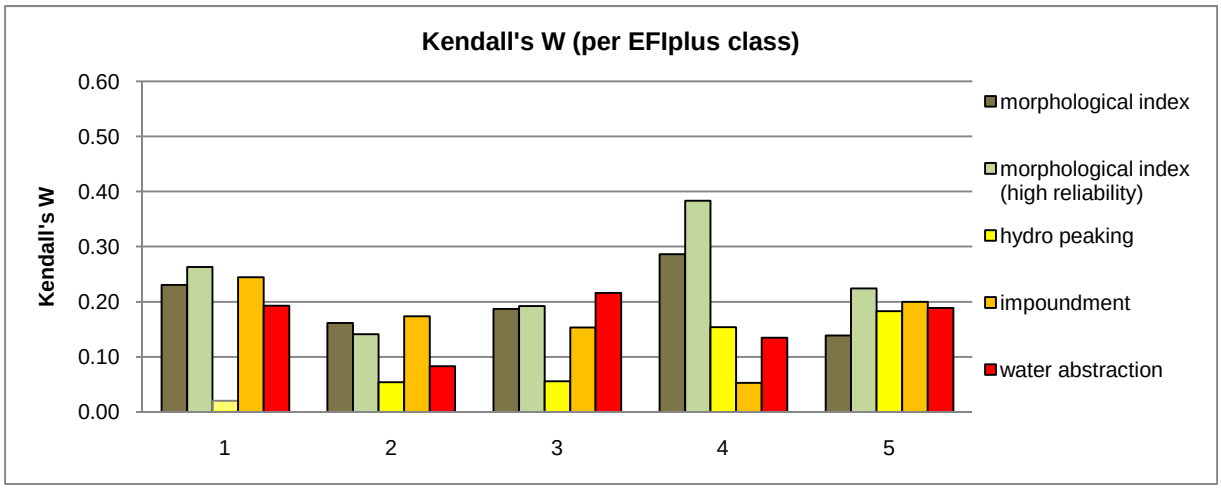


Figure 44: Kendall's W (per pressure and EFIplus class).

Since the values for Kendall's W are not very high the ratings are not very unanimous. This means that the highest/ lowest values (morphological index or percentages of hydro peaking, impoundment or water abstraction) per FAME or EFIplus Index do not always occur at the same buffer.

5.4 Correlations

In this chapter the correlations between fish metrics and pressure data are presented. The Pearson correlation measures the correlation as linear dependence between two variables. Since we do not know if the variables show a linear dependency in addition the non-parametric correlation (Spearman correlation) was calculated. The Spearman correlation is also able to detect non-linear relations of two variables. As in other non-parametric tests it transforms the data into ranks. This means that the test is robust to outliers. Then a correlation between these ranks is calculated. Both the Pearson- and the Spearman correlation can show values from -1 to +1. For Pearson a correlation coefficient of ± 1 means that the variables are perfectly linear correlated while a value of 0 means, that the variables are not linear correlated. For Spearman a correlation coefficient of ± 1 means that the variables highly depend on each other, no matter if linear or in another way (SPSS INC., 2010a). Is has to be mentioned here that a high correlation coefficient does not mean that

one variable defines the other variable. There could be a third variable involved to which both variables are connected.

In a first step the correlations were calculated only for the FAME Index and EFIplus Index but since the resulting correlations were very low all single metrics were included in these statistical analyses.

The graphs in this chapter show the Pearson- and Spearman correlations for the morphological index, hydro peaking, impoundment, water abstraction as well as for the buffer length. All correlation coefficients were included in the graph generation, no matter if they were significant or not. The results of the correlation are shown in Annex D, where also the significance level can be looked up. Since there is so much information included in one graph only outstanding results are described.

The interpretation will be divided into selected EFIplus metrics (first 27 metrics, see Table 6), 10 FAME metrics (see Table 4) and 4 EFIplus metrics (Table 5) as described in chapter 1.7. It is expected that the lithophilic, potamodromous and rheophilic guilds decrease with increasing pressures while the omnivorous guild should increase with increasing pressures. Since the metrics of the FAME- and EFIplus Index were transformed all metrics should decrease with increasing pressures (see chapter 1.7).

Although both correlations (Spearman and Pearson) will be shown, only the graph with the highest correlations will be explained. This is also due to the fact, that the two correlations show mostly the same reaction and differ only in strength.

5.4.1 Correlation of fish metrics and morphological index at all scales

The interpretations in this chapter are based on a scenario where the morphological index increases. This means that if a metric is expected to increase, it rises with an increasing morphological pressure and declines with a decreasing morphological index.

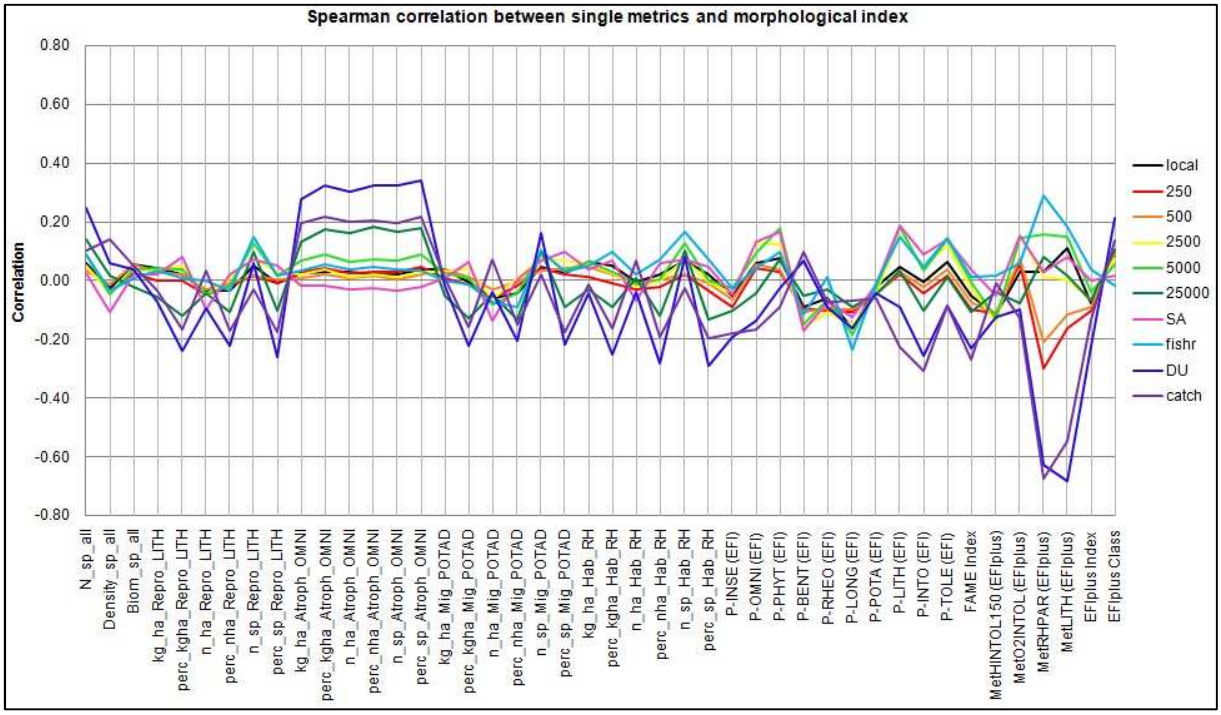


Figure 45: Spearman correlation for morphological index and selected metrics/ indices.

The selected EFIplus metrics show barely any significant correlation at the small buffers (local to 2500m). Nevertheless the large buffers (25000m-, DU- and catchment) show significant results (Spearman and Pearson) for most of the selected EFIplus metrics. It can be seen that the large buffers (25000m, DU, catchment) show the highest correlations. They are mostly higher in Figure 45 (Pearson) than in Figure 46 (Spearman) indicating a linear connection between the variables. High correlations occur for all guilds. The lithophilic guild shows a decline in the proportion of biomass, proportion of species and proportion of density. Since all these metrics are expressed as proportion this does not mean that lithophilic species decrease. The decrease in proportion can simply be based on the increase of other species. This assumption is emphasized by the smaller or even positive correlations of biomass, species and density of the lithophilic guild. The omnivorous guild increases with a rising morphological index. The correlation is the smallest for the biomass metrics. The potamodromous and rheophilic guilds show a similar reaction as previously described for the lithophilic guild (↓ proportion of biomass, ↓ proportion of species, ↓ proportion of density). Additionally the Spearman correlation shows an increase of potamodromous species while the Pearson correlation indicates an increase in the density of rheophilic species.

The FAME metrics again present a similar picture for Pearson and Spearman. Unfortunately all Pearson correlations for the catchment buffer are not significant (see Annex D). Since all metrics were transformed to show the same reaction to pressures they should decrease with

an increasing morphological index. The significance varies strongly between fish metrics and buffers. The DU buffer shows the highest number of significant correlations for Pearson. According to Pearson correlations of the DU buffer the density of insectivorous, omnivorous and phytophilic species as well as the relative abundance of lithophilic species and the relative number of intolerant and tolerant species decreases. The Pearson correlation in Figure 46 presents a similar picture.

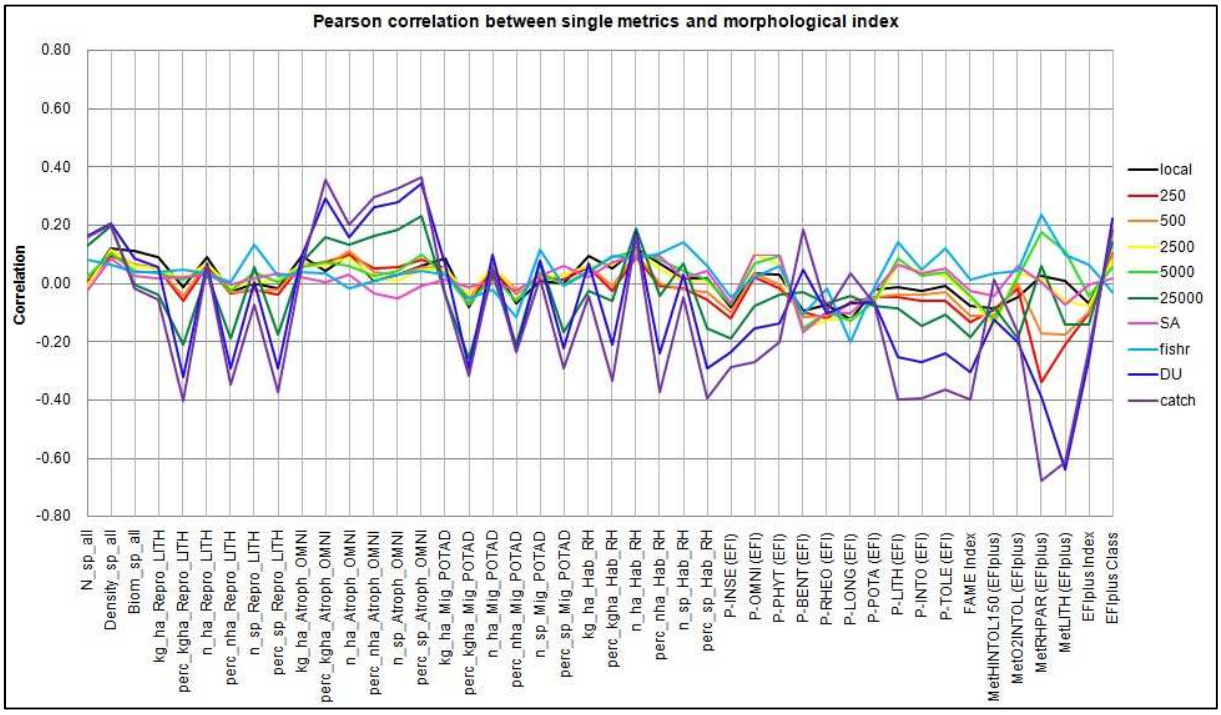


Figure 46: Pearson correlation for morphological index and selected metrics/ indices.

This time all correlations (except for the migration guilds) are significant, showing a decrease of intolerant species. Although some metrics and buffers show even positive reactions (increase) to an increasing morphological index, the FAME Index reacts the expected way at most scales. Exceptions are the fish region- and the SA buffer. The FAME Index is reacting the most at the catchment scale according to the Pearson correlation. However this correlation is only significant for morphological indices with high reliability (see Annex D).

The EFIplus metrics generally are expected to show a decline for an increasing morphological index. The expected reactions for all 4 EFIplus metrics are solely given at the DU buffer since the catchment buffer partly views insignificant correlations. Also the EFIplus Index shows the highest correlation and the expected reaction at the DU scale. Although the Pearson correlations for the catchment buffer are not significant, they are for the morphological index with high reliability (see Annex D). This means that cyprinid rivers show a strong reaction to a morphological degradation. Nevertheless these correlations are based

on a small sample size since the EFIplus metrics for cyprinid rivers are only available for 85 sample sites.

5.4.2 Correlation of fish metrics and hydro peaking at all scales

Figure 47 and Figure 48 show the Pearson and Spearman correlations between fish metrics and hydro peaking. Comparing the graphs displays that Spearman correlations show higher values than Pearson correlations. Again the reactions (increase, decrease) are interpreted for the scenario of an increasing percentage of hydro peaking.

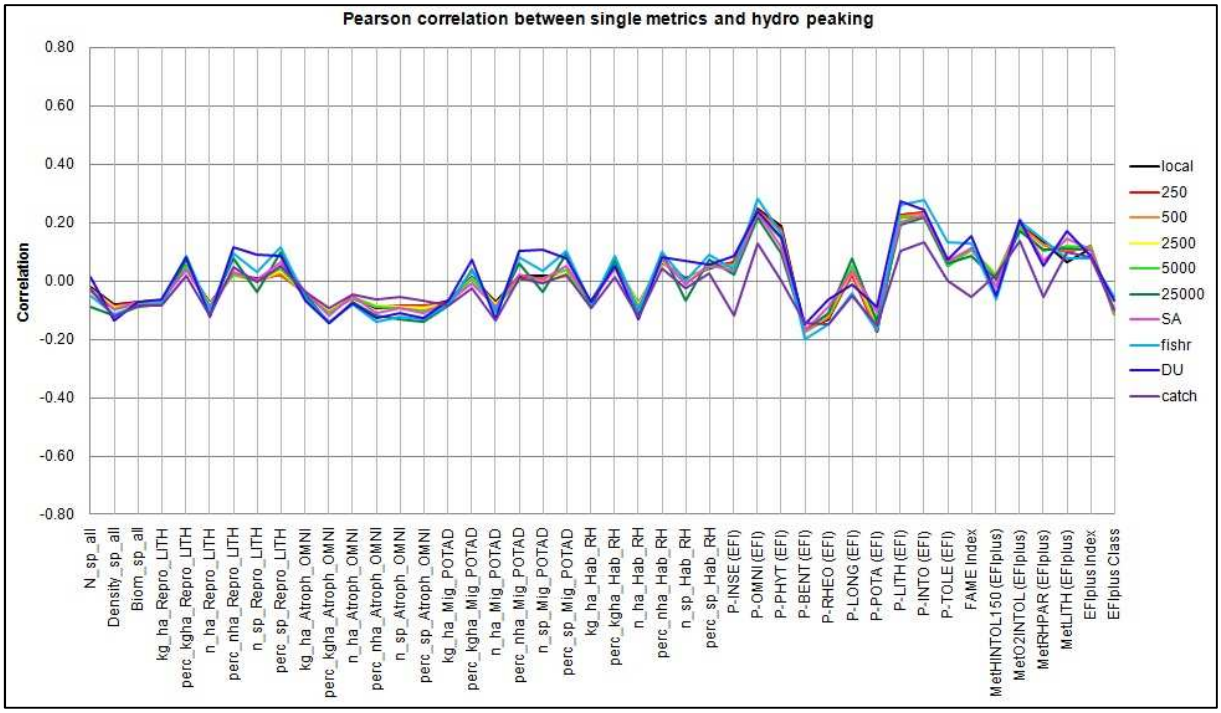


Figure 47: Pearson correlation for hydro peaking and selected metrics/ indices.

The correlations in Figure 48 show that the selected EFIplus metrics react the same way (increase, decrease) at most scales. The highest correlations can be seen at the DU buffer.

It shows a decrease of total density and density of lithophilic, potamodromous and rheophilic species while number of lithophilic, potamodromous and rheophilic species increases. This opposite reaction is noticeable and indicates a higher number of species providing fewer individuals for theses guilds. Metrics describing the omnivorous guild show a decreasing reaction to hydro peaking.

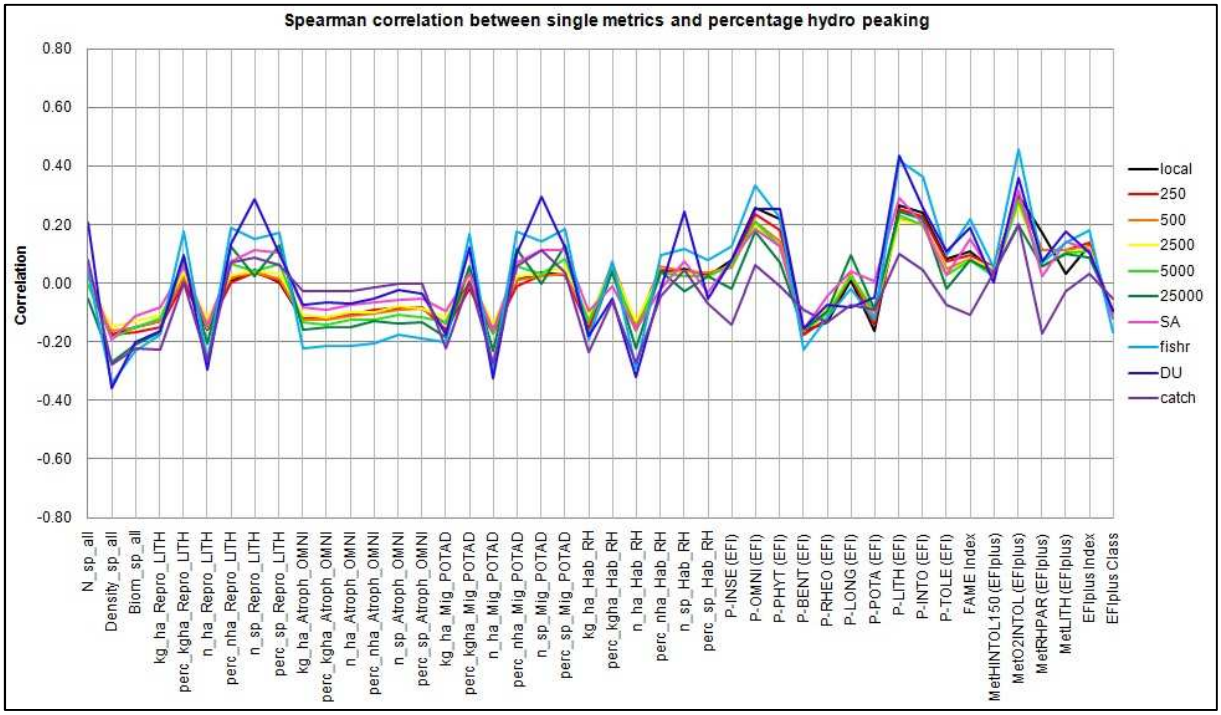


Figure 48: Spearman correlation for hydro peaking and selected metrics/ indices.

The two buffers showing the highest correlations for the FAME metrics are the DU- and the fish region buffer. Although both buffers show the same reaction respectively the reaction with the highest correlation will be described. Contrary to expectations some metrics of the FAME Index rise with an increasing percentage of hydro peaking. This reaction is best visible for the density of omnivorous and the relative number of intolerant species (for fish region) and the relative abundance of lithophilic species (for catchment) and leads to a positive reaction of the FAME Index. Hence, if the percentage of hydro peaking increases the FAME Index rises too, indicating a better FAME status. Solely the catchment buffer shows the expected reaction even though the correlations for both Spearman and Pearson are not very high.

5.4.3 Correlation of fish metrics and impoundment at all scales

Although Figure 49 and Figure 50 show the same reactions Spearman shows higher correlations than Pearson and therefore will be described here. Again the reactions will be explained for the scenario of an increasing percentage of impoundment.

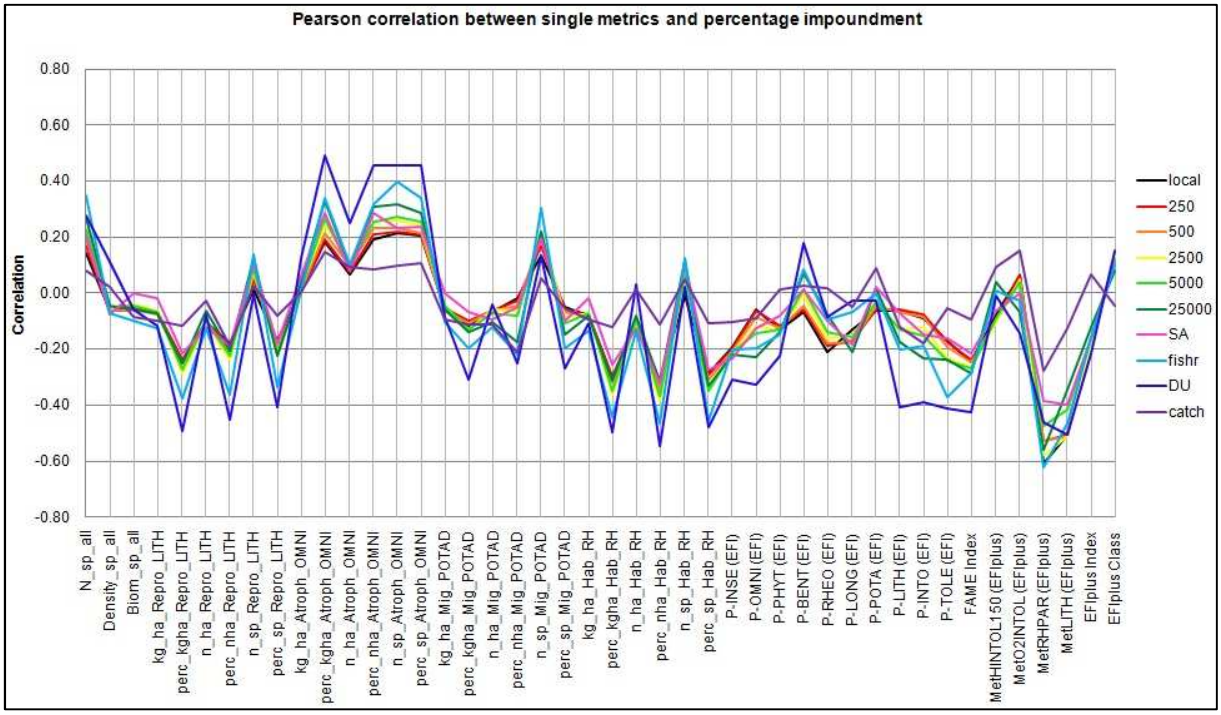


Figure 49: Pearson correlation for impoundment and selected metrics/ indices.

The selected EFIplus metrics show higher values for the Pearson correlation. Although the DU buffer represents the most reacting scale also the fish region- and the 25000m buffers show high values. The fish region buffer displays an increase in total number of species and an increasing number of potamodromous species. The DU buffer shows a decrease for all lithophilic metrics, while all omnivorous metrics increase. Although also the potamodromous metrics show a general decline, the number of potamodromous species increases as mentioned for the fish region buffer. The rheophilic guild decreases in all metrics except for the density and number of rheophilic species.

Also the FAME metrics react with higher Pearson correlations than Spearman correlations and again the DU buffer shows the highest values. Here all metrics except for the migratory guilds show the expected decline. The FAME Index shows negative reactions (decrease) at all scales.

For EFIplus metrics especially the cyprinid metrics show a high reaction and decrease as expected. Although the salmonid metrics show partly positive reactions, all EFIplus metrics decline with an increasing percentage of impoundment, whereby the DU buffer shows the highest value again. The richness of rheophilic species is the strongest at the fish region scale (-0.62).

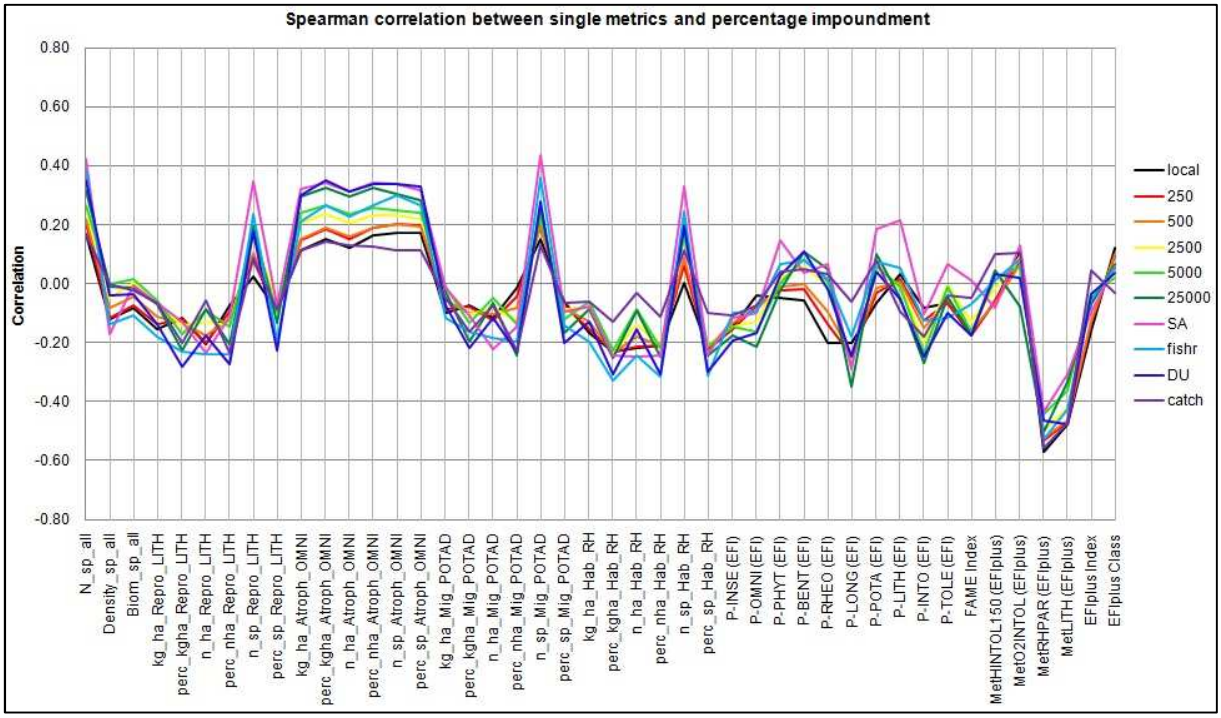


Figure 50: Spearman correlation for impoundment and selected metrics/ indices.

5.4.4 Correlation of fish metrics and water abstraction at all scales

Figure 51 and Figure 52 show the Pearson- and Spearman correlation between the single metrics and water abstraction.

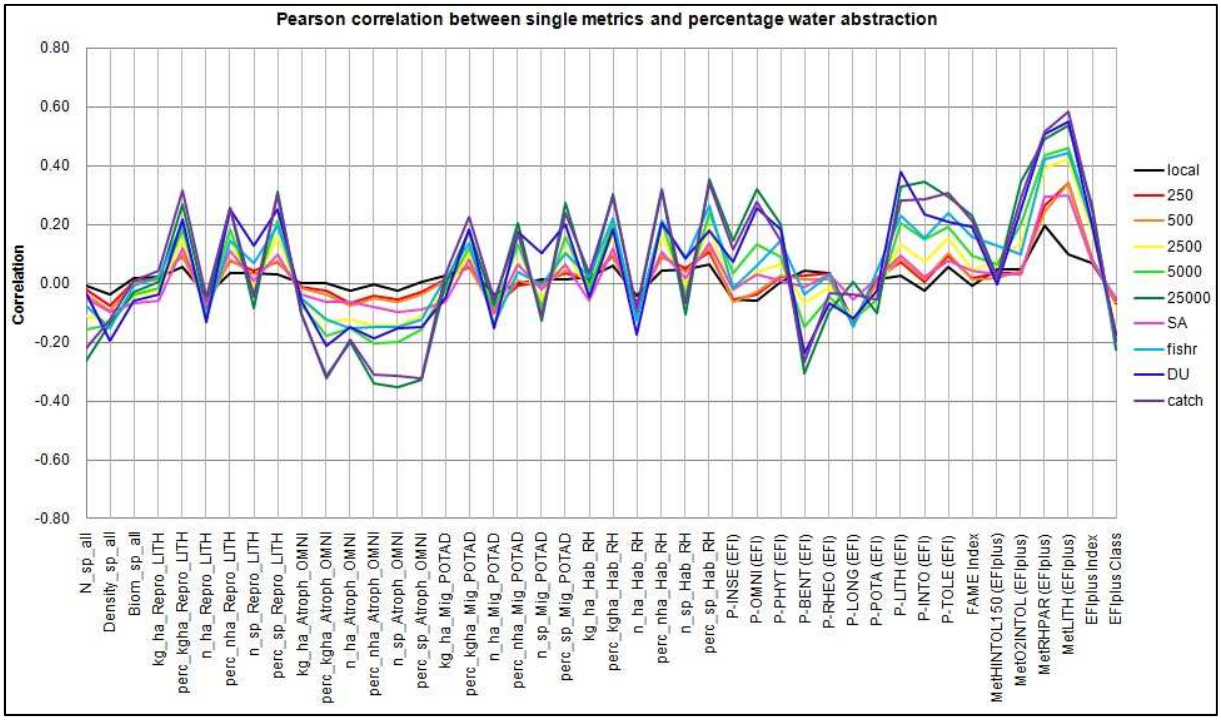


Figure 51: Pearson correlation for water abstraction and selected metrics/ indices.

The reactions of metrics are again described for an increasing percentage of water abstraction. Although both graphs show nearly the same correlations Figure 52 (Spearman) includes higher values than Figure 51 (Pearson). Therefore only this graph will be described.

The most reacting scale for the selected EFIplus metrics is the 25000m buffer although some metrics in the DU buffer show higher correlations. It is also noticeable that smaller buffers (especially local to 500m) show very low correlations which are not significant. The total density of all species decreases which is also reflected by the decreasing density of lithophilic, omnivorous, potamodromous and rheophilic species. All metrics describing omnivorous species decrease (highly negative correlations for 25000m and catchment). Lithophilic, potamodromous and rheophilic species increase their proportions of biomass, species and density. Since the absolute values for biomass, species and density are lower or even negative this reaction might be described by a decrease of other guilds.

For the FAME metrics only the number of benthic and diadromous species reflect the expected reaction. If we leave insignificant values out, all other FAME metrics increase. The only negative correlations for the FAME Index occur at the local and 250m buffer but these values are not significant.

Finally the EFIplus metrics show an opposite reaction than expected (see introduction of chapter 5.4). All single metrics increase for both correlations (Pearson and Spearman) thereby leading to an increasing reaction of the EFIplus Index.

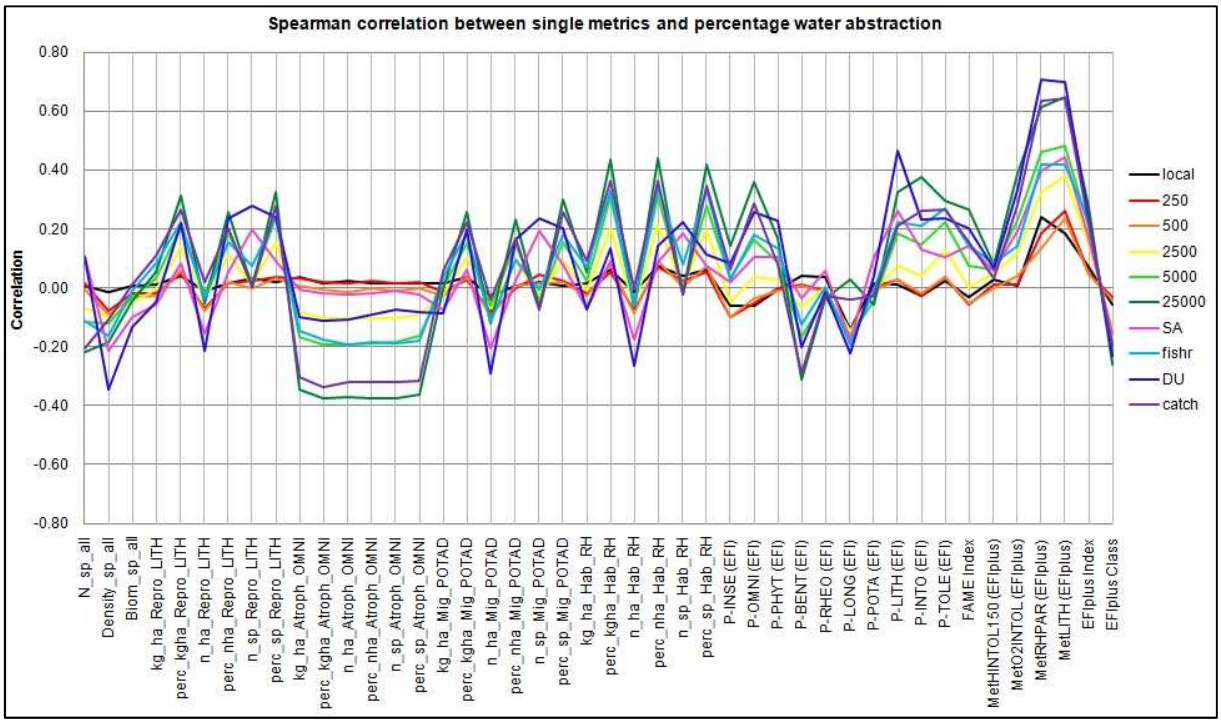


Figure 52: Spearman correlation for water abstraction and selected metrics/ indices.

5.4.5 Correlation of fish metrics and buffer length at all scales

As mentioned the number of barriers was not investigated itself since it is represented by the SA buffer. However, it might not be enough to look only at the pressures within the SA. Another important factor is the length of the SA itself. A very short SA can have a very strong influence on the present fish community, even if other pressures are absent. Therefore also the length of the SA was correlated with the single fish metrics. To be able to compare the results of the SA with the length of other scales, all buffers (except for the local scale which has no length) were separately correlated with the fish metrics. Since the Spearman correlation showed higher values only these are presented (see Figure 53). The graph for the Pearson correlation and the correlation coefficients with their significance level can be looked up in Annex D.

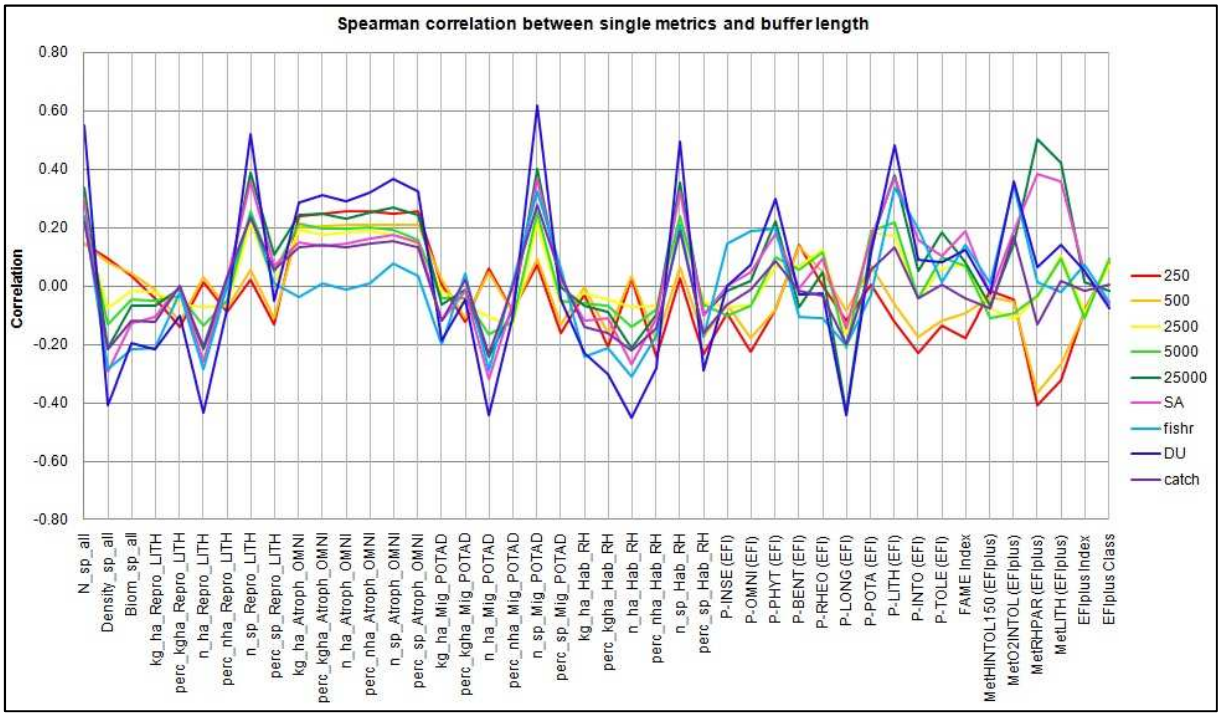


Figure 53: Spearman correlation for buffer length and selected metrics/ indices.

Although the correlations for the SA buffer length in Figure 53 include values up to 0.39 the 25000m- and DU buffer lengths show higher correlations. The total number of species as well as the number of lithophilic, omnivorous, potamodromous and rheophilic species increases while the density decreases for those guilds. Especially the lithophilic guild from the FAME Index rises with an increasing buffer length. Also the EFIplus metrics react with an increase to a high 25000m-, SA- or DU length. The influence of the SA size can be seen for some of the fish metrics although other buffer lengths show a stronger reaction. The length of the 25000m buffer can be explained by the fact that larger 25000m buffers occur where many side arms and tributaries occur thereby offering a wide habitat variability. The length of

the DU buffer reflects the position of the sample site within a catchment (upper or lower reaches). The reaction of most fish metrics might be due to their natural variability (e.g. distribution of fish regions). Since we are only interested in the SA buffer length the curve fitting was only calculated for this buffer. The result did not include high R^2 values wherefore they are not presented in this chapter (see Annex D).

5.5 Regression analyses using curve fittings

Since Spearman correlations partly resulted in higher values linear functions might not be able to explain the data distribution. Therefore five different models were used for the curve fitting. These are linear, quadratic, cubic, exponential and logistic fitting models. The last two functions could only be calculated if the fish metrics did not show negative or 0 values (see Table C.1 in Annex C). Therefore they were not calculated for all single metrics.

Curve fitting is an approach to explain the distribution of points by a model function. In our case the points are represented by sample sites with the pressure values on the x- and the fish metric values on the y-axis. SPSS© offers different kinds of model functions, as for example linear, quadratic or cubic. The results of the curve fitting per fish metric and scale are listed in Annex E. The resulting R^2 value expresses how many percent of the data distribution can be explained by each function (SPSS© INC., 2010a). In this chapter only selected fish metrics and scales with the highest R^2 values will be presented. Additionally some examples will be shown graphically.

Single fish metrics in combination with percentage of hydro peaking do not result in high R^2 values except for two EFIplus metrics (rheopar and lithophilic). Therefore this pressure won't be included in this interpretation. Although the two EFIplus metrics for cyprinid rivers (richness of rheopar and density of lithophilic species) show the highest R^2 values, there is only a small sample size behind these variables (N=85) so that included samples might not be representative for all cyprinid river segments in Austria. Furthermore the results of these two variables in combination with the catchment buffer have to be treated with high caution. The 85 sample sites are located only in 11 (out of total 63) catchments. All 11 catchments are impacted by water abstraction, 10 are impacted by impoundment whereas only 3 catchments are impacted by hydro peaking. This means that the highest R^2 values between the percentage of hydro peaking on catchment scale and the richness of rheopar species are based on only 4 percentage values for hydro peaking (inclusive 0 percent values).

5.5.1 Lithophilic guild (selected EFIplus metrics)

As it was mentioned in chapter 5.4 the lithophilic metrics decreased with an increasing morphological index value and percentage of impoundment. Furthermore they increased with increasing water abstraction. The three metrics included in Table 31 also showed higher correlation values than the other lithophilic metrics. The description of lithophilic metrics by the morphological index and the percentage of water abstraction show the highest results (R^2) at the catchment level. The curve fitting of the lithophilic metrics in combination with the percentage of impoundment shows the best results (highest R^2) at the DU scale.

The pressures of other buffers were not able to explain the distribution of these metrics and showed very low R^2 values (see Annex E). Comparing the pressures with each other regarding their ability to explain lithophilic metrics, the percentage of impoundment exceeds other pressures (see grey highlighted cells in Table 31).

Table 31: Lithophilic metrics best explained by pressures and scales (R^2 values)

	morphological index		**water abstraction**		**impoundment**		
Lithophilic metrics	DU	catch	25000	catch	25000	fishr	DU
perc_kgha_Repro_LITH							
linear	**0.10**	**0.16**	0.07	0.10	0.06	**0.14**	**0.24**
quadratic	**0.10**	**0.29**	**0.11**	**0.16**	0.07	**0.15**	**0.26**
cubic	**0.11**	**0.30**	**0.15**	**0.24**	0.08	**0.22**	**0.27**
perc_nha_Repro_LITH							
linear	0.09	**0.12**	0.07	0.07	0.04	**0.13**	**0.21**
quadratic	0.09	**0.21**	0.09	0.09	0.05	**0.13**	**0.21**
cubic	0.10	**0.22**	**0.12**	**0.16**	0.06	**0.18**	**0.22**
perc_sp_Repro_LITH							
linear	0.09	**0.14**	0.10	0.09	0.05	**0.11**	**0.17**
quadratic	0.09	**0.20**	**0.12**	**0.12**	0.05	**0.11**	**0.17**
cubic	0.10	**0.21**	**0.14**	**0.17**	0.07	**0.18**	**0.18**

The quadratic and cubic functions include higher R^2 values than the linear function. Nevertheless, the linear function is the most useful to interpret the connection between scales, pressures and fish metrics. The guild's proportion of biomass shows the highest R^2 values, followed by the proportion of species and the proportion of density.

Figure 54 shows the curve fitting of lithophilic guild's proportion of biomass in combination with the percentage of impoundment at the DU scale as an example.

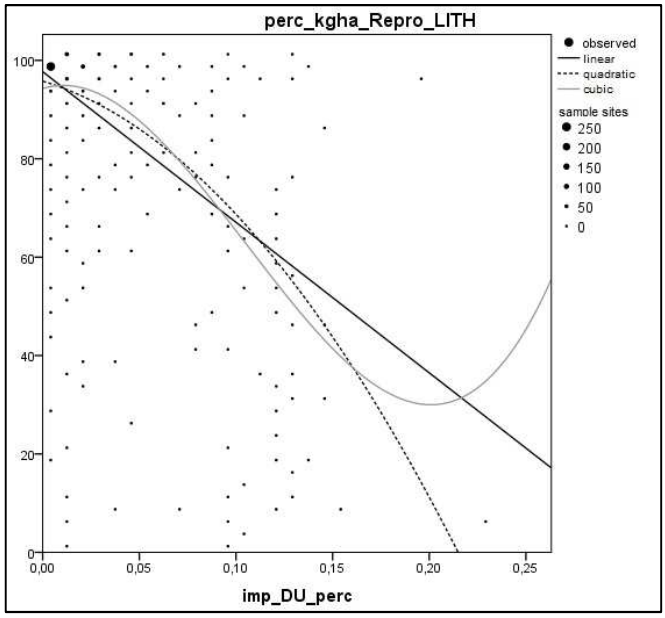


Figure 54: Curve fitting for the proportion of biomass (lithophilic guild) in combination with the percentage of impoundment at the DU scale.

Since the sample sites overlap each other in the graph, the size of the points indicates the number of sample sites behind one point. The 3 curves do not differ considerably in the shown area. Therefore the linear curve is used to explain influence of percentage impoundment on the lithophilic guild's proportion of biomass. As the percentage of impoundment increases the proportion of biomass of the lithophilic guild decreases. This means that either the biomass of other guilds increases or that the biomass of the lithophilic guild decreases.

5.5.2 Omnivorous guild (selected EFIplus metrics)

It is expected that the omnivorous guild increases with rising pressure intensity. This assumption was met for an increasing morphological index and percentage of impoundment, while the percentage of hydro peaking and water abstraction resulted in an opposite reaction of the omnivorous guild for most scales (see chapter 5.4).

Table 32: Omnivorous metrics best explained by pressures and scales (R^2 values).

	morphological index		water abstracion		impoundment		
Omnivorous metrics	DU	catch	25000	catch	25000	fishr	DU
perc_kgha_Atroph_OMNI							
linear	0.08	**0.13**	0.10	**0.10**	**0.11**	**0.12**	**0.24**
quadratic	**0.10**	**0.15**	**0.14**	**0.15**	**0.13**	**0.12**	**0.24**
cubic	**0.12**	**0.15**	**0.16**	**0.20**	**0.14**	**0.18**	**0.27**
perc_nha_Atroph_OMNI							
linear	0.07	0.09	**0.12**	0.10	0.10	**0.10**	**0.21**
quadratic	0.09	**0.10**	**0.15**	**0.14**	**0.12**	**0.10**	**0.21**
cubic	**0.11**	**0.10**	**0.18**	**0.18**	**0.13**	**0.14**	**0.23**
n_sp_Atroph_OMNI							
linear	0.08	**0.11**	**0.12**	0.10	0.10	**0.16**	**0.21**
quadratic	0.10	**0.12**	**0.17**	**0.14**	**0.11**	**0.16**	**0.21**
cubic	0.10	**0.12**	**0.20**	**0.19**	**0.12**	**0.19**	**0.21**
perc_sp_Atroph_OMNI							
linear	**0.12**	**0.13**	**0.11**	**0.10**	0.08	**0.12**	**0.21**
quadratic	**0.13**	**0.16**	**0.14**	**0.15**	0.09	**0.12**	**0.21**
cubic	**0.13**	**0.16**	**0.17**	**0.20**	0.10	**0.15**	**0.21**

Table 32 presents omnivorous metrics in combination with pressures at different spatial scales showing the highest R^2 values of conducted analyses. The catchment buffer seems best suitable for explaining the influence of morphological index on the omnivorous guild. For water abstraction the 25000m buffer seems more applicable while impoundment again shows the highest R^2 values for the DU scale. Once again the percentage of impoundment seems to have the highest influence on the omnivorous guild (see grey highlighted cells in Table 32). The values for linear, quadratic and cubic curve fittings are similar, especially for impoundment at the DU scale. Figure 55 exemplary visualizes the connection between the omnivorous guild's biomass proportion and the percentage of impoundment at the DU scale.

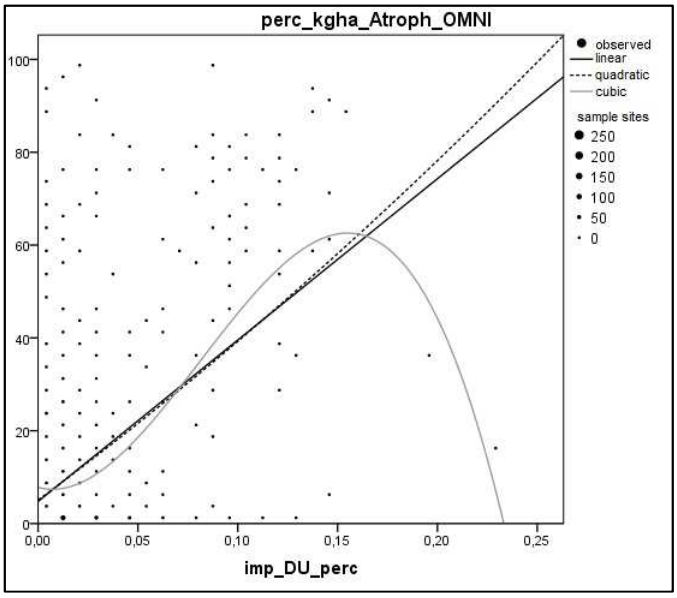


Figure 55: Curve fitting for the proportion of biomass (omnivorous guild) in combination with the percentage of impoundment at the DU scale.

Although the cubic function in Figure 55 has the highest R^2 value this curve is not reasonable, since it is not assumed that the percentage of biomass of the omnivorous guild declines again at higher percentages of impoundment. This assumption could maybe be correct for the total biomass of this guild.

5.5.3 Rheophilic guild (selected EFIplus metrics)

Also for the rheophilic guild the proportion of biomass, number of species and density include the highest values (R^2). Again the metrics decrease with an increasing morphological index and percentage of impoundment and increase with an increasing percentage of hydro peaking and water abstraction (see chapter 5.4). Table 33 shows the mentioned fish metrics in combination with the most explanatory pressures and scales. Again the highest R^2 values occur for the percentage of impoundment at the DU scale, whereby the variability of the guild's proportion of species can be explained up to 30 percent (see Table 33) by the linear function. This example is also shown in Figure 56.

Table 33: High R^2 values for rheophilic metrics and pressures (R^2 values).

	morphological index		**water abstracion**		**impoundment**		
Rheophilic metrics	DU	catch	25000	catch	25000	fishr	DU
perc_kgha_Hab_RH							
linear	0.04	**0.11**	0.09	0.09	0.10	**0.20**	**0.24**
quadratic	0.05	**0.15**	**0.14**	**0.14**	0.10	**0.20**	**0.25**
cubic	0.07	**0.15**	**0.17**	**0.20**	**0.11**	**0.24**	**0.30**
perc_nha_Hab_RH							
linear	0.06	**0.14**	0.10	**0.10**	**0.10**	**0.22**	**0.30**
quadratic	0.07	**0.19**	**0.15**	**0.16**	**0.10**	**0.22**	**0.30**
cubic	0.10	**0.19**	**0.20**	**0.23**	**0.13**	**0.29**	**0.36**
perc_sp_Hab_RH							
linear	0.08	**0.16**	**0.13**	**0.12**	**0.11**	**0.21**	**0.23**
quadratic	0.09	**0.20**	**0.18**	**0.17**	**0.11**	**0.21**	**0.24**
cubic	**0.10**	**0.20**	**0.22**	**0.23**	**0.13**	**0.28**	**0.26**

Although the cubic function once more includes the highest R^2 it is not very likely that the species density of this guild will increase again at higher percentages of impoundment.

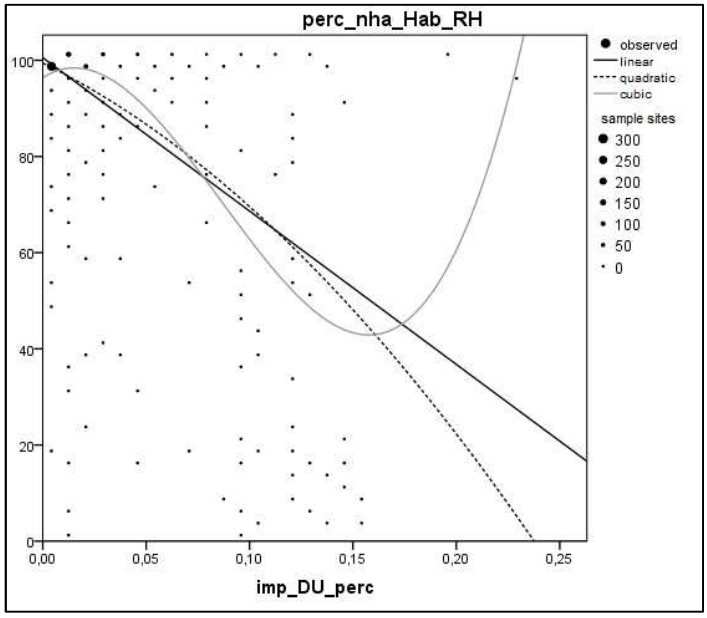


Figure 56: Curve fitting for the proportion of species (rheophilic guild) in combination with the percentage of impoundment at the DU scale.

5.5.4 FAME metrics

The FAME metrics to be best explained by the pressures are the relative abundance of lithophilic species, the relative number of intolerant and tolerant species as well as the FAME Index itself. The expected decrease of these metrics with increasing pressure can only be seen for the morphological index and the percentage of impoundment. The opposite reaction can be seen by a rising percentage of hydro peaking or water abstraction which leads to an increase of these metrics. For the morphological index the catchment buffer represents the most suitable scale to explain the variability of the metrics. While the percentage of water abstraction of the DU buffer shows the highest values for the lithophilic metric, the metrics of intolerant and tolerant species as well as the FAME Index react stronger at the 25000m buffer. For impoundment again the DU buffer includes the highest R^2 values.

Table 34: FAME metrics best explained by pressures and scales (R^2 values).

	morphological index		water abstraction			impoundment		
FAME Index metrics	DU	catch	25000	DU	catch	25000	fishr	DU
P-LITH (EFI)								
linear	0.06	**0.16**	**0.11**	**0.14**	0.08	0.03	0.04	**0.17**
quadratic	**0.11**	**0.24**	**0.15**	**0.22**	**0.13**	0.03	0.05	**0.20**
cubic	**0.15**	**0.24**	**0.18**	**0.23**	**0.17**	0.06	**0.14**	**0.26**
exponential	**0.12**	**0.15**	0.08	0.07	0.10	0.03	0.08	**0.20**
logistic	**0.12**	**0.15**	0.08	0.07	0.10	0.03	0.08	**0.20**
P-INTO (EFI)								
linear	0.07	**0.15**	**0.12**	0.06	0.08	0.05	0.04	**0.15**
quadratic	0.08	**0.16**	**0.14**	0.06	0.10	0.08	0.04	**0.16**
cubic	0.10	**0.17**	**0.16**	0.07	**0.12**	0.08	0.07	**0.18**
exponential	**0.11**	**0.19**	**0.12**	0.07	**0.11**	0.06	0.07	**0.19**
logistic	**0.11**	**0.19**	**0.12**	0.07	**0.11**	0.06	0.07	**0.19**
P-TOLE (EFI)								
linear	0.06	**0.13**	0.09	0.04	0.10	0.06	**0.14**	**0.17**
quadratic	0.06	**0.19**	**0.13**	0.06	**0.16**	0.06	**0.14**	**0.18**
cubic	0.08	**0.19**	**0.17**	0.07	**0.22**	**0.11**	**0.23**	**0.22**
exponential	0.08	**0.19**	0.08	0.04	0.10	0.10	**0.18**	**0.22**
logistic	0.08	**0.19**	0.08	0.04	0.10	0.10	**0.18**	**0.22**
EFI-Index								
linear	0.09	**0.16**	0.05	0.04	0.05	0.08	0.08	**0.18**
quadratic	**0.11**	**0.21**	**0.11**	0.07	0.10	0.08	0.09	**0.19**
cubic	**0.15**	**0.21**	**0.16**	0.08	**0.15**	**0.10**	**0.16**	**0.21**
exponential	**0.11**	**0.17**	0.06	0.04	0.06	0.09	0.09	**0.20**
logistic	**0.11**	**0.17**	0.06	0.04	0.06	0.09	0.09	**0.20**

The highest R^2 value for the linear curve fitting occurs for the FAME Index in combination with the percentage of impoundment at the DU scale. This example is given in Figure 57.

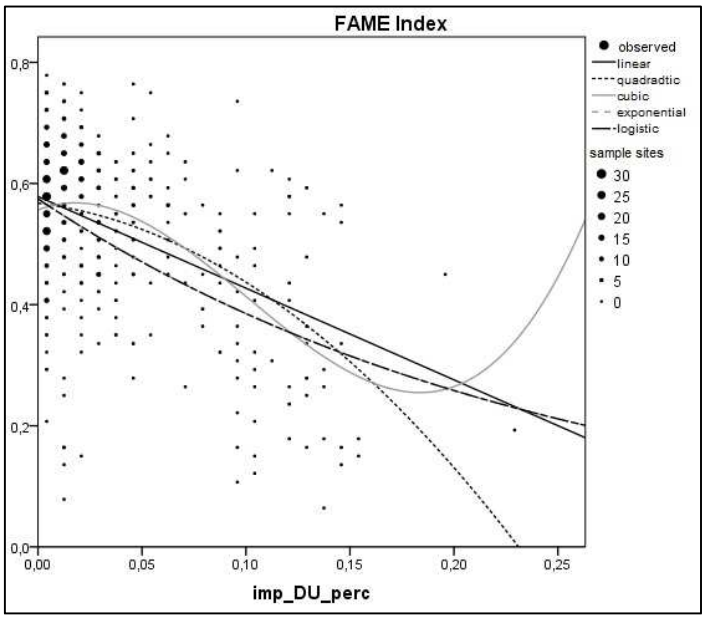


Figure 57: Curve fitting for the FAME Index (EFI Index) in combination with the percentage of impoundment at the DU scale.

Again the cubic function shows the highest R^2 value where the Index seems to increase again after a special percentage of impoundment is reached. This curve reflects an unlikely reaction and is therefore not taken into account. Therefore it is expected that the FAME Index decreases with an increasing percentage of impoundment at the DU scale.

5.5.5 EFIplus metrics

As mentioned at the beginning of this chapter (chapter 5.5) the R^2 values of the EFIplus metrics (rheopar and lithophilic guild) in combination with the catchment scale have to be treated with caution. Therefore they are printed and highlighted grey in Table 35. Nevertheless these fish metrics can best be explained by the below listed pressures and scales. The morphological index of the catchment scale is able to explain nearly 50 percent of the rheopar guild, while the DU buffer is better suitable to describe the variation of the lithophilic guild. The R^2 values for water abstraction are similar for the DU and catchment buffer. Finally the percentage of impoundment in the fish region seems to have a high influence on the rheopar guild.

Table 35: EFIplus metrics best explained by pressures and scales (R^2 values).

	morphological index		**water abstraction**			**impoundment**		
EFIplus Index	DU	catch	25000	DU	catch	25000	fishr	DU
MetRHPAR (EFIplus)								
linear	**0.15**	0.46	**0.24**	**0.26**	0.27	**0.31**	**0.39**	**0.21**
quadratic	**0.30**	0.47	**0.30**	**0.39**	0.46	**0.33**	**0.42**	**0.22**
cubic	**0.30**	0.47	**0.33**	**0.43**	0.49	**0.48**	**0.55**	**0.38**
exponential	0.08	0.34	**0.15**	**0.17**	0.20	**0.25**	**0.32**	**0.18**
logistic	0.08	0.34	**0.15**	**0.17**	0.20	**0.25**	**0.32**	**0.18**
MetLITH (EFIplus)								
linear	**0.41**	0.38	**0.29**	**0.30**	0.34	**0.12**	**0.22**	**0.25**
quadratic	**0.46**	0.41	**0.39**	**0.39**	0.43	**0.13**	**0.23**	**0.31**
cubic	**0.46**	0.40	**0.43**	**0.44**	0.45	**0.26**	**0.34**	**0.39**

Figure 58 and Figure 59 show the influence of the morphological index on the rheopar and the lithophilic EFIplus Index metrics at the catchment and the DU scale.

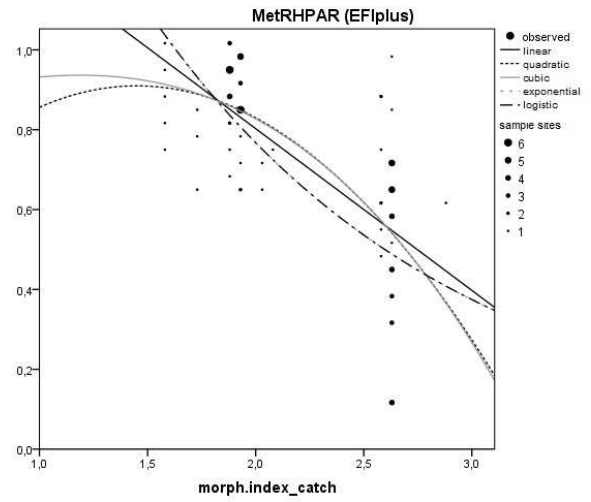


Figure 58: Curve fitting for the rheopar EFIplus metric and the morphological Index at the catchment scale.

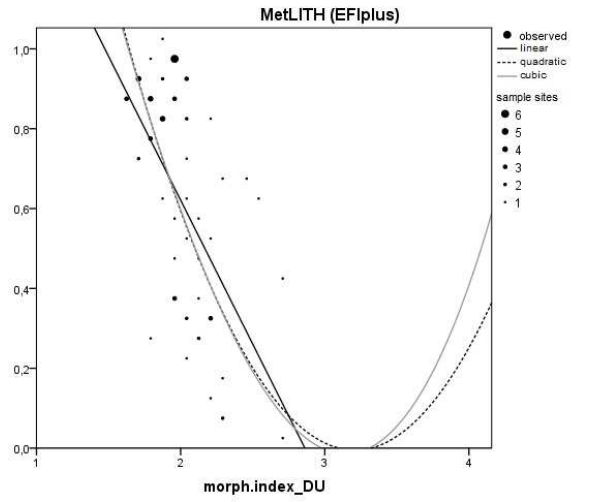


Figure 59: Curve fitting for the lithophilic EFIplus metric and the morphological Index at the DU scale.

Since the linear, quadratic and cubic function do not highly differ the linear curve is used for the interpretation. The two metrics seem to decrease with in increasing morphological index at the DU- or catchment scale.

Figure 60 and Figure 61 show the same fish metrics but in combination with the percentage of impoundment (fish region) and the percentage of water abstraction (DU scale). As mentioned before an increase in percentage of water abstraction seems to induce an increase for the EFIplus metrics (see rising curve in Figure 61).

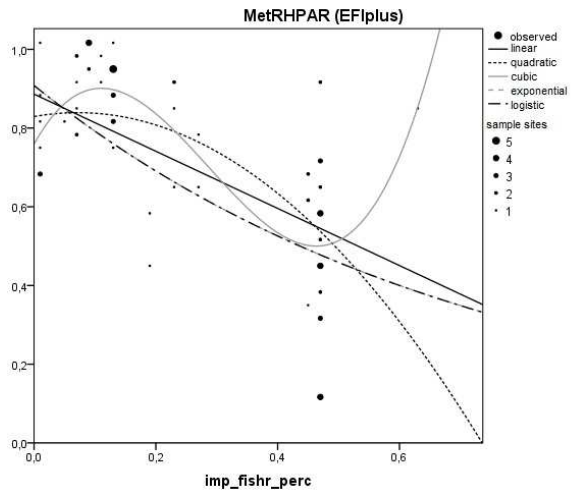


Figure 60: Curve fitting for the rheopar EFIplus metric and the percentage of impoundment at the fish region scale.

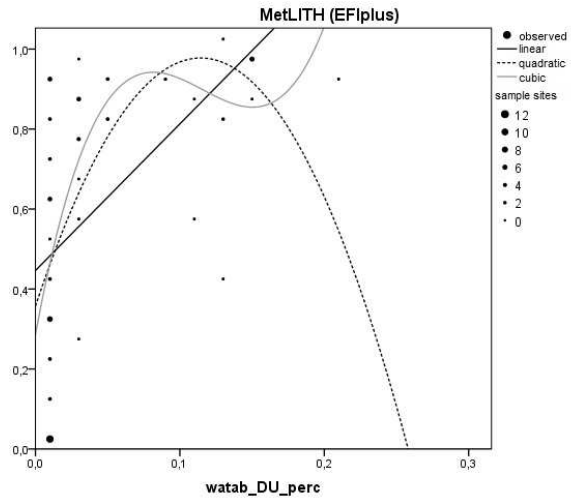


Figure 61: Curve fitting for the lithophilic EFIplus metric and the percentage of water abstraction for the DU scale.

5.6 Threshold analyses for impacted vs. unimpacted sites

The threshold analysis was performed to evaluate a percentage threshold per pressure and scale above which a significant influence on the fish population occurs. To do so the Mann-Whitney U test was used. The sample sites had to be divided into two groups whereby one group represented unimpacted sample sites and one group impacted sample sites. This was done for each combination of scale, pressure and single fish metric.

The Mann-Whitney U test is a nonparametric test to investigate if two independent samples belong to the same population e.g. if they are homogenous and show the same distribution (SPSS INC., 2010a).

The null hypothesis is:

H_0 = the two groups have the same fish metric distribution and therefore belong to the same population.

At the beginning sample sites were divided into two groups whereby sites with a morphological index of 1 were rated as unimpacted, while sites with a morphological index above 1 were rated as impacted. These two groups were defined for each scale and then tested with the Mann-Whintey U test to see if they differ or not. In a second step the groups were redefined whereby the unimpacted group included morphological index values between 1 and 2 while the impacted group contained all other sites (with morphological index > 2).

Again the Mann-Whitney test was done for each scale separately. Two more thresholds were used to define the groups (see Table 36).

Table 36: Thresholds (morphological index) for the group classification used for the Mann-Whitney U test.

test	morphological index of group 1	morphological index of group 2
Test 1	1	> 1
Test 2	1 – 2	> 2
Test 3	1 – 3	> 3
Test 4	1 – 4	> 4

The results of these tests are shown in Table F.1 in Annex F. The same calculations were done for sample sites with a high reliable morphological index (see Table F.3 in Annex F).

To investigate a suitable threshold for each scale the number of single metrics with high significance (e.g. rejection of H_0) were compared among the different analyses.

A significant difference between defined groups 1 and 2 occurs at listed scales in Table 37.

Table 37: Investigated thresholds of morphological index per scale.

scales	group 1	group 2	threshold
local, 250m, 500m	morphological index = 1	morphological index > 1	~ 1
2500m, 5000m, SA, fish region, DU, catch	morphological index = 1 – 2	morphological index > 2	~ 2
25000m	morphological index = 1 – 3	morphological index > 3	~ 3

The same analyses were made for the percentages of hydro peaking, impoundment and water abstraction whereby the groups were defined as shown in Table 38.

Table 38: Thresholds (percent hydro peaking, impoundment and water abstraction) for the group classification used for the Mann-Whitney U test.

test	pressure percentage of group 1	pressure percentage of group 2
Test 1	0	> 0
Test 2	0 – 10	> 10
Test 3	0 – 20	> 20
Test 4	0 – 30	> 30

The most suitable threshold per buffer and pressure is listed in Table 39.

Table 39: Investigated thresholds for impoundment, hydro peaking and water abstraction per scale.

impoundment	group 1	group 2	threshold
catchment	threshold is expected to be between 0 and 10 % and can't be detected by the		
2500m, 5000m, 25000m, SA, DU	0 – 10 % impoundment	> 10 % impoundment	~ 10 %
500m, fish region	0 – 20 % impoundment	> 20 % impoundment	~ 20 %
local, 250 m	no difference	-	-
hydro peaking			
25000m, fish region, DU, catchment	0 % hydro peaking	> 0 % hydro peaking	~ 0 %
5000m, SA, (fish region)	0 - 10 % hydro peaking	> 10 % hydro peaking	~ 10 %
2500m, 250m, 500m	0 - 30 % hydro peaking	> 30 % hydro peaking	~ 30 %
local	no difference	-	-

water abstraction			
SA	0 % water abstraction	> 0 % water abstraction	~ 0 %
2500m, 5000m, fish region, DU, catchment	0 - 10 % water abstraction	> 10 % water abstraction	~ 10 %
500m, 2500m	0 – 20 % water abstraction	> 20 % water abstraction	~ 20 %
250 m	0 – 30 % water abstraction	> 30 % water abstraction	~ 30 %
local	no difference	-	-

Of course the thresholds are only an approximation since their classes are roughly defined. The thresholds can also differ between single metrics (see Annex F). Nevertheless it can be seen that the threshold is lower for larger scales (DU, catchment, 25000m) and higher for smaller scales. Since the local scale shows either 0 or 100 percent of a pressure the tested groups are not able to detect a threshold for this scale.

5.7 Decision trees

Since all previous analyses were made separately for each pressure group the decision trees are an attempt to explain the characteristics of FAME Index and EFIplus Index by combined pressures. The decision tree classifies cases into groups, whereby values of dependent variables (e.g. FAME- and EFIplus Index) are predicted by independent variables (in this case pressures) (SPSS Inc., 2010b). Two analyses were made for each scale, whereby the first explains the FAME Index and the second the EFIplus Index. The input data consisted of previous discussed pressures (morphological index, hydro peaking, impoundment and water abstraction) and the total number of impassable barriers per buffer. For the SA buffer also the SA length was included. Exhaustive CHAID was used as growing method with 50 parent and 30 child nodes. As an expected result, higher percentages of a pressure, a higher number of impassable barriers and a higher morphological index should lead to a decrease of both, the FAME- and the EFIplus Index. The tree starts to divide the data using the most explaining variable until all data are assigned to a branch or no explaining variables are left.

In addition to decision trees, box plot showing the FAME- and EFIplus Index for each pressure combination are created. Since not all pressure combinations are present at each scale only the occurring combinations are shown. Each sample site was given a label for each buffer, reflecting the occurring pressures. Table 40 decodes the used labels.

Table 40: Decoding of pressure labels.

number of pressures	label	impoundment 1000	water abstraction 100	hydro peaking 10	impoundment 1
0	0				
1	1				x
	10			x	
	100		x		
	1000	x			
2	11			x	x
	101		x		x
	110		x	x	
	1001	x			x
	1010	x		x	
	1100	x	x		
3	111		x	x	x
	1011	x		x	x
	1101	x	x		x
	1110	x	x	x	
4	1111	x	x	x	x

As Table 40 shows, each pressure was given a number. If two pressures occurred in a buffer of the same sample site the numbers of these two pressures were summed up. For instance, if a sample site is impacted by hydro peaking (10) and impoundment (1000) it is coded as 1010 (10 + 1000).

A sample site was rated as impacted by a pressure if the buffer showed a percentage above 0. It was rated as morphologically impacted if the morphological index was higher than 2. Barriers were not included in the pressure combination since they are present for most scales anyway and the resulting number of codes would be too high.

Figure 62 shows the percentage of sample sites with 0 or 1 to 4 pressures per buffer. The data base on 800 sample sites with an available FAME Index. The distribution of the sample sites with available EFIplus Index (597) is very similar and was therefore not included. As it can be seen sample sites with no or 1 pressure decrease while sample sites with 2 or more pressures increase with increasing buffer size.

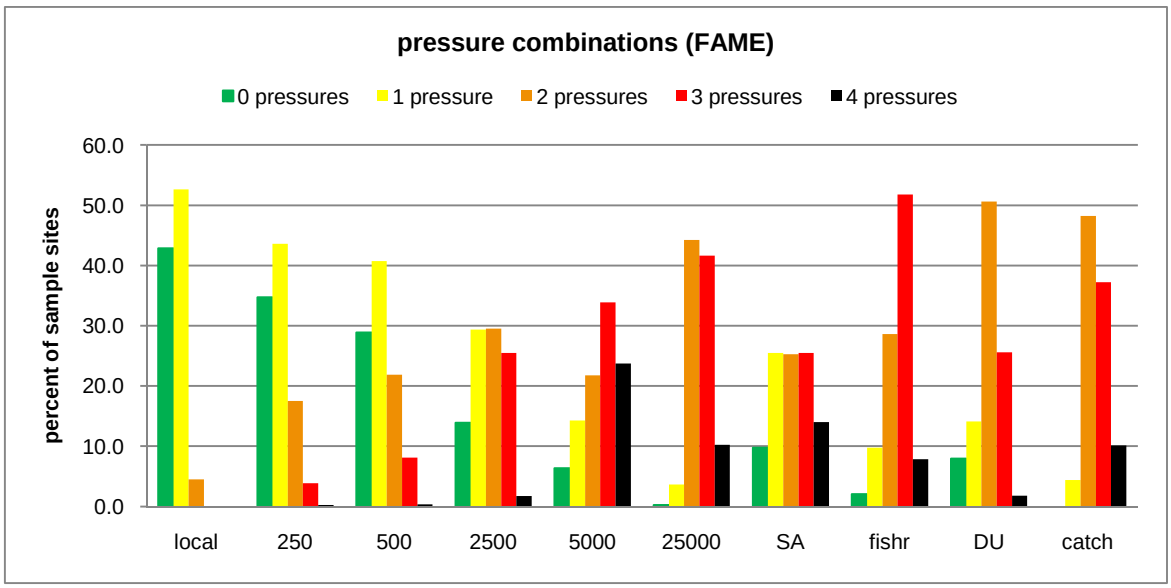


Figure 62: Percentage of sample sites with 0, 1, 2, 3 or 4 pressures per buffer (for sites with available FAME Index)

5.7.1 Decision trees for the local scale

The box-plots in Figure 63 and Figure 64 show the FAME- and EFIplus Index for pressure combinations at the local scale. As it can be seen, label 1 (impoundment) and label 101 (impoundment and water abstraction) show the lowest values for both, FAME- and EFIplus Index. Sample sites with no pressures do not show the highest FAME or EFIplus Index, as it might be expected.

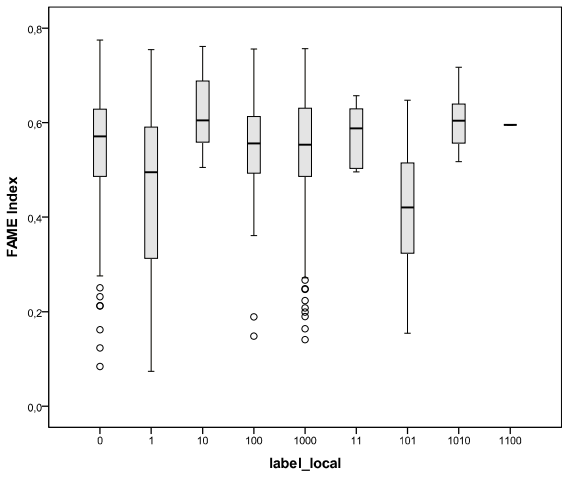


Figure 63: Box-plots showing the FAME Index for pressure combinations at local scale.

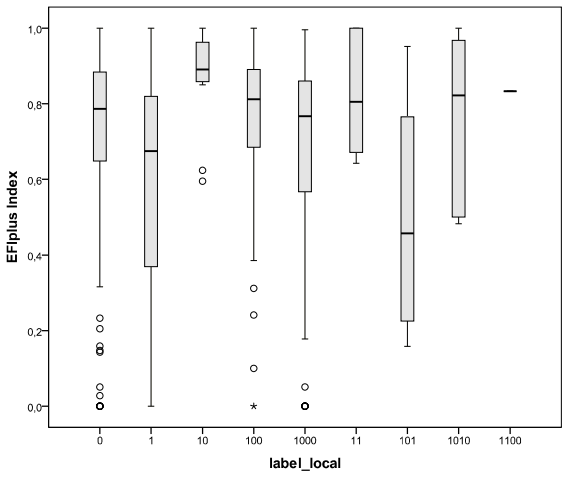


Figure 64: Box-plots showing the EFIplus Index for pressure combinations at local scale.

Figure 65 (left side) shows the decision tree for the FAME Index on the local scale. Here sample sites with a percentage impoundment exceeding 0 have the lowest FAME Index (0.457). Sites with 0 percent of impoundment are further divided in sites with a morphological index below or above 3. Other pressures (hydro peaking, water abstraction) seem to have no significant influence and were not included in the graph. The conclusion drawn by this figure is that sites with no impoundment and a morphological index below 3 show the highest FAME Index (0.557). Nevertheless the predicted FAME Indices hardly differ from each other and belong to the same FAME class (i.e. “good”).

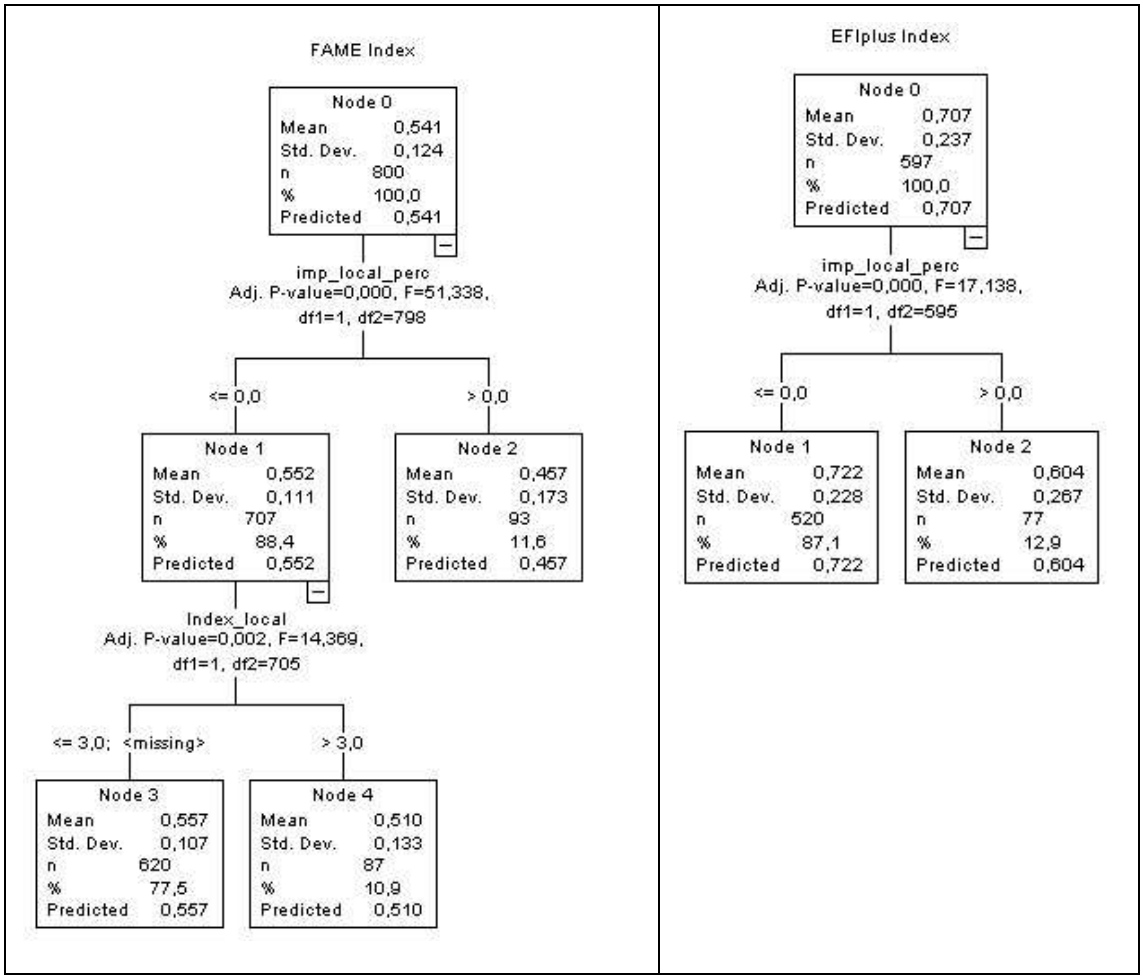


Figure 65: Decision trees for FAME- and EFIplus Index at local scale.

The decision tree for the EFIplus Index at the local scale (Figure 65, right side) only differentiates between sample sites with and without impoundment. Sites without impoundment show the highest EFIplus Index (0.722).

5.7.2 Decision trees for the 250m scale

For the 250m scale the lowest FAME Index can be found for the label 1001 (morphological impact and impoundment, see Figure 66) while the lowest EFIplus Index occurs at label 1

(impoundment, see Figure 67). Again the highest values do not occur at unimpacted sites while the lowest values are not to be found at sites with all impacts (1111).

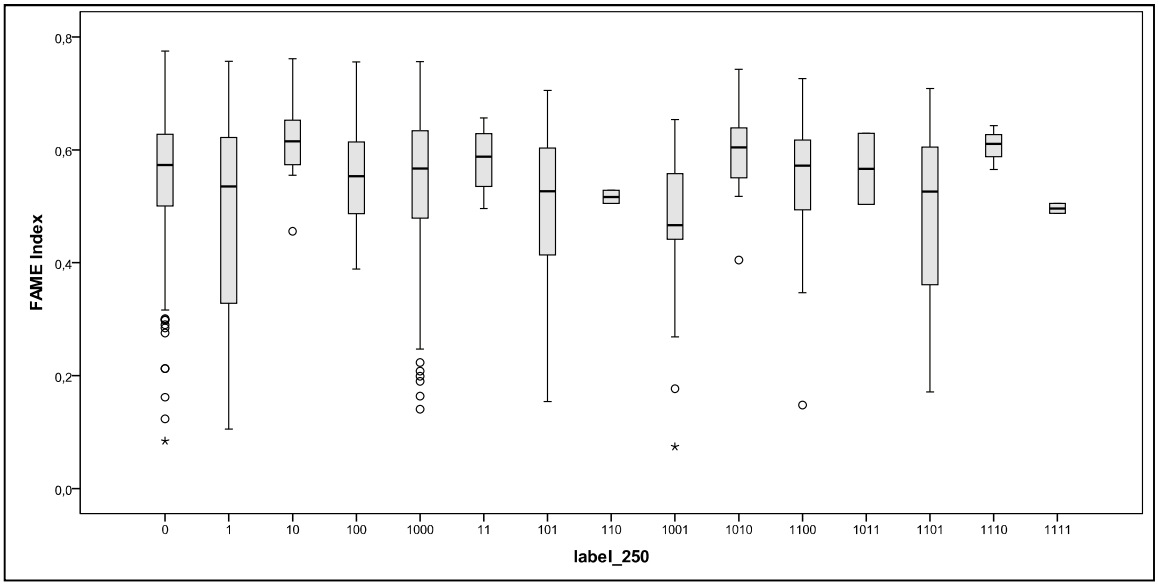


Figure 66: Box-plots showing the FAME Index for pressure combinations at 250m scale.

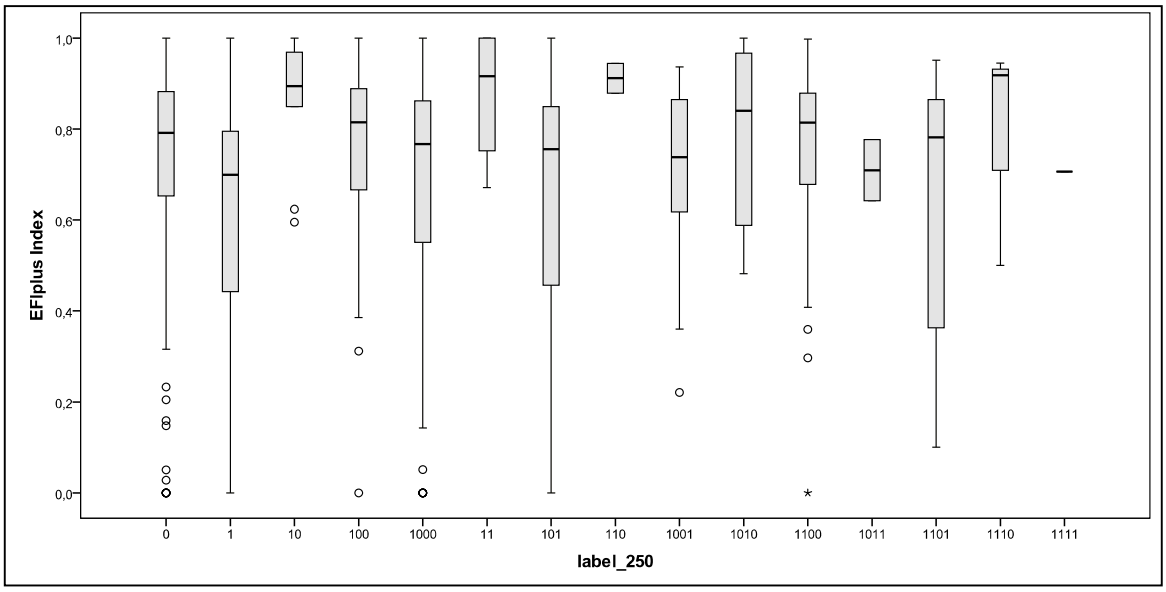


Figure 67: Box-plots showing the EFIplus Index for pressure combinations at 250m scale.

Figure 68 shows the decision trees for the FAME- and EFIplus Index at the 250m scale. The FAME Index starts to divide the sites by the percentage of impoundment (more or less than 40%). Sites with less than 40 percent impoundment are further divided by the morphological index (~4), whereby sites with a morphological index smaller than 4 are again divided by sites impacted or unimpacted by impoundment (threshold = 0%). As expected sites with a

low morphological index and not impacted by impoundment have the highest FAME Index (0.560 = “good” status). Sites with more than 40 percent impounded length have a FAME Index of 0.447 and therefore are fall dedicated to the “moderate” category.

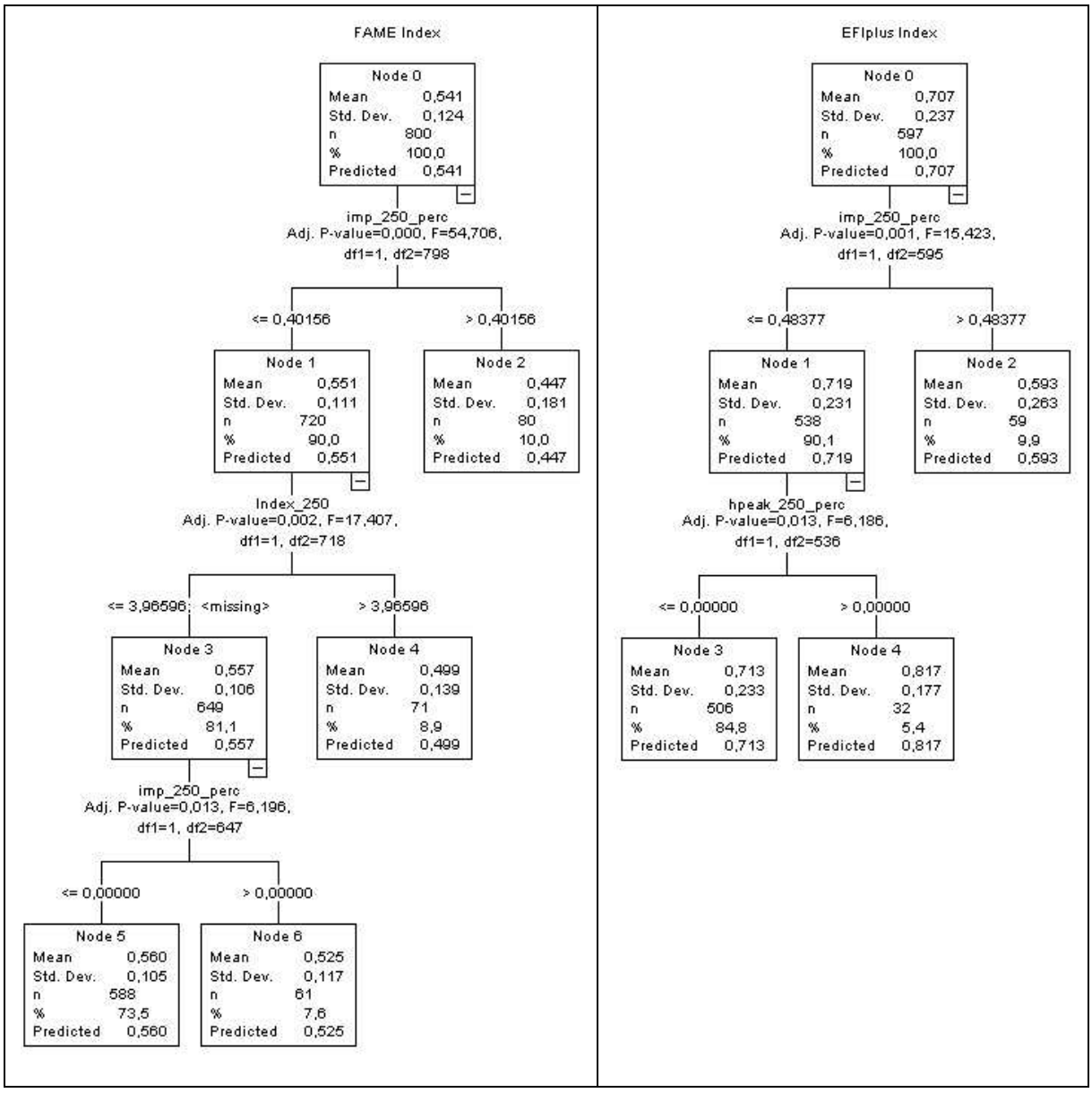


Figure 68: Decision trees for FAME und EFIplus Index at 250m scale.

Also the decision tree for the EFIplus Index starts to divide the sample sites by the percentage of impoundment (threshold = 48%). Sites with more than 48 percent impoundment have an EFIplus Index of 0.593. Sample sites with less than 48 percent impounded length are further divided in sites impacted by hydro peaking (>0% hydro peaking) and unimpacted sites (=0% hydro peaking). As mentioned before hydro peaking seems to increase the EFIplus Index, wherefore sites impacted by hydro peaking have a higher EFIplus Index (0.817) than unimpacted sites (0.713).

5.7.3 Decision trees for the 500m scale

As it can be seen in Figure 69 the lowest FAME Index can be found for the pressure combinations 1001 (morphological impact and impoundment) and 1111 (all pressures). All other pressure combinations do not show high differences.

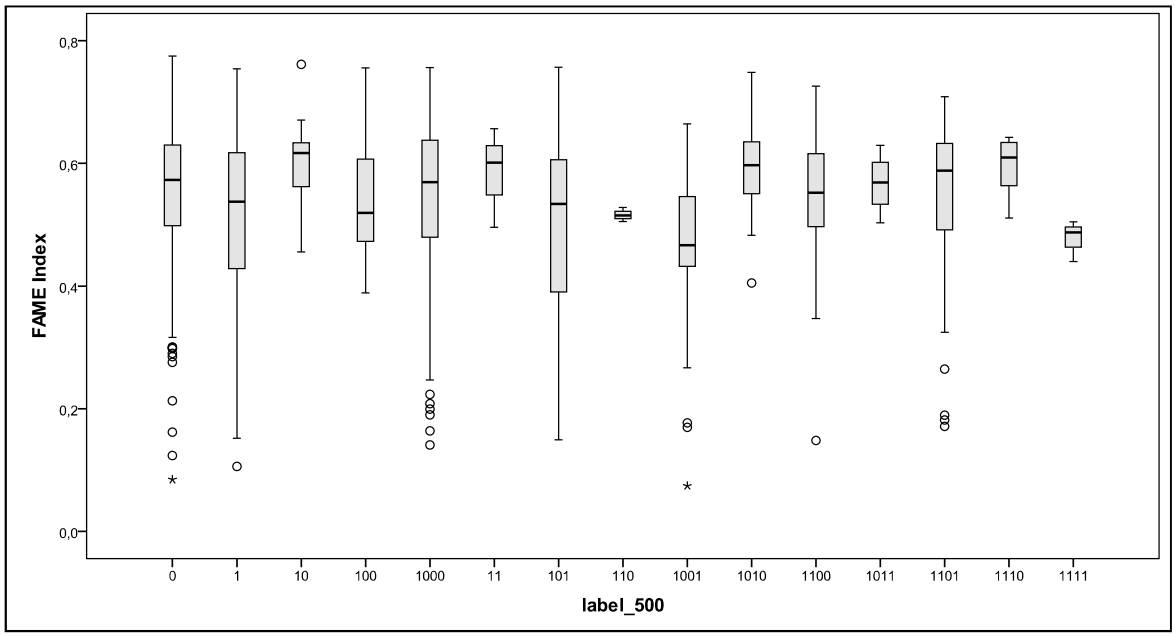


Figure 69: Box-plots showing the FAME Index for pressure combinations at 500m scale.

Figure 70 shows the dicision tree for the FAME Index at the 500m scale. The sample sites are again divided by the percentage of impounded length (threshold = 35%) the morphological index (threshold = 3.8%) and then once more by the percentage of impoundment (threshold = 9%). Sample sites with more than 35 percent of impounded length show the lowest FAME Index (0.441) and are rated as “moderate”. Although sites with a morphological index lower than 3.8 and less than 9 percent impoundment have the highest FAME Index (0.560) they belong to the same status class (i.e. “good”) as sites with an higher morphological index and more than 9 percent (but less than 35 %) impoundment.

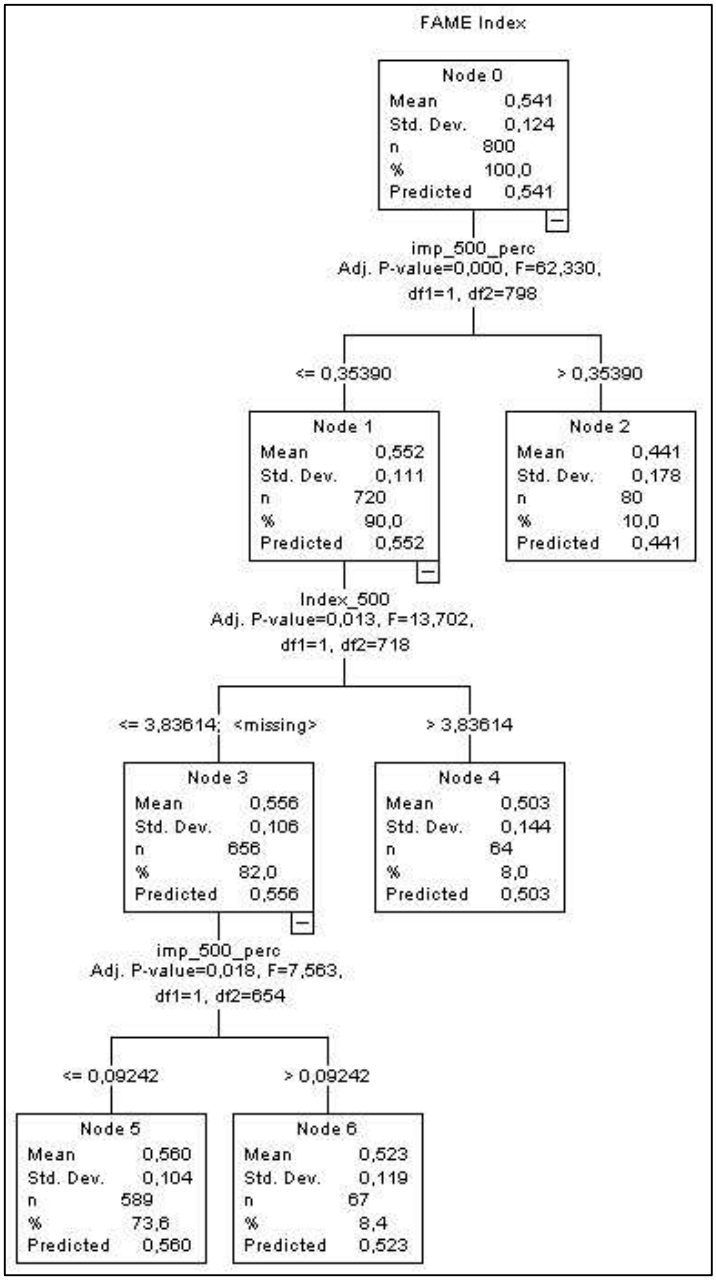


Figure 70: Decision tree for FAME Index at 500m scale.

As it is shown in Figure 71, also the EFIplus Index has its lowest value at labels 1001 (morphological impact and impoundment) and 1111 (all pressures) as well as 1110 (morphological impact, hydro peaking, water abstraction). It is also noticeable that the highest EFIplus Index occurs at label 110 (hydro peaking and water abstraction).

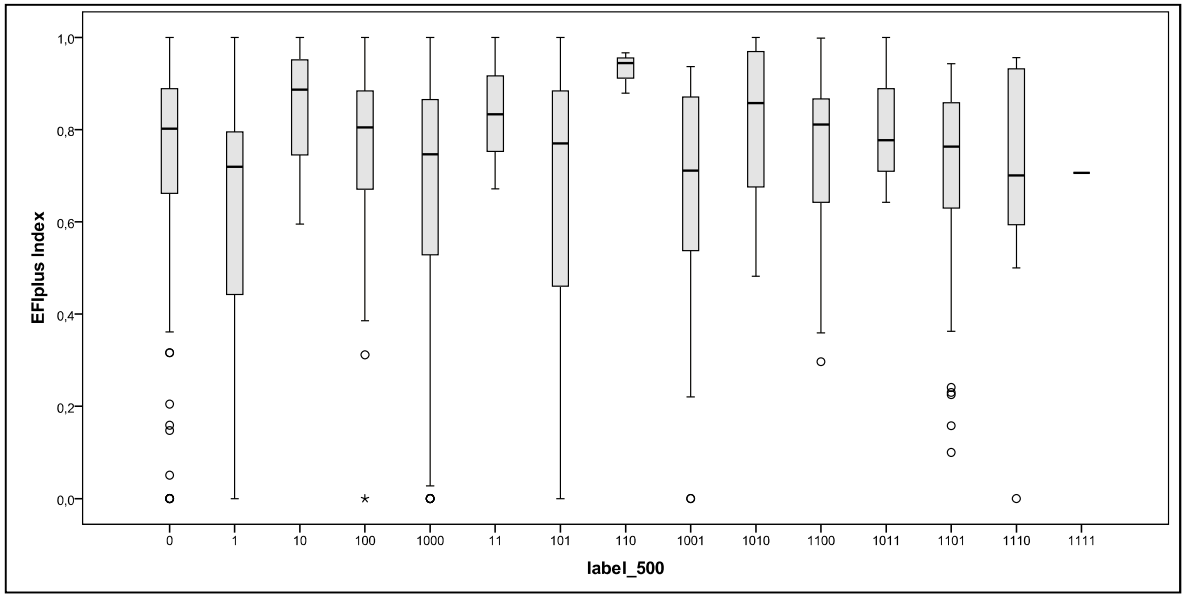


Figure 71: Box-plots showing the EFIplus Index for pressure combinations at 500m scale.

The decision tree for the EFIplus Index is given in Figure 72. The tree starts to divide the sample sites into 4 categories with different percentages of impoundment. Sites with no impoundment are further split up in sites with hydro peaking (> 0 %) or without hydro peaking (0%). Again it is noticeable that sample sites impacted by hydro peaking have the highest EFIplus Index (0.795) while sites with no hydro peaking show a lower value (EFIplus Index = 0.713).

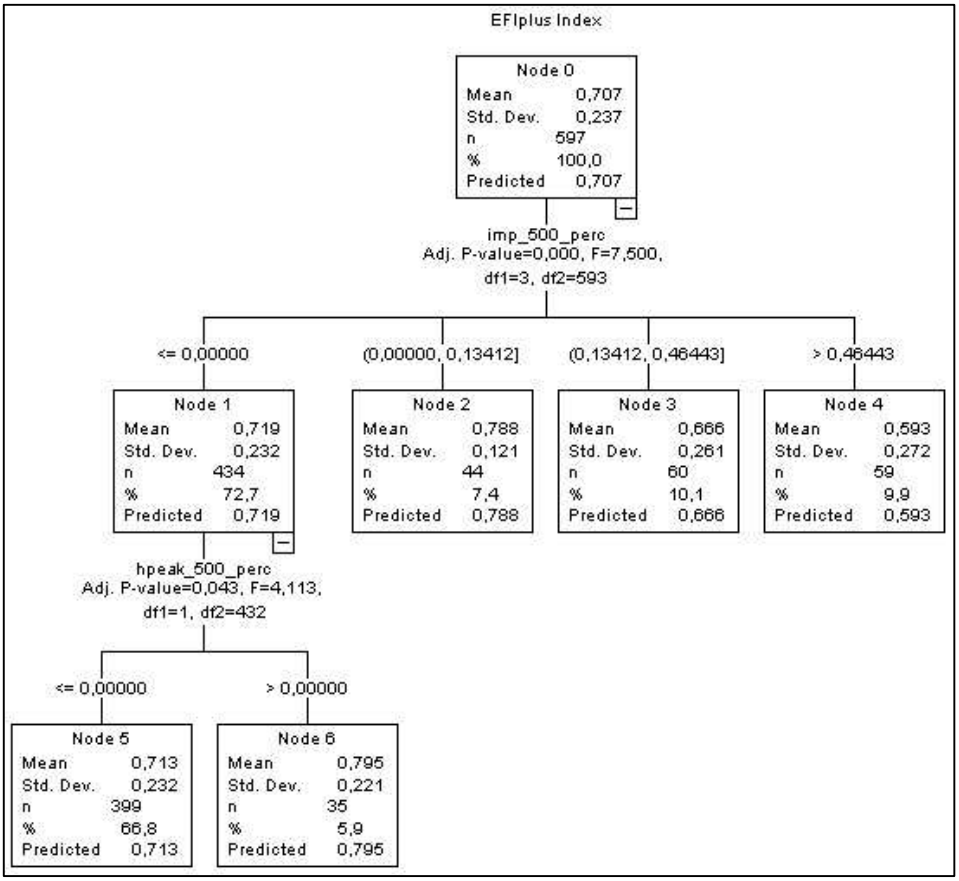


Figure 72: Decision tree for EFIplus Index at 500m scale.

5.7.4 Decision trees for the 2500m scale

Also the 2500m scales indicate the lowest FAME Index (Figure 73) for the labels 1001 (morphological index and impoundment) and 1111 (all pressures) while all other pressure combinations show similar medians.

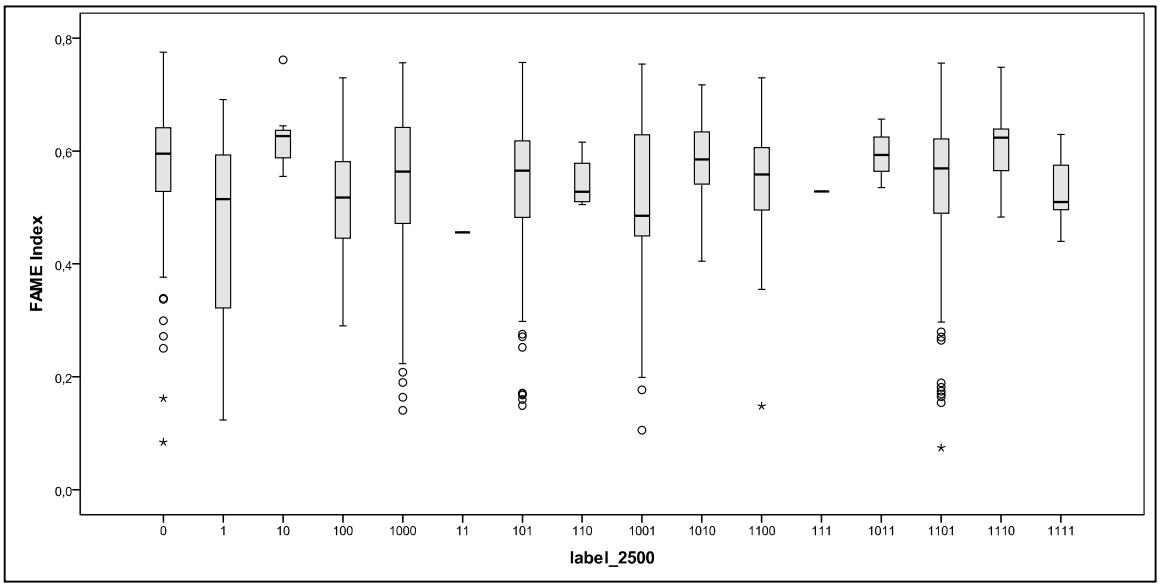


Figure 73: Box-plots showing the FAME Index for pressure combinations at 2500m scale.

The decision tree for the FAME Index at the 2500m scale (see Figure 74) includes all pressure groups (except for the number of impassable barriers). The division of the sample sites again starts with the percentage of impounded length (<5%, 5 to 27% and >27%). Sites with more than 27 percent impoundment within the scale have the lowest FAME Index (0.446) and fall into status class “moderate”. All other combinations fall into status class “good” (0.449 – 0.669). Sites with less than 27 but more than 5 percent impoundment are further divided by the percentage of water abstraction (<3%, 3 to 13% and >13%). A rising percentage of water abstraction also seems to increase the FAME Index, wherefore the branch with the highest percentage of water abstraction shows the highest FAME Index (0.580). Sites with less than 5 percent impoundment are further divided by the morphological index (threshold = 3.4) and hydro peaking. Again the sample sites impacted by hydro peaking (>0%) have a higher FAME Index than unimpacted sites.

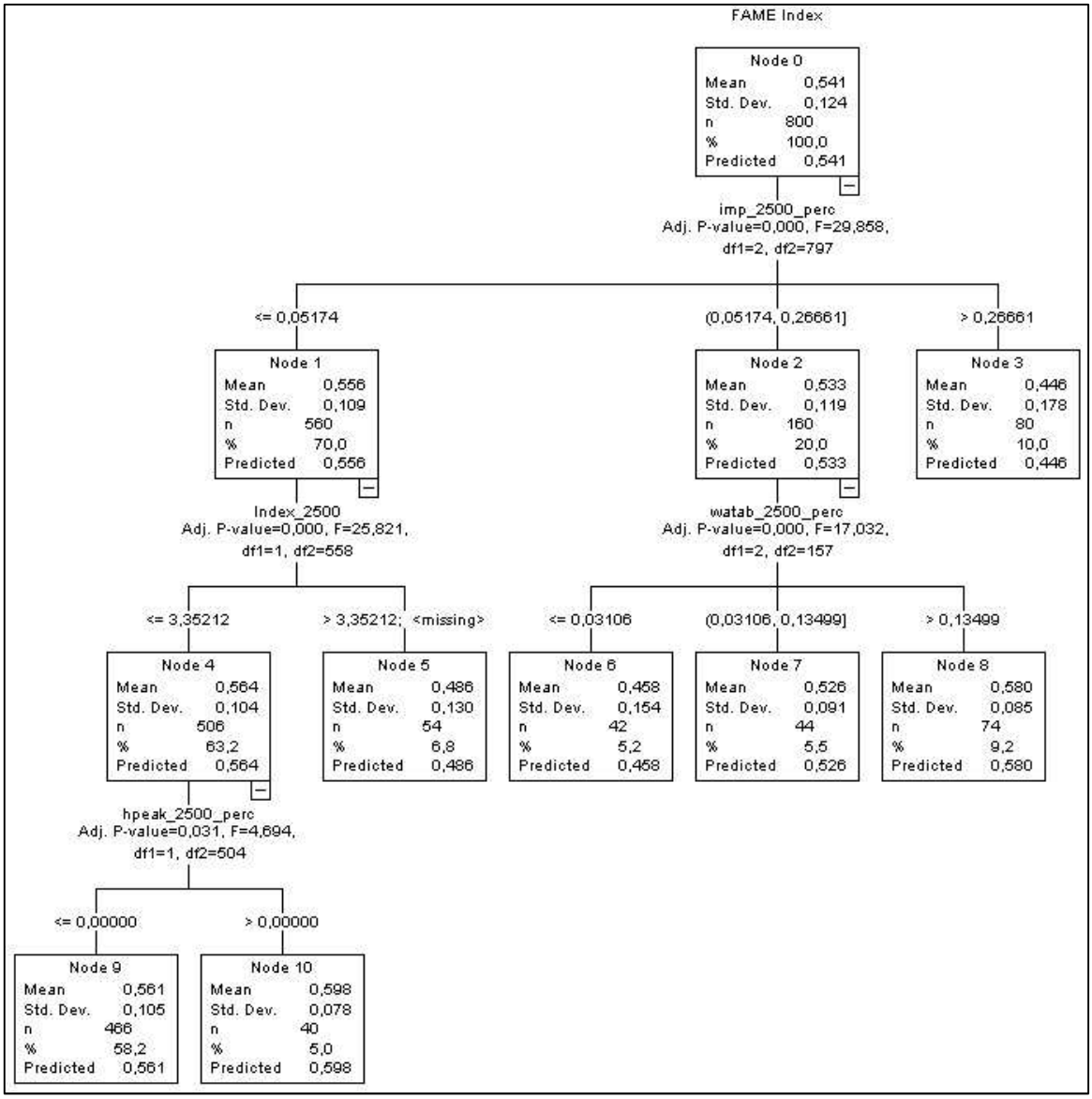


Figure 74: Decision tree for FAME Index at 2500m scale.

Figure 75 visualizes the box-plots for the 2500m scale and the EFIplus Index, whereby the lowest EFIplus Index can be detected for the labels 1 (impoundment), 1000 (morphological impact) and 1001 (impoundment and morphological impact). The highest value again occurs at the label 110 (hydro peaking and water abstraction). The combination of all 4 pressures (1111) does not result in a low EFIplus Index.

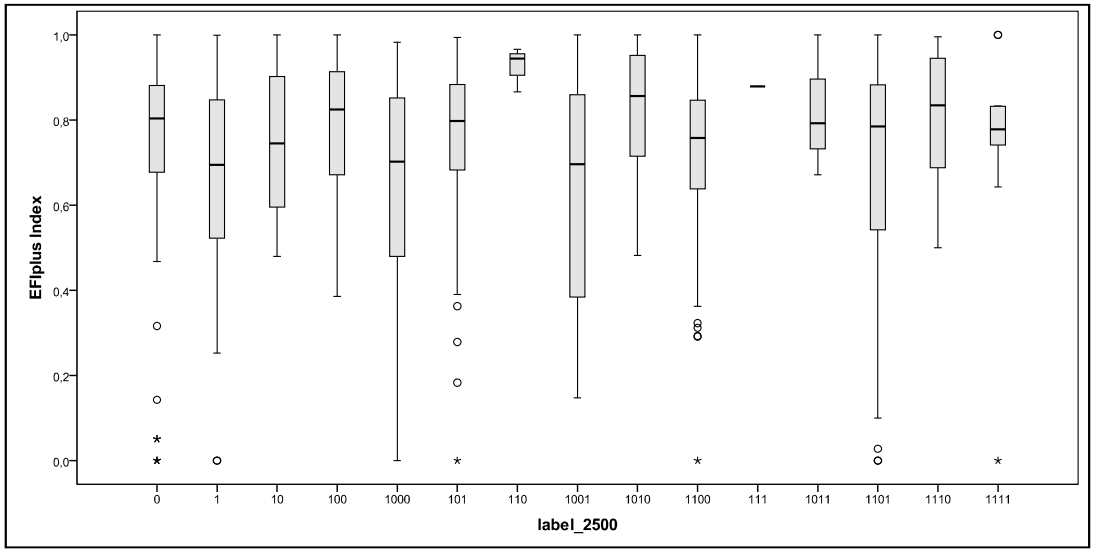


Figure 75: Box-plots showing the EFIplus Index for pressure combinations at 2500m scale.

The decision three in Figure 76 only includes the pressures impoundment and water abstraction. While a percentage of more than 34 percent impounded length seems to decrease the EFIplus Index (0.557), a higher percentage of water abstraction (>15%) predicts a higher EFIplus Index (0.777).

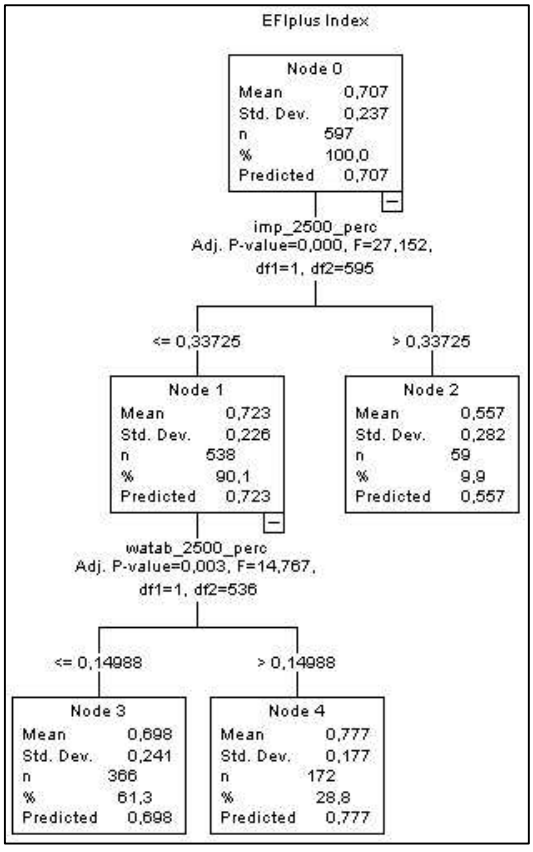


Figure 76: Decision tree for EFIplus Index at 2500m scale.

5.7.5 Decision trees for the 5000m scale

Also for the 5000m scale the lowest FAME Index occurs for pressure combinations 1 (impoundment) and 1001 (impoundment and morphological impact) as well as 101 (impoundment and water abstraction, see Figure 77).

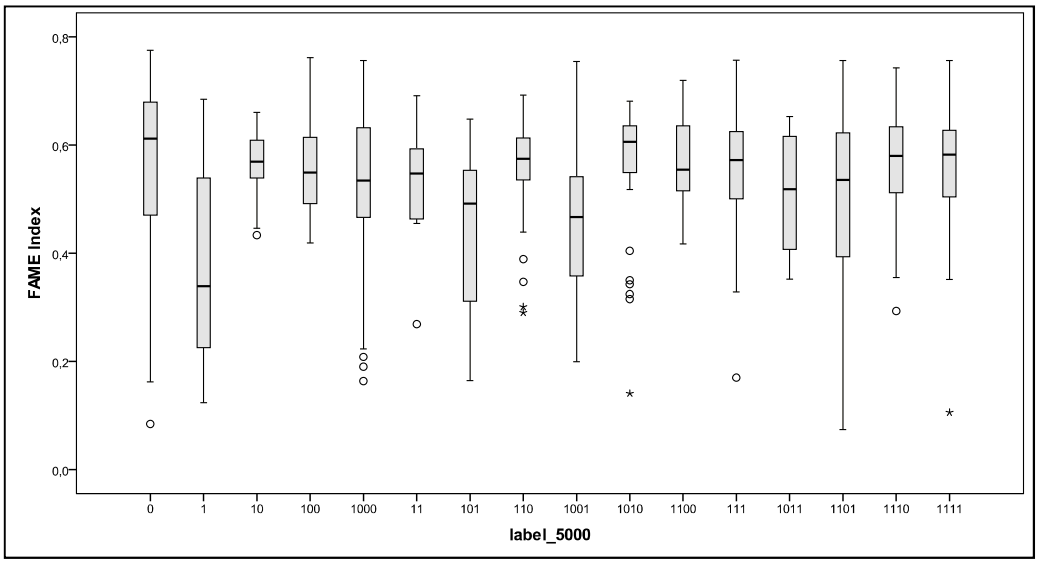


Figure 77: Box-plots showing the FAME Index for pressure combinations at 5000m scale.

The decision tree for the FAME Index at the 5000m scale is shown in Figure 78. The sample sites are first divided by the percentage of impoundment (<9%, 9 to 22% and >22%). Sites with less than 9 or more than 22 percent are further divided by the morphological index, whereas sites with 9 to 22 percent impoundment are split up by the percentage of water abstraction (threshold = 6%). Finally the number of impassable barriers is used to divide sample sites with less than 9 percent impoundment and a morphological index below 2. Sample sites with less than 1 impassable barrier have a higher Index than sites with more barriers. Again a higher percentage of water abstraction results in a higher FAME Index.

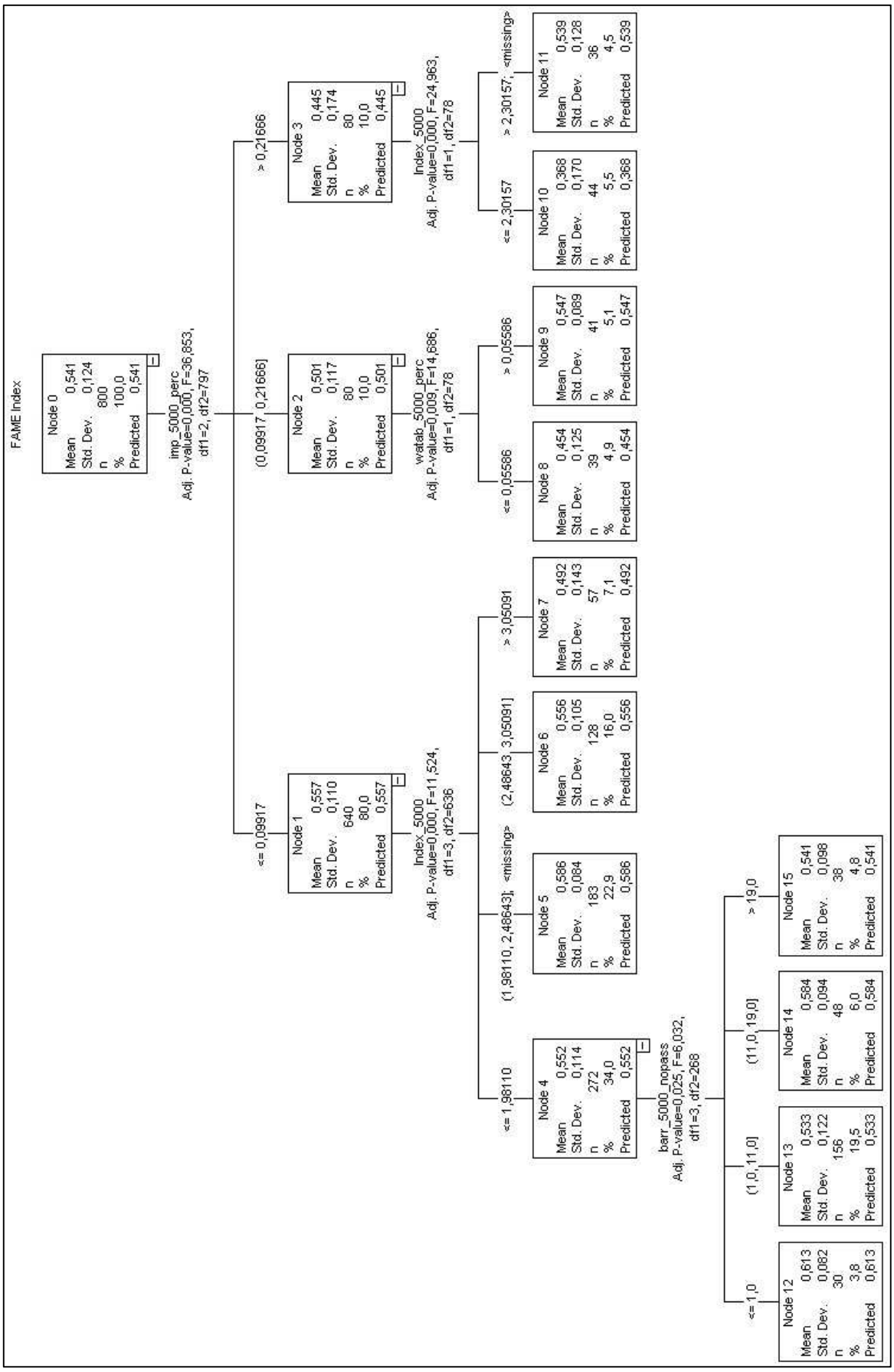


Figure 78: Decision tree for FAME Index at 5000m scale.

The EFIplus Index at the 5000m scale in Figure 79 shows the lowest median for labels 1 (impoundment), 1000 (morphological impact) and 1001 (impoundment and morphological impact).

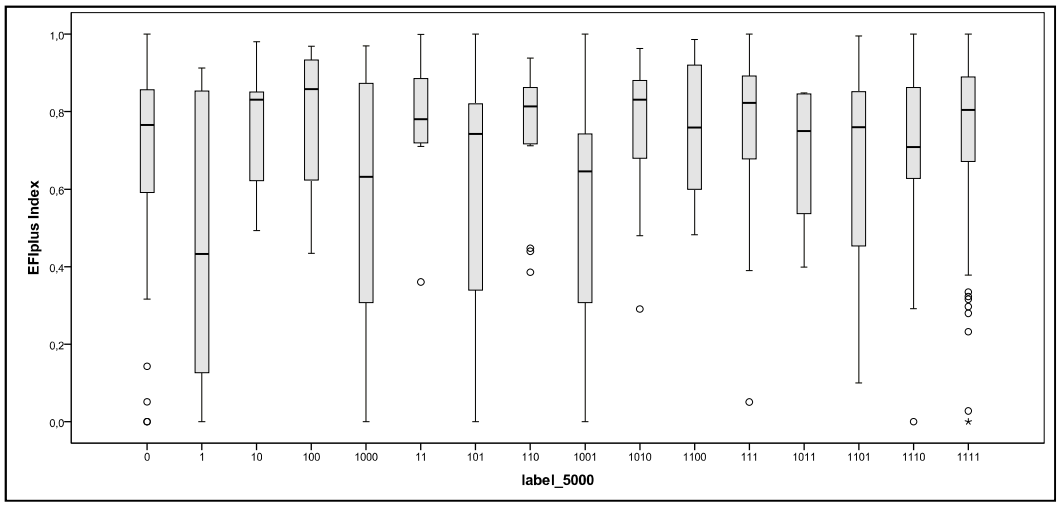


Figure 79: Box-plots showing the EFIplus Index for pressure combinations at 5000m scale.

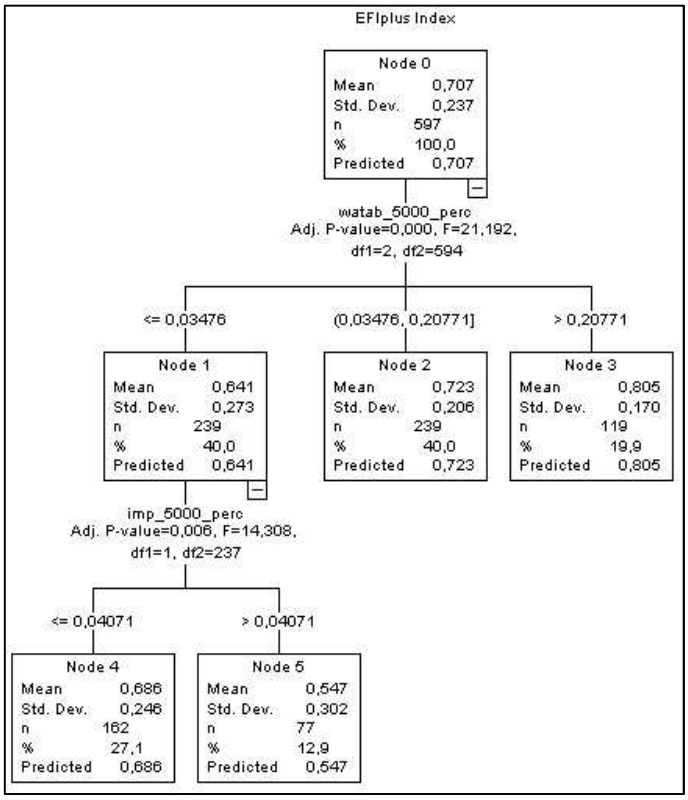


Figure 80: Decision tree for the EFIplus Index at the 5000m scale.

Figure 80 shows the decision tree for EFIplus Index at the 5000m scale. The sample sites are initially divided by the percentage of water abstraction (<3.5%, 3.5 to 21% and >21%). The group with the lowest percentage of water abstraction is further divided by the percentage of impoundment (threshold = 4%). The highest EFIplus Index is assumed to occur at sites with more than 21 percent of water abstraction. Due to their mean EFIplus Index of 0.805 these sites would be rated as EFIplus class 2.

5.7.6 Decision trees for the 25000m scale

Figure 81 is the first graph showing high differences between the pressure combinations. In this case the pressure combination 1001 (impoundment and morphological impact) greatly differs from all other pressure combinations, showing a very low FAME Index. Sites with no pressures achieve the second lowest FAME Index, which is against all expectations. But since there is only a line instead of a box, it can be assumed that the number of sample sites with no pressures is very low.

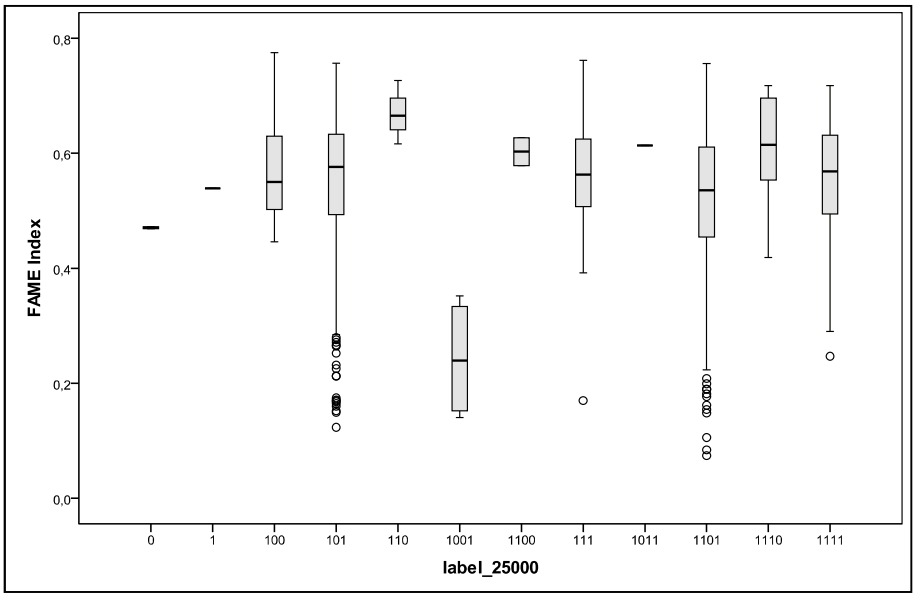


Figure 81: Box-plots showing the FAME Index for pressure combinations at 25000m scale.

The decision tree for the FAME Index at the 25000m scale is shown in Figure 82. The tree includes all pressures except hydro peaking. Again a higher percentage of water abstraction seems to increase the FAME Index. Since the tree is very complex and shows a lot of branches it won't be further discussed but the percentage of water abstraction and the number of barriers mostly show an unexpected influence on the FAME Index.

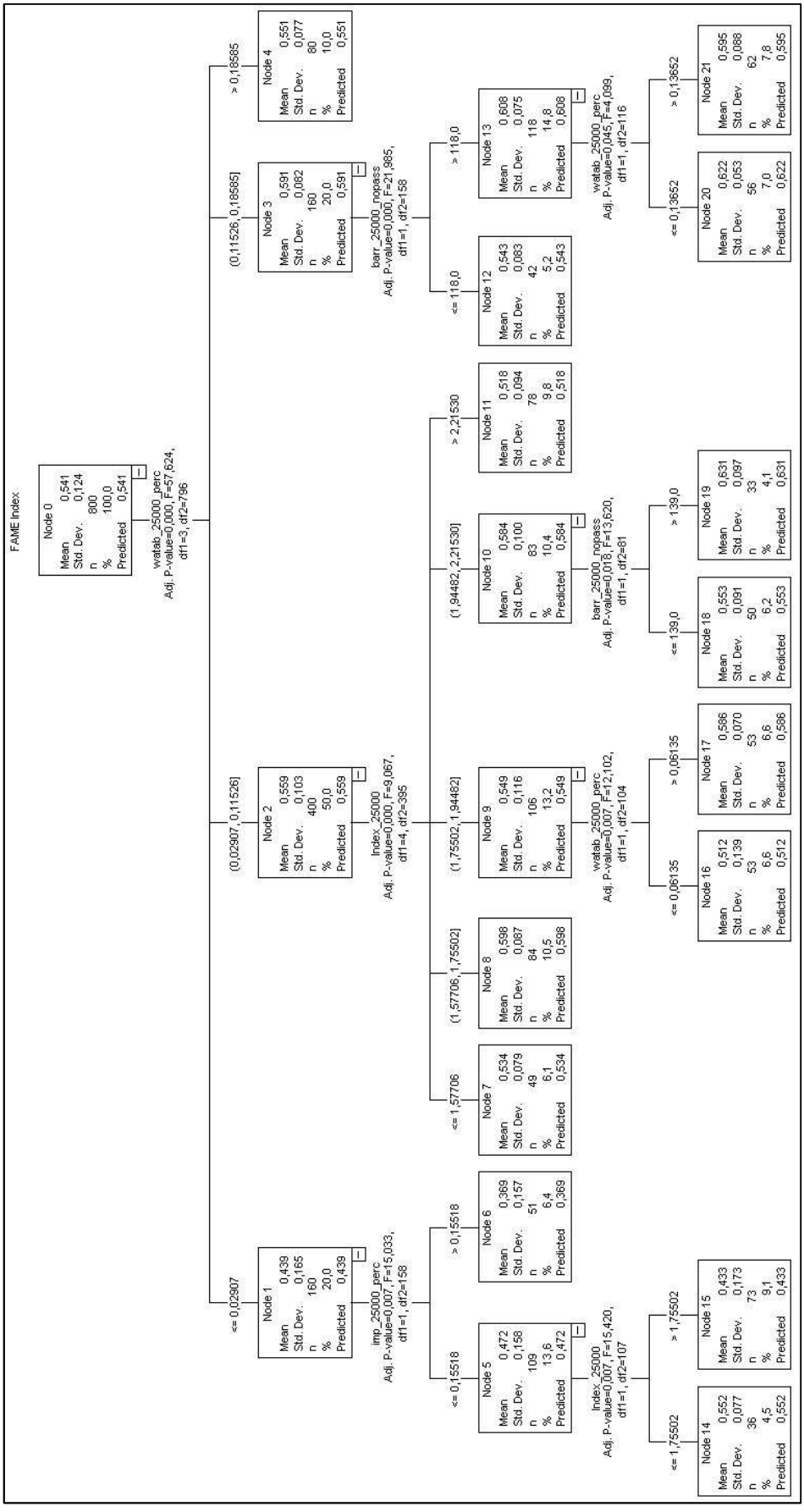


Figure 82: Decision tree for the FAME Index at the 25000m scale.

Figure 83 shows a more homogenous picture than previously seen in Figure 81. The lowest median occurs if all pressures are present at the scale (1111).

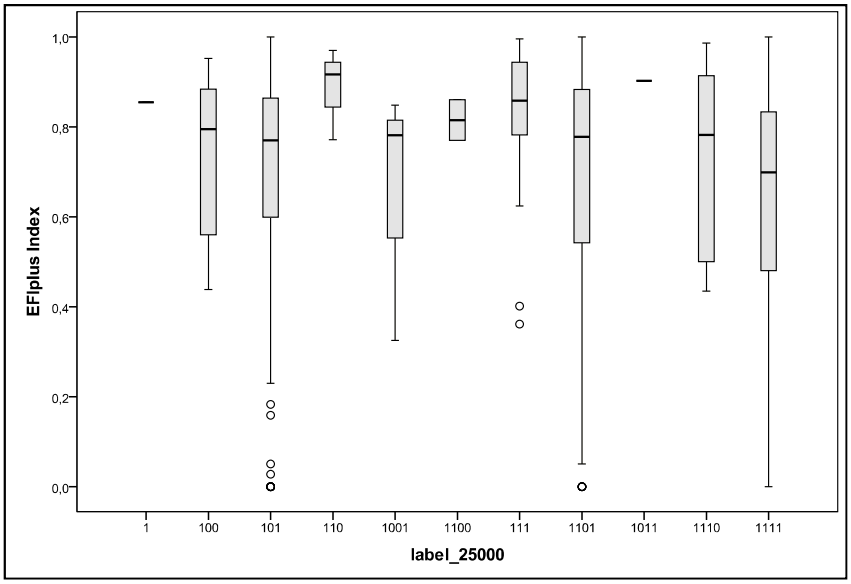


Figure 83: Box-plots showing the EFIplus Index for pressure combinations at 25000m scale.

Figure 84 shows the resulting tree for the EFIplus Index. It includes only the percentage of water abstraction and hydro peaking. Again, the more percent impacted by water abstraction (thresholds are <2%, 2 to 4%, 4 to 12% and >12%) the higher is the EFIplus Index. The group with 4 to 12 percent water abstraction is further divided in unimpacted and impacted sites concerning hydro peaking. Sites with no hydro peaking have a higher EFIplus Index than sites impacted by hydro peaking (0.746 > 0.638). It is noticeable that the branch with more than 12 percent water abstraction has a higher EFIplus Index than sites with less percent water abstraction and no hydro peaking. This group has with 0.794 the highest EFIplus Index and therefore belongs to class 2.

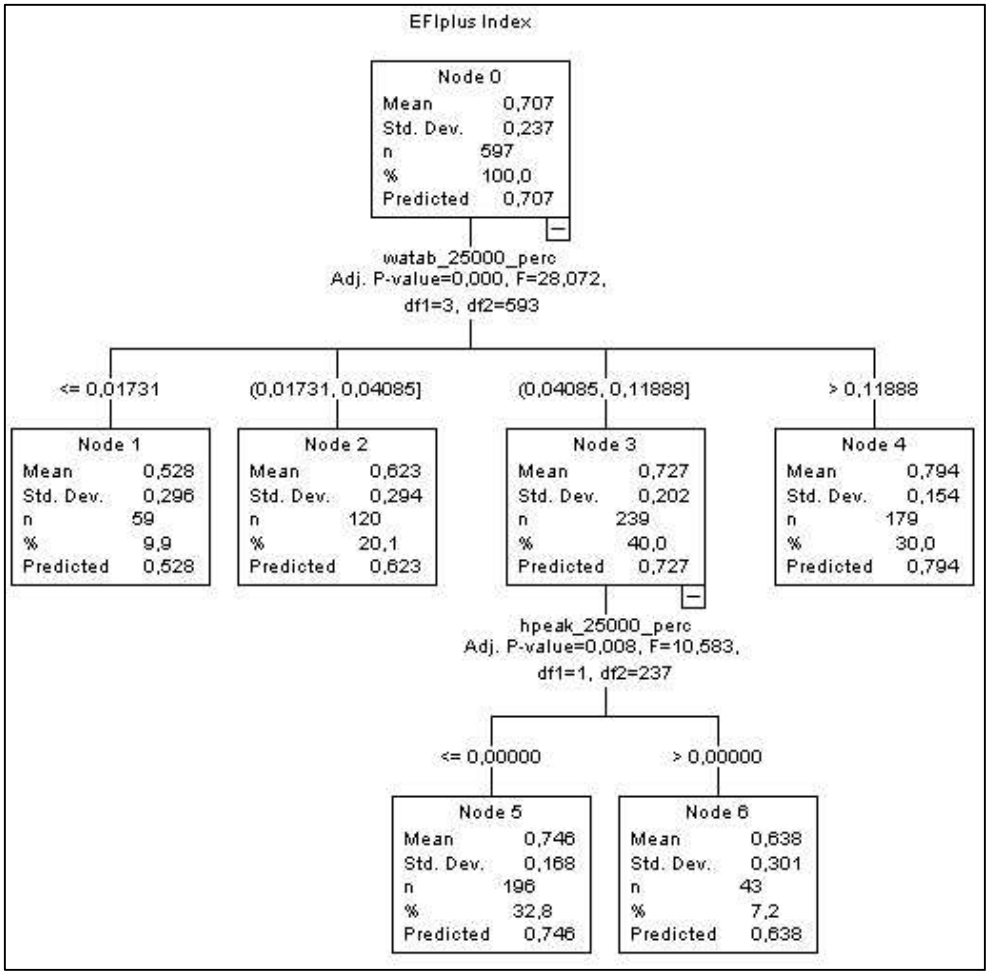


Figure 84: Decision tree for the EFIplus Index at the 25000m scale.

5.7.7 Decision trees for the SA scale

The FAME Indices for the differen pressure combinations in the SA scale do not show high differences. Nevertheless label 1010 (morphological impact and hydro peaking) shows a lower index than all other pressure combinations (see Figure 85).

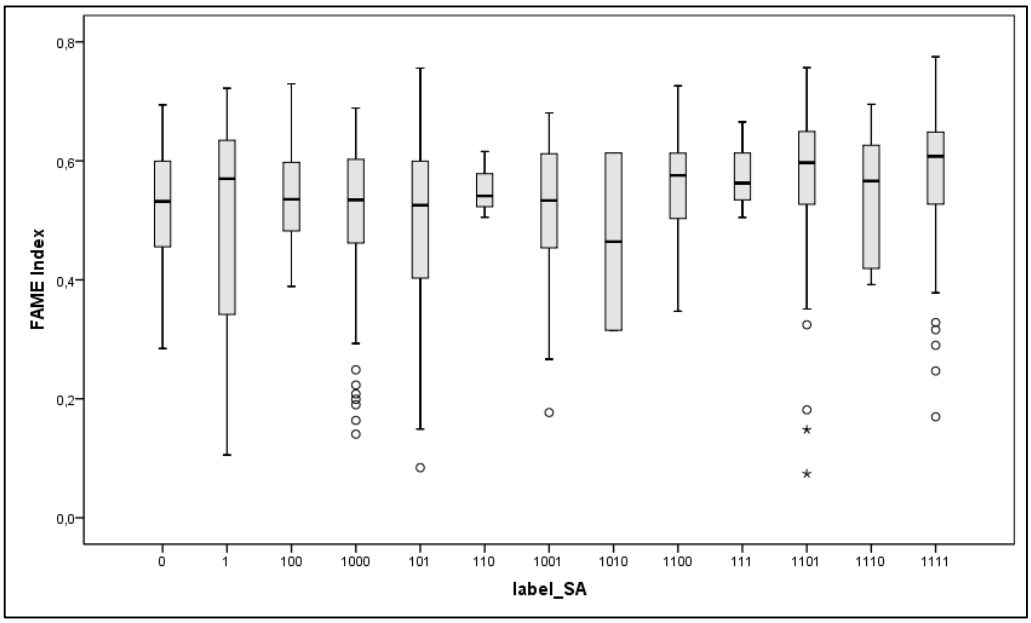


Figure 85: Box-plots showing the FAME Index for pressure combinations at SA scale.

The decision tree for the FAME Index at the SA scale is shown in Figure 86. As mentioned at the beginning of this chapter (5.7) for this scale also the SA length was included. This characteristic was used for the first split at the thresholds <10km, 10 to 23 km and >23 km. The smallest SAs (<10km) are further divided by the percentage of impoundment and the morphological index while the biggest SAs (>23km) were further divided by the percentage of water abstraction, impoundment and the morphological index. The highest FAME Index can be seen at node 9 (0.632) where the SA is longer than 23km and impacted by 5 to 9 percent of water abstraction. The lowest FAME Index occurs at node 7 (0.435) which is the only branch belonging to status class “moderate”. It is represented by small SAs (<10km) and more than 24% impoundment.

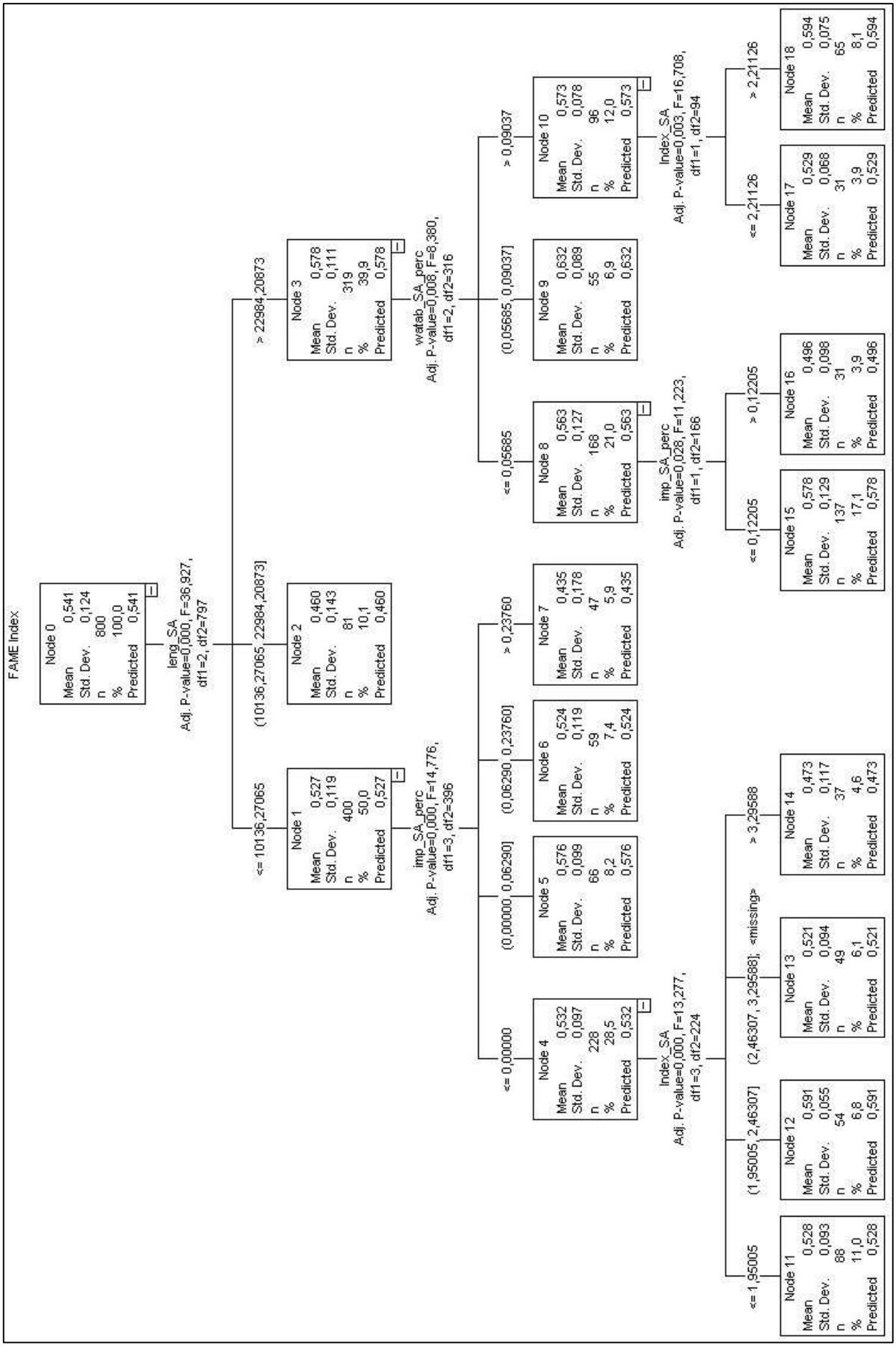


Figure 86: Decision tree for the FAME Index at the SA scale.

The pressure combinations at the SA scale in Figure 87 indicate the highest EFIplus Index for label 110 (hydro peaking and water abstraction) while the lowest Index can be seen for the pressures impoundment and morphological impact (labels 1 and 1001).

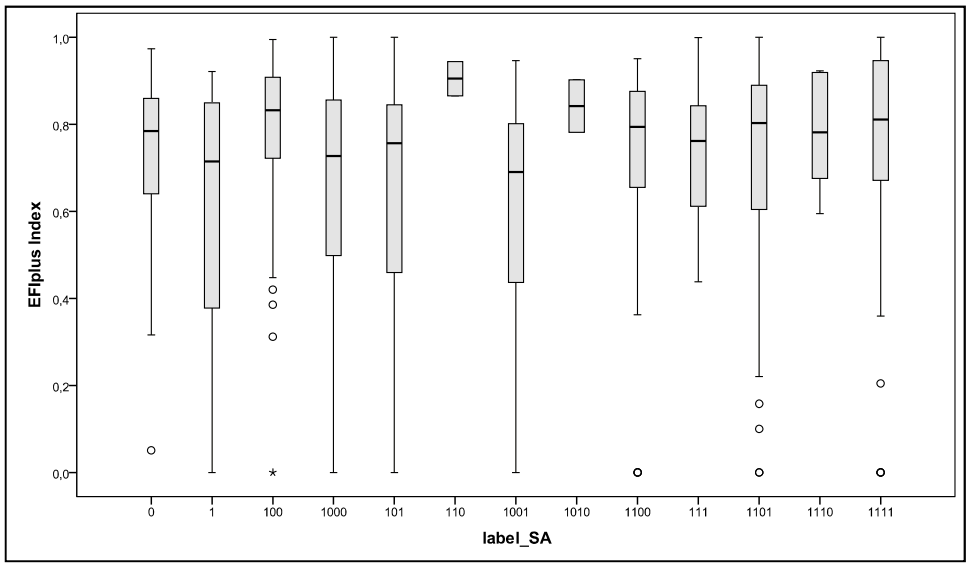


Figure 87: Box-plots showing the EFIplus Index for pressure combinations at SA scale.

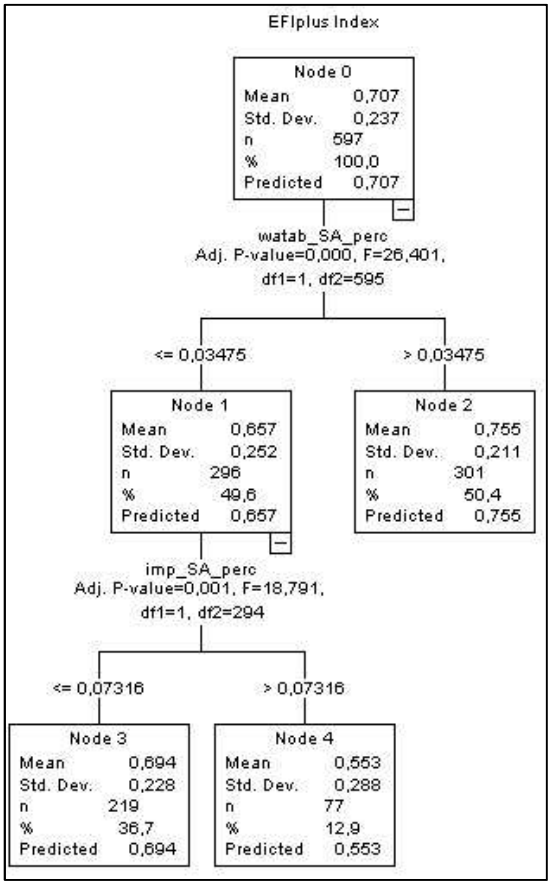


Figure 88: Decision tree for the EFIplus Index at the SA scale.

The decision tree for the EFIplus Index (see Figure 88) includes only the percentage of water abstraction and impoundment. Again sites with a higher percentage of water abstraction (>3.5%) have a higher EFIplus Index (0.755 = class 2) than sites with less water abstraction. These sites are further divided using the percentage of impounded length (threshold = 7%), whereby less impacted sites show a higher EFIplus Index.

5.7.8 Decision trees for the Fish region scale

Figure 89 shows that for the fish region scale the lowest FAME Index occurs for the pressure combinations 1000 (morphological impact), 101 (water abstraction and impoundment), 110 (water abstraction and hydro peaking) as well as 1001 (imoundment and morphological impact). The highest FAME Index can be detected for label 1010 (morphological impact and hydro peaking).

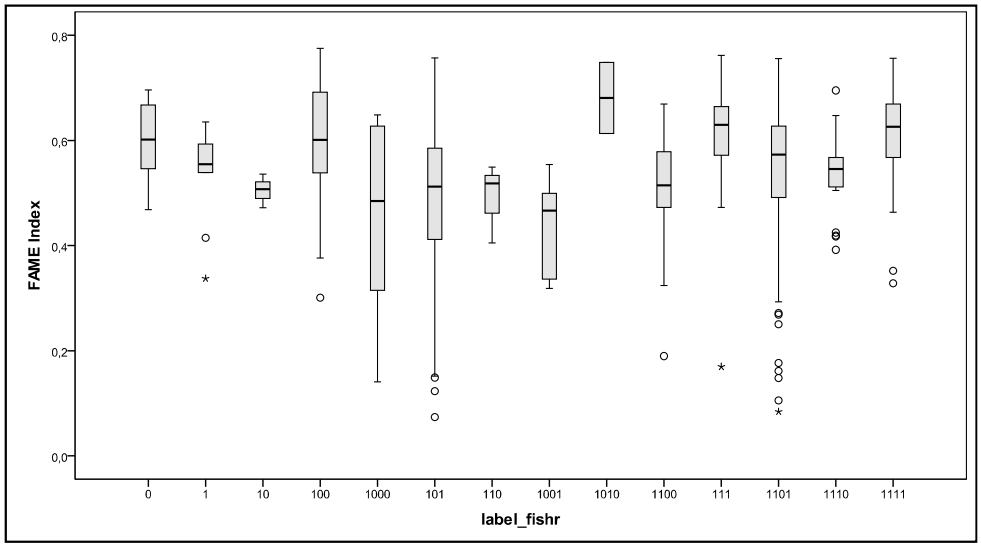


Figure 89: Box-plots showing the FAME Index for pressure combinations at fish region scale.

The decision tree for the FAME Index at the fish region scale is visualized in Figure 90. The tree includes all pressures (except for the morphological index). The first division is made by the percentage of water abstraction (5 branches). The branch with the lowest percentage of water abstraction (<2.7%) is further divided by the percentage of impoundment (threshold 12%). Sites with 2.7 to 4 percent water abstraction are split up by the number of impassable barriers (threshold 17). The branch with 8 to 12 percent water abstraction is divided by the percentage of hydro peaking (threshold 0%) while sites with more than 12 percent water abstraction are again split up by the percentage of impoundment (<3.6%, 3.6 to 6.9% and >6.9%). The highest FAME Index occurs at node 11 (8 to 12% water abstraction and more than 0% hydro peaking). The lowest FAME Index occurs at node 9 (2.7 to 4% water abstraction and more than 17 impassable barriers).

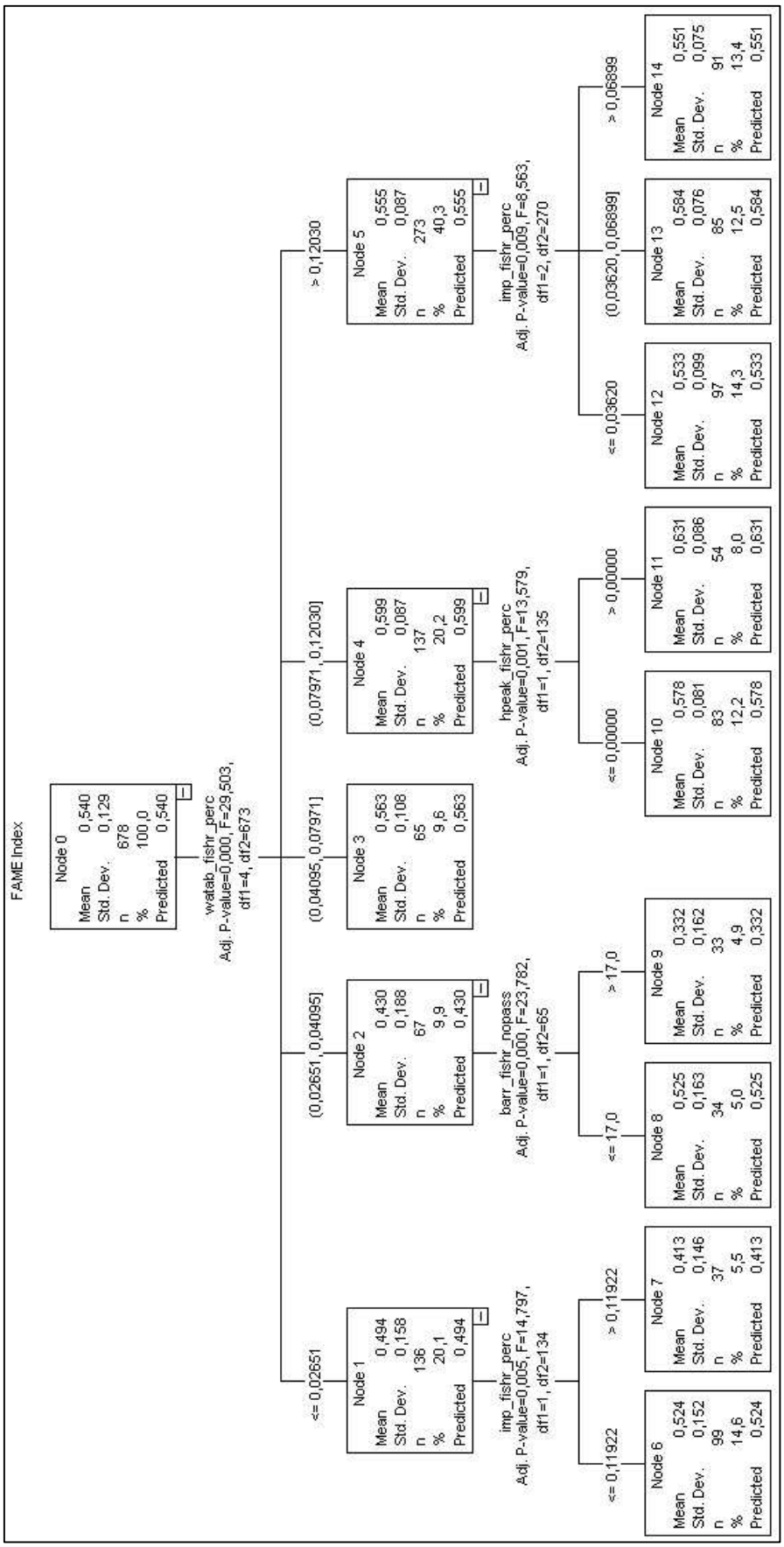


Figure 90: Decision tree for the FAME Index at the fish region scale.

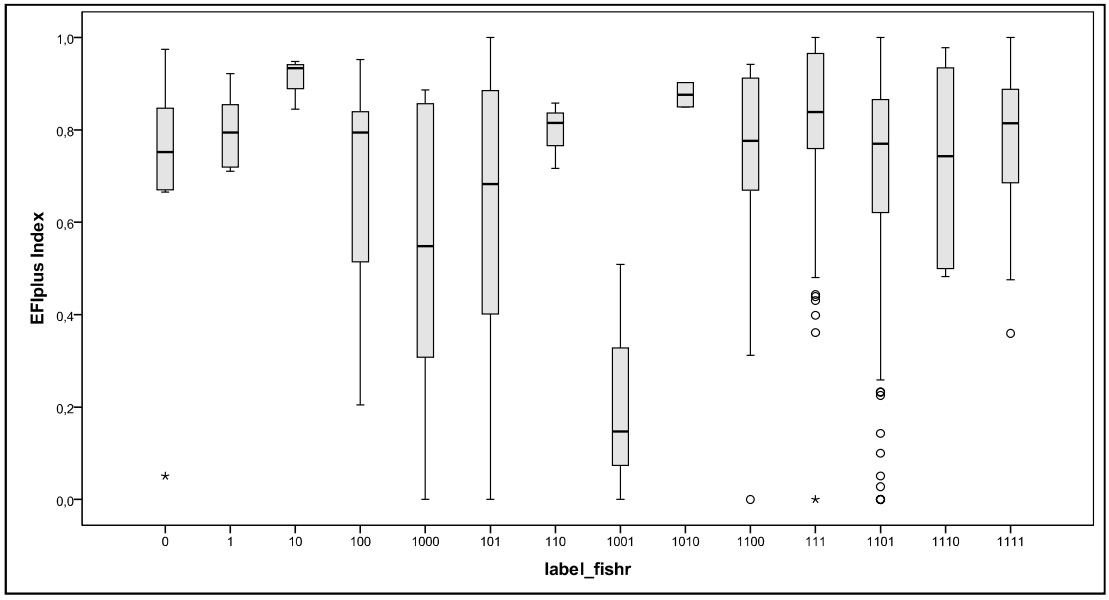


Figure 91: Box-plots showing the EFIplus Index for pressure combinations at fish region scale.

Label 1001 (impoundment and morphological impact) in Figure 91 highly differs from all other pressure combinations as it shows a very low EFIplus Index. Also a bad morphological index (1000) or water abstraction in combination with impoundment (101) are rated with a bad Index value.

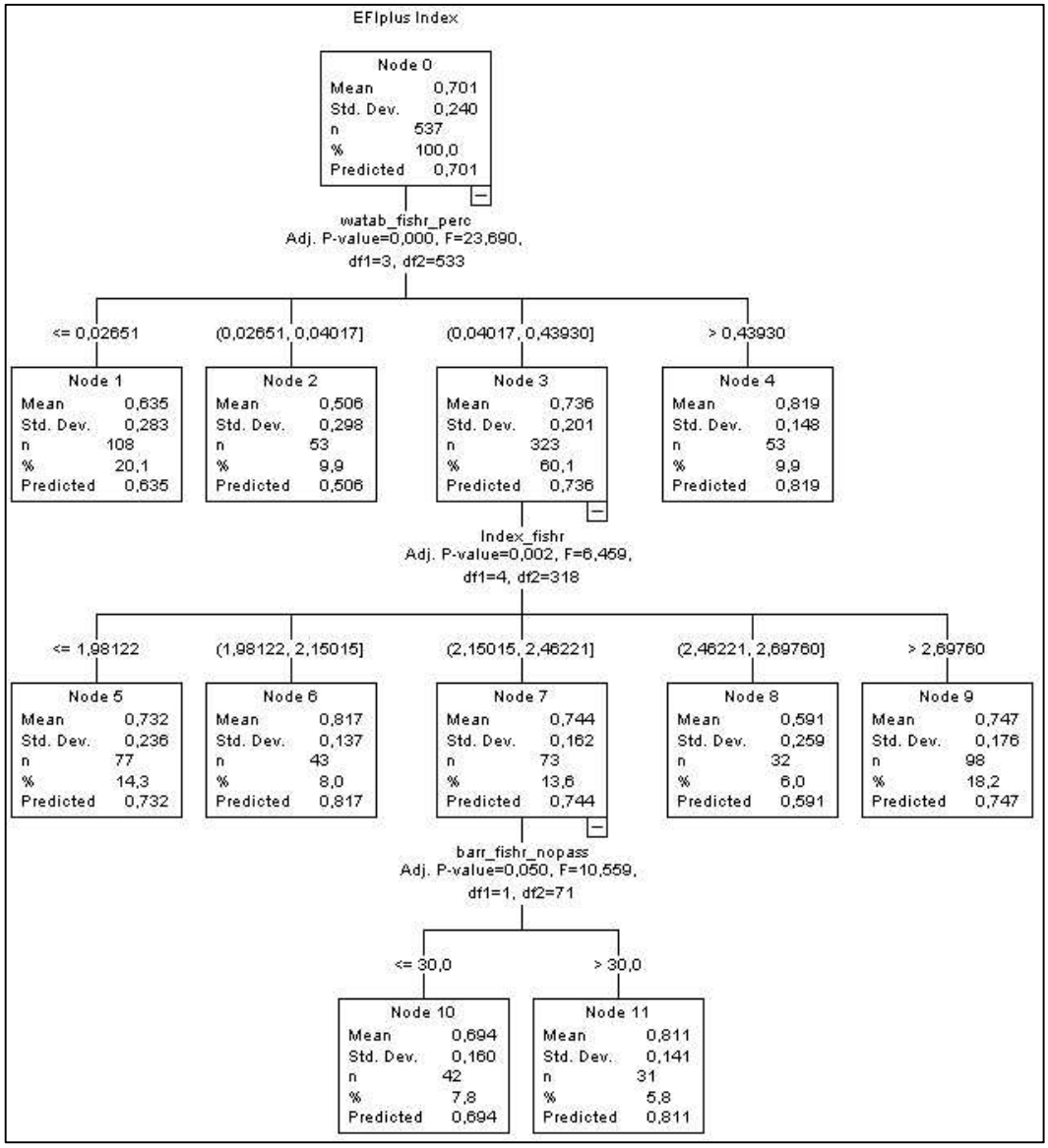


Figure 92: Decision tree for the EFIplus Index at the fish region scale.

The decision tree for the EFIplus Index (Figure 92) includes the percentage of water abstraction (first division), the morphological index (second division) and the number of impassable barriers (third division). Again the branch with the highest percentage of water abstraction (i.e. >44%) has the highest EFIplus Index (0.819 = class 2). The morphological index does not reflect the expected distribution where sites with the lowest morphological index have the highest EFIplus Index. Contrary the highest EFIplus Index (0.817) occurs for sites with a morphological index between 2.0 and 2.2. Sites with a morphological index between 2.2 and 2.5 are further split using the number of impassable barriers (threshold = 30). Surprisingly sites with more than 30 barriers have a higher EFIplus Index (0.811 = class 2) than sites with less than 30 barriers.

5.7.9 Decision trees for the DU scale

The lowest FAME Indices can be seen for label 1001 (impoundment and morphological impact) and 1101 (impoundment, morphological impact and water abstraction). While the highest FAME Index occurs for water abstraction in combination with hydro peaking (110).

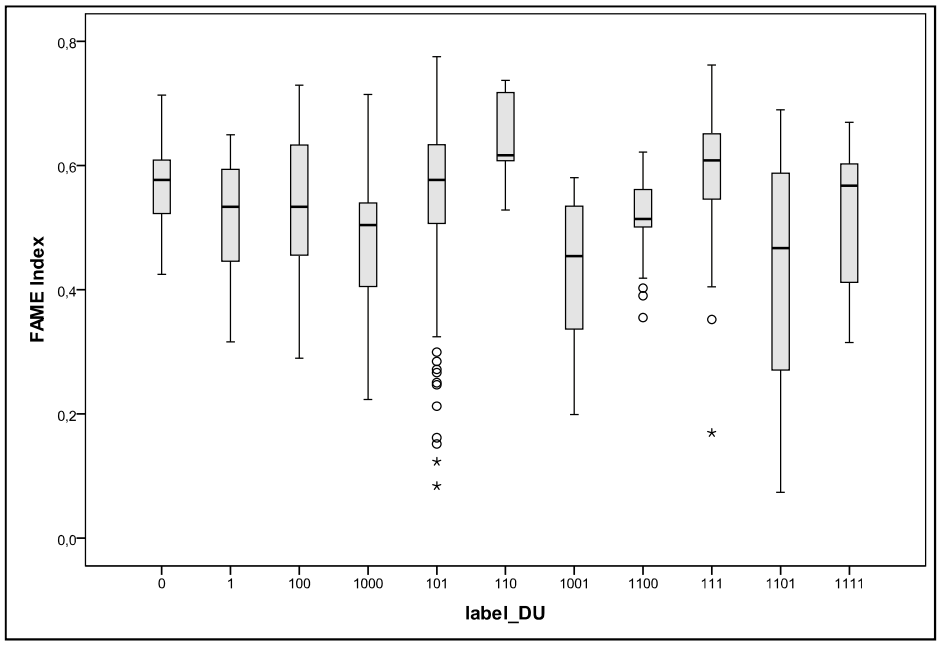


Figure 93: Box-plots showing the FAME Index for pressure combinations at DU scale.

Figure 94 visualizes the decision tree for the FAME Index at the DU scale which includes the percentage of impoundment and the morphological index. In a first step the sites are divided by the percentage of impounded length (0%, >0 to 2.6%, 2.6 to 8.2% and >8.2%). The two branches with less impounded length are further split by the morphological index. The highest FAME Index occurs at node 8 (>0 to 2.6% impoundment and a morphological index between 1.7 and 1.8) while the lowest value can be found at node 4 (>8.2% impounded length).

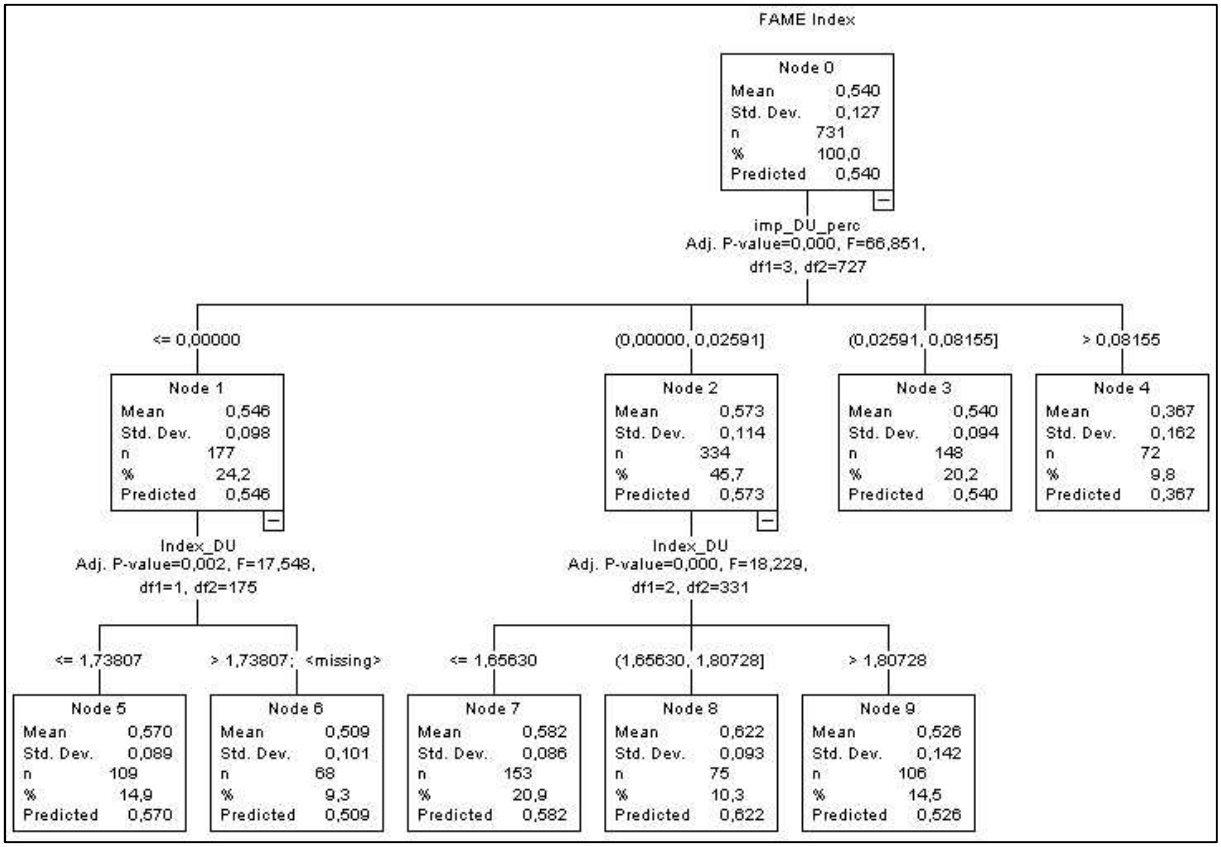


Figure 94: Decision tree for the FAME Index at the DU scale.

The pressure combination showing the lowest EFIplus Index in Figure 95 is a bad morphological index in connection with impoundment (1001). But also if all pressures occur together (1111) the EFIplus Index shows a low EFIplus Index as expected. The highest EFIplus Index occurs for label 110 (water abstraction and hydro peaking).

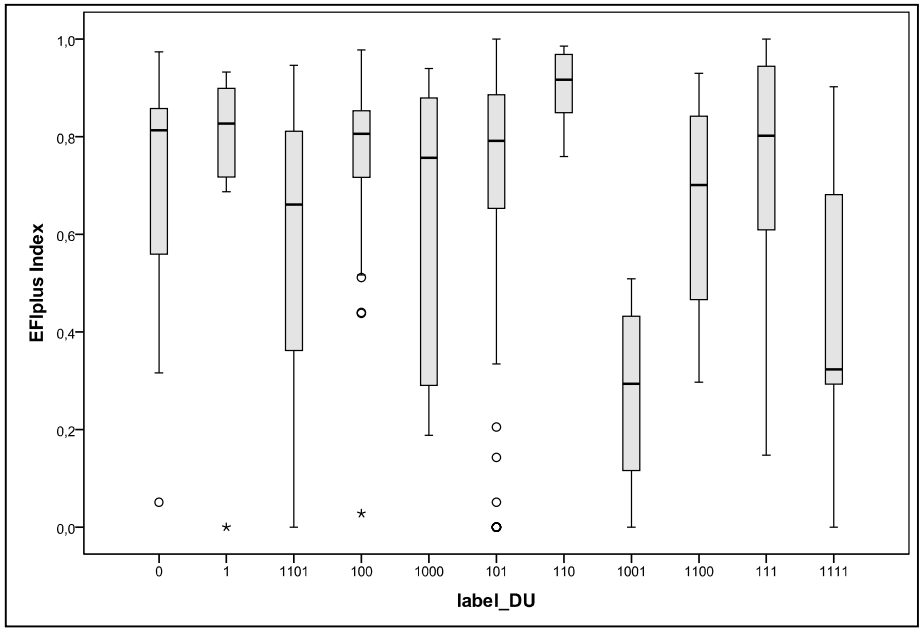


Figure 95: Box-plots showing the EFIplus Index for pressure combinations at DU scale.

Figure 96 shows the decision tree for the EFIplus Index at the DU scale. This time only the percentage of impoundment is used and splits the tree up in 6 branches (<0.3%, 0.3 to 0.9%, 0.9 to 1.4%, 1.4 to 2.0%, 2.0 to 8.9 % and >9%). Surprisingly sites with 0.9 to 1.4 percent and 2.0 to 8.9 percent show the highest EFIplus Index, followed by sites with less than 0.3 percent impoundment. Therefore this decision tree is rated as unsuitable to explain the EFIplus Index.

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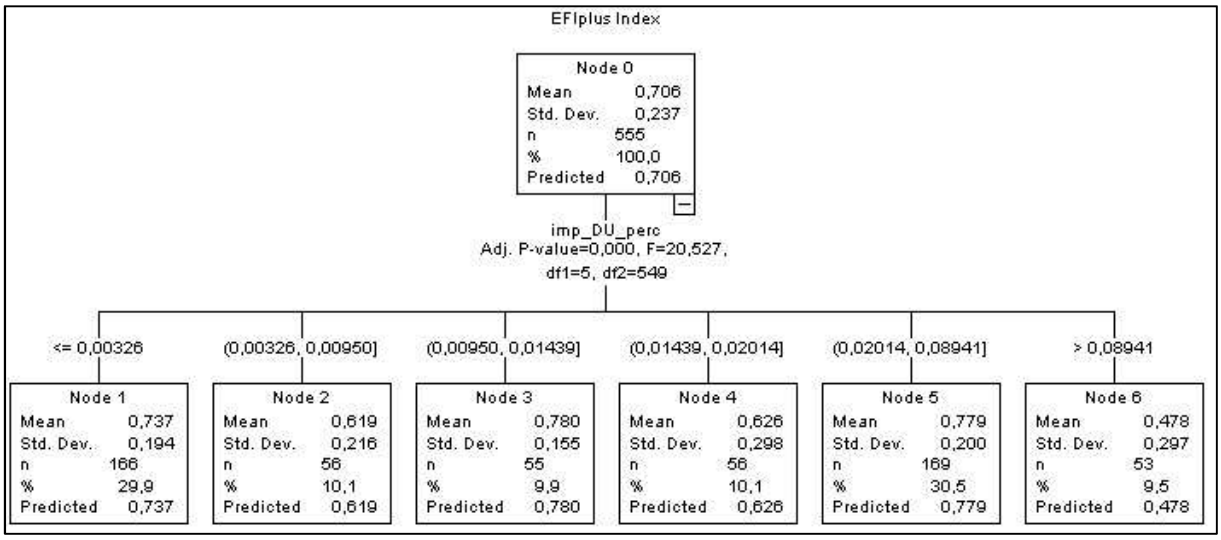

Figure 96: Decision tree for the EFIplus Index at the DU scale

5.7.10 Decision trees for the catchment scale

The combination of all pressures (1111) in Figure 98 shows the lowest FAME Index. At this scale no unimpacted sites occur any more. Only one group with a single pressure is present (i.e. 100, water abstraction) but does not show the highest FAME Index as it would be expected.

The decision tree for the FAME Index at the catchment scale can be seen in Figure 97. It includes the morphological index, the percentage of water abstraction and the number of impassable barriers. A closer look at the graph shows that the FAME Index of different branches varies only slightly and that the tree is unsuitable to explain the FAME Index as expected (higher FAME Indices for sites with higher pressure values).

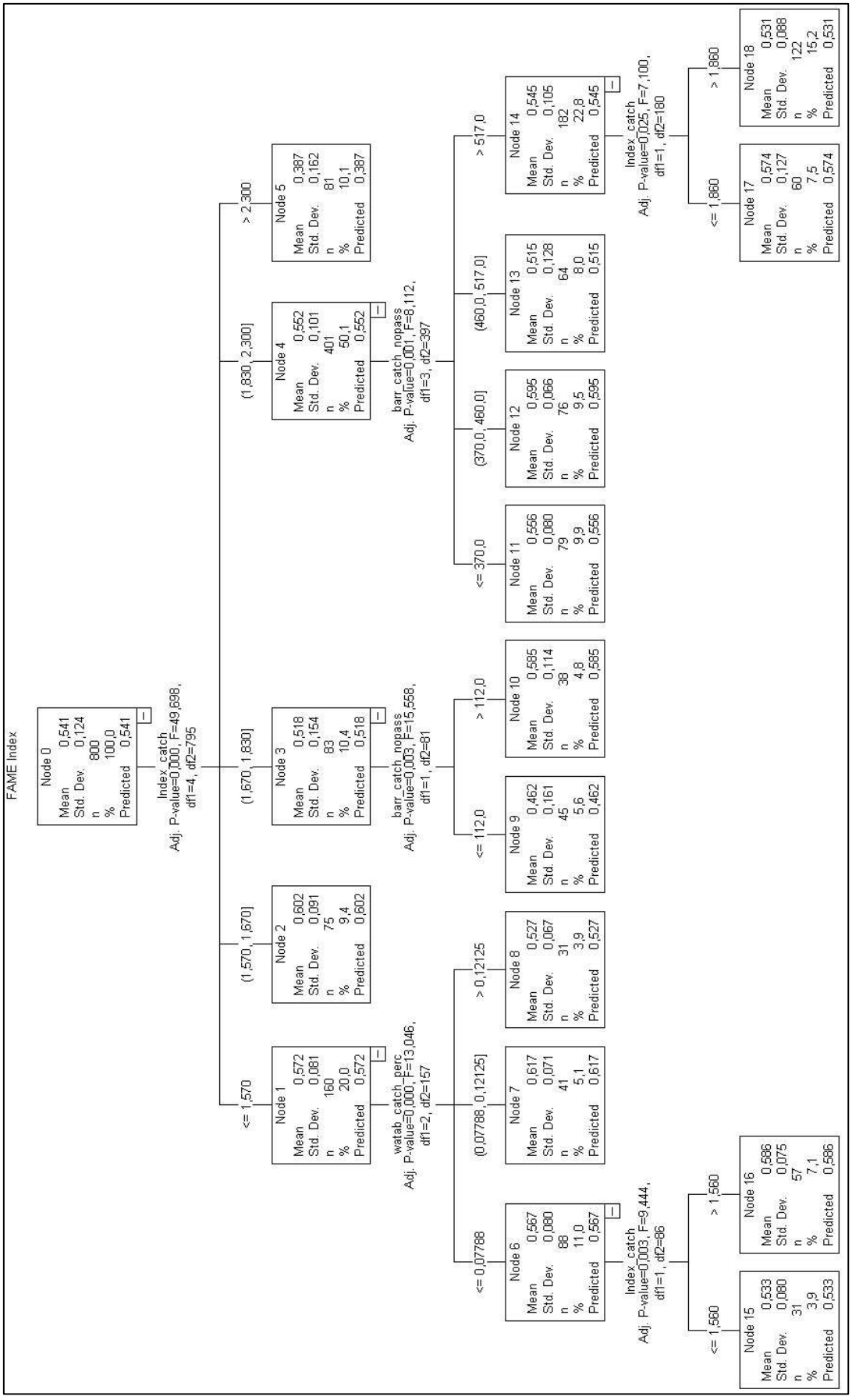

Figure 97: Decision tree for the FAME Index at the catchment scale.

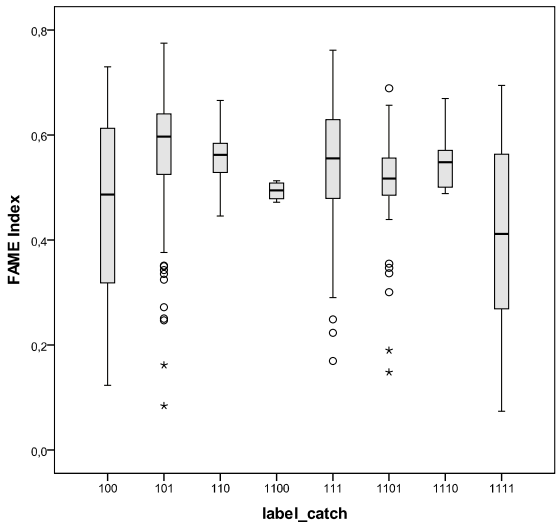

Figure 98: Box-plots showing the FAME Index for pressure combinations at catchment scale.

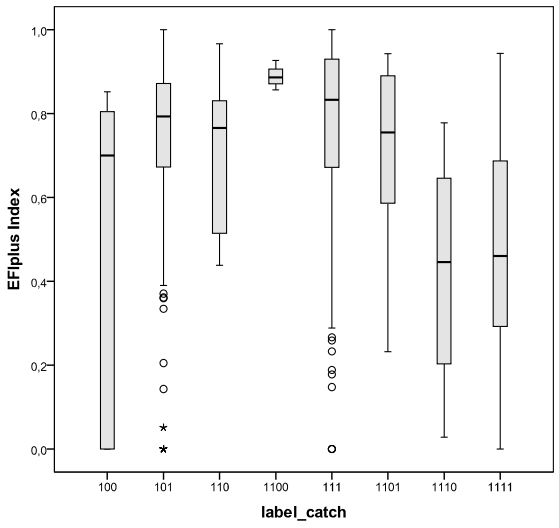

Figure 99: Box-plots showing the EFIplus Index for pressure combinations at catchment scale.

In Figure 99 the group labelled as 1110 (morphological impact, water abstraction and hydro peaking) shows even a lower EFIplus Index as sample sites impacted by all pressures (1111). The highest EFIplus Index occurs for label 1100 (morphological impact and water abstraction).

Figure 100 shows the decision tree for the EFIplus Index at the catchment scale. It includes the morphological index the percentage of hydro peaking and the number of impassable barriers. The morphological index splits the sample sites into 7 branches whereby the distribution of EFIplus Indices is not as expected (highest value for lowest morphological index). Nevertheless the sites without hydro peaking show a higher EFIplus Index as sites impacted by hydro peaking. Also sites with less than 438 impassable barriers within the catchment have a higher EFIplus Index than sites with more than 438 barriers.

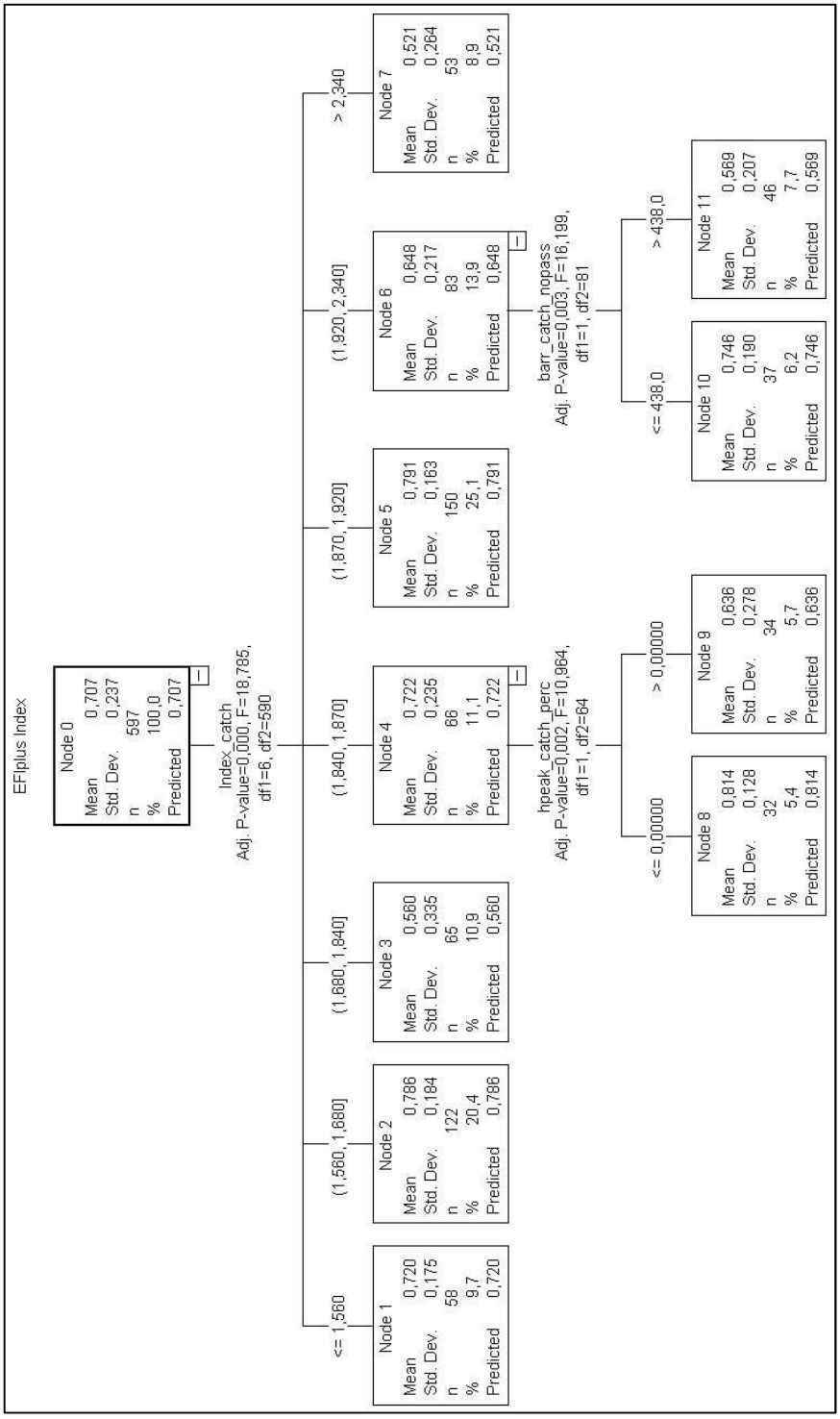

Figure 100: Decision tree for the EFIplus Index at the catchment scale.

5.7.11 Decision tree summary

Table 41 summarizes the output of all decision trees. It shows which parameters were included for the different scales and Indices and if they showed the expected reaction. If the Indices decreased with increasing pressure they were marked with ✓and if they increased

with increasing pressure they were labelled with x. If the indices showed both reactions (e.g. if they were included twice) they were marked with ~.

Table 41: Decision tree summary, showing the reactions of FAME- and EFIplus Index on different scales for different pressures.

		morph. Index	barriers	hydro peaking	impoundment	water abstraction
local	FAME	✓			✓	
	EFIplus				✓	
250	FAME	✓			✓	
	EFIplus			x	✓	
500	FAME	✓			✓	
	EFIplus			x	✓	
2500	FAME	✓		x	✓	x
	EFIplus				✓	x
5000	FAME	~	x		✓	x
	EFIplus				✓	x
25000	FAME	~	x		✓	~
	EFIplus			✓		x
SA	FAME	x			✓	x
	EFIplus				✓	x
fish region	FAME		✓	x	~	x
	EFIplus	x	x			x
DU	FAME	~			~	
	EFIplus				x	
catchment	FAME	~	x			x
	EFIplus	x	x			x

As it can be seen impoundment induces mostly the right reaction for both Indices. The morphological index works for some scales while barriers, hydro peaking and water abstraction mostly have an unexpected influence on the Indices.

6. Conclusions

This master thesis was an attempt to investigate the instream pressure-fish relationships in Austrian rivers on different spatial scales. As recommended by ANGERMEIER and WINSTON (1998) the chosen spatial scales were defined for a large range, including both local to reach scales, intermediate scales and the catchment scale. While some of the used buffers were adapted from other surveys like the MIRR project (SCHMUTZ et al., 2007a) also new scales as the service area were invented and applied.

For this thesis the pressures (morphological impact, hydro peaking, impoundment and water abstraction) were investigated for each sample site and its associated buffers and then related with the local fish population. Modifications of the fish community were measured by the use of multimetric indices (FAME Index and EFIplus Index) as well as single metrics of 4 selected guilds (lithophilic, omnivorous, potamodromous and rheophilic species).

The calculated percentage values per pressure within the Austrian river network differ slightly from the percentages stated in the NGP (BMLFUW, 2009). While the percentage of hydro peaking is the same in the NGP and this thesis (i.e. 2.5%), the percentage of impoundment seems to be overestimated (3.8% calculated vs. 3.5% in NGP) and the percentage of water abstraction seems to be underestimated (9.1 % vs. 9.9% in NGP). Also the percentage of morphologically impacted river segments (i.e. segments with morphological status > 2) differs slightly, whereby the NGP mentions 26.3 percent while in this thesis 22.2 percent of morphologically impacted rivers segments were calculated. This deviation might be due to different calculations methods. In this thesis all shape files were cut at the Austria border, while the NGP might have included some short river segments outside of Austria. Furthermore in this thesis the length of real lakes was subtracted from the total river length. While the surface-water-body shape file was not consistent for all federal states, the route shape file was chosen in this thesis to calculate the total length. Another reason could be, that in this thesis all impacted segments were used no matter if the pressure was rated as significant according to the NGP or not. As mentioned in chapter 0 this approach was chosen since most impacted segments were rated as unknown or significant pressure anyways. Nevertheless the presented percentage values are very similar and therefore give a good approximation of the real situation.

The descriptive analyses showed that the percentage of impacted sample sites increases for larger scales. This observation is similar for all pressures except for the morphological index, where the highest percentage of impacted sample sites occurs at 2500m, 5000m, service area and fish region scale while larger scales like the 25000m-, DU- and catchment buffer

show a lower number of impacted sample sites again. This observation is also reflected by the box-plots showing the morphological index for each scale (Figure 28). The morphological index shows no great variation between the 10 buffers and is approximately 2.

6.1 Morphology

The morphological condition of a river is mostly influenced by flood protection, rural areas and infrastructure, water power plants, shipping and agriculture (BMLFUW, 2009). Morphological alterations like channelization (AARTS, VAN DEN BRINK and NIENHUIS, 2004) or river bed degradation (BRAVARD et al., 1997; RAAT, 2001) modify the habitat and thereby influence the fish community.

The FAME status classes “high” and “good” showed lower morphological index values in comparison to FAME status classes “moderate” to “bad” and thereby reflect the expected distribution. For the EFIplus classes this distribution was more random. Also the mean ranks did not show the lowest values for good indices (i.e. “high” or “good” FAME Index or EFIplus class 1 or 2) as expected. The correlations indicated a linear connection between the single metrics and the morphological index, since the Pearson correlation resulted in higher values than the Spearman correlation. The relative density, relative biomass and relative number of species decreased for the lithophilic, potamodromous and rheophilic guild, whereby the omnivorous guild increased with an increase in morphological index. This means that the morphological index was able to induce the expected reactions for these guilds, whereby the highest R^2 values were measured at the DU- and catchment scale. Also most FAME and EFIplus metrics showed the expected reaction and decreased with an increasing morphological index. For this metrics again the DU- and the catchment buffer showed the highest R^2 values. If the morphological index was included in the decision trees it showed the expected reaction (i.e. higher FAME-/ EFIplus Index for lower morphological index) at smaller scales while it showed opposite reactions at larger scales. Nevertheless the morphological index seems to have an influence on the selected metrics. This was also found out during the MIRR project, where the morphological condition within 5km of the sample site (SCHMUTZ et al., 2007a) showed the highest influence.

6.2 Hydro peaking

Hydro peaking occurs, if the natural discharge and its natural fluctuations are changed and the discharge is controlled by anthropogenic induced fluctuations (BMLFUW, 2009). Thereby hydro peaking has an influence on fish communities (HOUSE, 2001; HALLERAKER et al., 2003; FLODMARK, VOLLESTAD and FORSETH, 2004).

As it can be seen in the graphs concerning hydro peaking in chapter 0, the FAME status classes “bad” and “poor” or EFIplus class 5 are absent from local to 5000m scale which indicates that these sample sites are not impacted by hydro peaking. Sample sites rated as “high”, “good” (FAME) or 1 (EFIplus) exhibited the highest percentages of hydro peaking, although the lowest percentage would have been expected for this status classes. Since the Spearman correlation showed higher values for this pressure in comparison to the Pearson correlation, a non-linear relationship between hydro peaking and the fish metrics can be assumed. Although it would be expected that the omnivorous guild increases with increasing percentage of hydro peaking and that all other metrics decrease, this reaction was not observed. In contrast, an increase of the hydro peaking percentage induced a decrease of omnivorous species and an increase of all other metrics. Again the relative biomass, density and number of species showed the strongest reaction, in this case at the fish region- and the DU scale. Also the FAME metrics reacted best at the fish region scale. Half of the FAME metrics increased with an increasing percentage of hydro peaking. These were insectivorous, omnivorous, phytophilic, lithophilic, intolerant and tolerant species, thereby indicating a better situation for these guilds when hydro peaking is present. All other FAME metrics show the expected decrease with increasing percentage of hydro peaking. If we look at the EFIplus metrics, all of them increase with increasing percentage of hydro peaking, indicating a better situation than would be expected. The regression analysis showed no high R^2 values for this pressure. Hydro peaking was only included in 5 decision trees, where it again lead to an increase in the FAME- and EFIplus Index. This indicates that this pressure cannot be adequately detected by the selected metrics.

6.3 Impoundment

Impoundment is rated as a morphological pressure since it leads to modifications of the flow and morphological parameters (BMLFUW, 2009). The influence of impoundment of the local fish communities was already shown by McAllister et al. (2001) and Reid (2004). Together with the morphological index impoundment is the pressure that best met the assumptions made in this thesis. The FAME status class “high” always included the lowest percentage of impoundment while the highest percentages occurred in status class “poor” and “bad”. This observation was similar for the EFIplus Index at most scales. Again the Pearson correlation showed higher values in comparison to the Spearman correlation, thereby indicating a linear relationship between the pressure and the metrics. The percentage of impoundment showed the reactions described in chapter 1.7. All omnivorous metrics increased with an increase in percentage of impoundment. On the other hand the relative density, biomass and number of species of lithophilic, potamodromous and rheophilic species decreased. All FAME metrics

decreased with increasing proportion of impoundment except for the benthic and potamodromous guild. For the EFIplus metrics the two cyprinid metrics showed the highest reaction and decrease with an increasing proportion of impoundment. However these metrics are based only on 85 sample sites. The fish region-, DU- and 25000m scale were detected as most reacting scales for impoundment. Also the MIRR project proved the importance of impoundment. There the percentage of impoundment in a 10 kilometer distance from the sample site as well as the dimension of the impoundment were identified to be important. Also the reacting guilds are similar, since they investigated a decrease of intolerant, insectivorous, rheophilic, lithophilic and benthic species while tolerant species increased (SCHMUTZ et al., 2007a). Impoundment was included in most decision trees and also induced the expected decrease of the FAME- and EFIplus Index in most cases.

6.4 Water abstraction

Water abstraction is a significant pressure, if the river segment downstream of the abstraction is not sufficiently provided with water leading to a significant pressure for the biocenosis of a river (BMLFUW, 2009). According to ARTHINGTON and PUSEY (2003) and PYRCE, (2004) water abstraction has an influence on the fish community.

The highest percentages of water abstraction occurred at sample sites with FAME status class “high”, “good” and “moderate” while sites with other status classes showed lower percentages. The EFIplus showed a similar picture which means that this pressure cannot be adequately detected by the FAME- and EFIplus Index. The higher Spearman correlations indicated a non-linear relationship between the single metrics and water abstraction. Also this pressures showed the opposite reaction than it would be expected. A high percentage of water abstraction induced a decrease of all omnivorous metrics while other guilds increased (especially relative biomass, density and number of species). Also all FAME metrics increased with increasing percentage of water abstraction, except for benthic, rheophilic, diadromous and potamodromous species, which showed the expected decrease. The highest R^2 values were measured for lithophilic species at the DU scale as well as intolerant and tolerant species at the catchment scale. Also the 25000m buffer showed high correlations for this pressure. All EFIplus metrics increased with increasing percentage of water abstraction, which is against the described expectations. If water abstraction was included in the decision trees it always failed to induce the expected reaction (i.e. decrease) of both FAME- and EFIplus Index. In the MIRR project an increase in tolerant and omnivorous species together with a decrease of intolerant species was observed (SCHMUTZ et al., 2007a). The described reactions cannot be confirmed by this thesis. Nevertheless it is

very likely that water abstraction has an influence on the fish community. Maybe other guilds than used in this thesis would be more suitable for indicating this pressure.

6.5 Barriers

According to the NGP there are 28848 barriers in Austria. However the shape file included 55040 barriers, of which 60.5 percent were rated as impassable. Barriers represent a lateral (TROCKNER, SCHIEMER and WARD, 1998; BUIJSE et al., 2002; HUGHES and ROOD, 2003) or longitudinal (RIEMAN and DUNHAM, 2000) disruption of the natural river continuum and prohibit the migration of aquatic organisms (e.g. fishes) and the transport of sediments, thereby leading to habitat fragmentation and an influence on the fish community (BMLFUW, 2009). Barriers mostly come together with other pressures like hydro peaking, impoundment, water abstraction or morphological alteration. Since these pressures were already covered by other pressure variables, the barriers in this thesis were considered in another way than for instance in the MIRR project (SCHMUTZ et al., 2007a). As mentioned before a special buffer considering the barriers was designed instead of using the total number of barriers for each scale. This buffer named service area represents the river segments, the fish population can use for free migration. The service area was delimited by impassable barriers while passable barriers were not taken into account. A correlation analysis between the SA length and the single metrics showed that the SA length is not irrelevant but since the further regression analysis showed no high R^2 values it might not be as relevant as expected. The number of impassable barriers was included in the calculation of the decision trees. It was only included in 6 out of 20 trees whereby only one tree showed a decreasing FAME Index for a higher number of barriers. In all other trees a higher number of barriers resulted in a higher FAME- or EFIplus Index. The MIRR project indicated a high relevance of connectivity in potamal rivers while connectivity disruptions in rhithral rivers played a minor role (SCHMUTZ et al., 2007a).

6.6 Fish metrics

The fish metrics used for this thesis were composed out of different guilds known for their reaction to increasing human pressures. Some metrics were transformed and combined to a multi-metric index (i.e. FAME- and EFIplus Index) while others were used in their original form (i.e. selected EFIplus metrics). The strongest reaction of metrics depends on the pressure in question. In general the cyprinid EFIplus metrics showed the highest correlation but as mentioned before they base on a very small number of sample sites and therefore have to be treated with caution. The FAME metrics show very different reactions for each

pressure. For the selected EFIplus metrics the relative biomass, density and number of species responded the strongest, no matter which guild was observed. Sometimes also absolute values showed high correlations, as for instance the total density of lithophilic, potamodromous or rheophilic species. These metrics even decreased with an increasing percentage of water abstraction or hydro peaking although the relative density increased. So at least the total-density metrics showed the expected reaction for these pressures although they did not result in high R^2 values.

It was noticeable that there is a difference between relative and absolute metrics. While the relative metrics (proportion of density, biomass and number of species) mostly showed high correlations their absolute metrics (total density, biomass and number of species) responded less strong or even in an opposite way. This means that the reaction of relative metrics might be influenced by the change of other guilds, which were not taken into account in this thesis.

Concluding there is to say that the FAME- and the EFIplus metrics are able to indicate at least some of the chosen pressures. The FAME Index shows higher correlations than the EFIplus Index although the EFIplus Index was generated as an improvement of the FAME Index. It needs to be considered that the EFIplus Index bases on only four single metrics while the FAME Index includes 10 single metrics. Since these Indices were created for a pan-European approach the selected single metrics might be more suitable for some countries than for others. Maybe the FIA (Fish Index Austria) would be more appropriate to describe the impact on fish communities in Austria, since it was especially designed for this purpose.

6.7 Further research

This thesis showed that the consideration of local pressures only is not sufficient to describe modifications of local fish communities. Larger scales need to be included in further studies to cover a wider range of influences.

Nevertheless, further research will be needed for the investigation of the most suitable scale. Although this thesis was able to show that larger scales play an important role for the local fish community, it was not possible to identify one single scale for each pressure, which detected best the changes in fish community. The scales used in this thesis might show some small errors like described for the DU buffer (see chapter 4.1) where partly wrong segments are included in the calculation. A new and more accurate version of the CCM database would be good to overcome these errors. Also the fish region buffer might include some inaccuracies since it does not include rivers with a catchment smaller than 10 km^2. Especially these river segments might represent a welcome refuge and spawning habitat for

certain species and therefore should be considered for any scale. Thus the missing fish regions should be defined for those rivers. According to the definition of the catchment scale it should represent the largest of all scales. Therefore smaller catchments were not considered. In the end the 875 considered sample sites were attributed to 63 catchments. Although a delineation of all catchments would be very time consuming it should be considered for further studies. Thereby each sample site would be attached to the catchment of its actual river.

For further calculations it also would be very important to include data for segments with missing morphological status. The morphological index calculated in this thesis was not always reliable due to missing data. Although the results of the morphological index with high reliability did not really differ from other calculations it is important to include as many useful data as possible. Therefore also the pressure data need to be updated. At this time there are too many segments with unknown pressure significance, especially for hydro peaking (62% with unknown hydro peaking ratio) and water abstraction (48% with unknown residual flow). This might also be the reason why these two pressures showed unexpected reactions. Further it would be important to calculate the fish metrics for all 1697 sample sites and compare them to the FIA.

The most important step for the beginning is to combine the data used in this thesis with the results of land use influences on the fish population (JUEN, in preparation). A combination of these data will give a more accurate reflection of the real situation than can be given by instream pressures alone.

Another important point to mention is that although the selected scales cover a wide spatial range there still might be unexplored scales which are more suitable for the investigation of pressure-fish relationships. Maybe a combination of different scales and parameters is necessary. Nevertheless it might not be possible to generate a buffer most suitable for each pressure since each sample site has its own characteristics and therefore maybe another scale they are influenced by exists. The scales used in this thesis were defined to be similar between all sample sites, but as it was shown, they partly showed high differences depending on the characteristics of each river. Of course it never will be possible to include all influencing factors since nature is too complex to frame it. But for the analysis of pressure-fish relationships the use of the most important factors seems sufficient. However not only instream variables but also land-use variables need to be considered.

Also the calculated fish metrics depend on so many different factors. Although they seem to give a good approximation of the real situation the question arises if it is possible to express the full complexity of a biocenosis in one single value.

For the analyses of large scales it might be necessary to lump all sample sites together but it is still important to not forget that each sample site is a unicum. This thought also has to be included for the planning of restoration measures.

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Annex

A. Descriptive Analyses of 875 sample sites with available fish metrics (additional graphs)

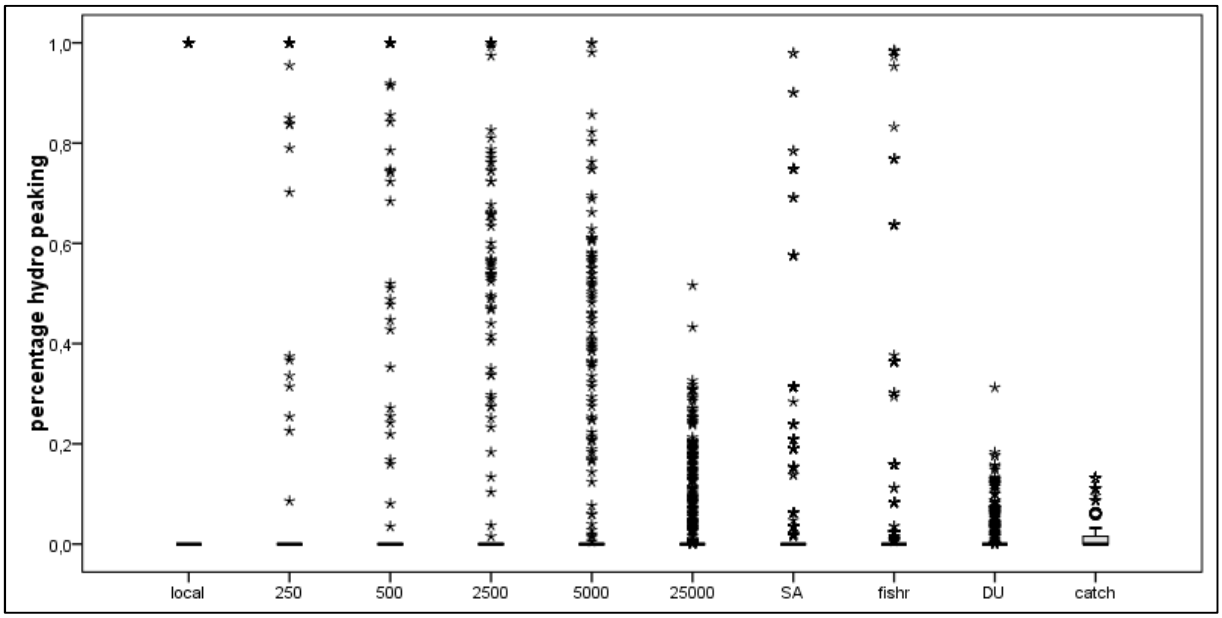

Figure A.1: Box-plots showing the percentage of hydro peaking length (inclusive 0 values) per buffer for sample sites with available fish metrics (875)

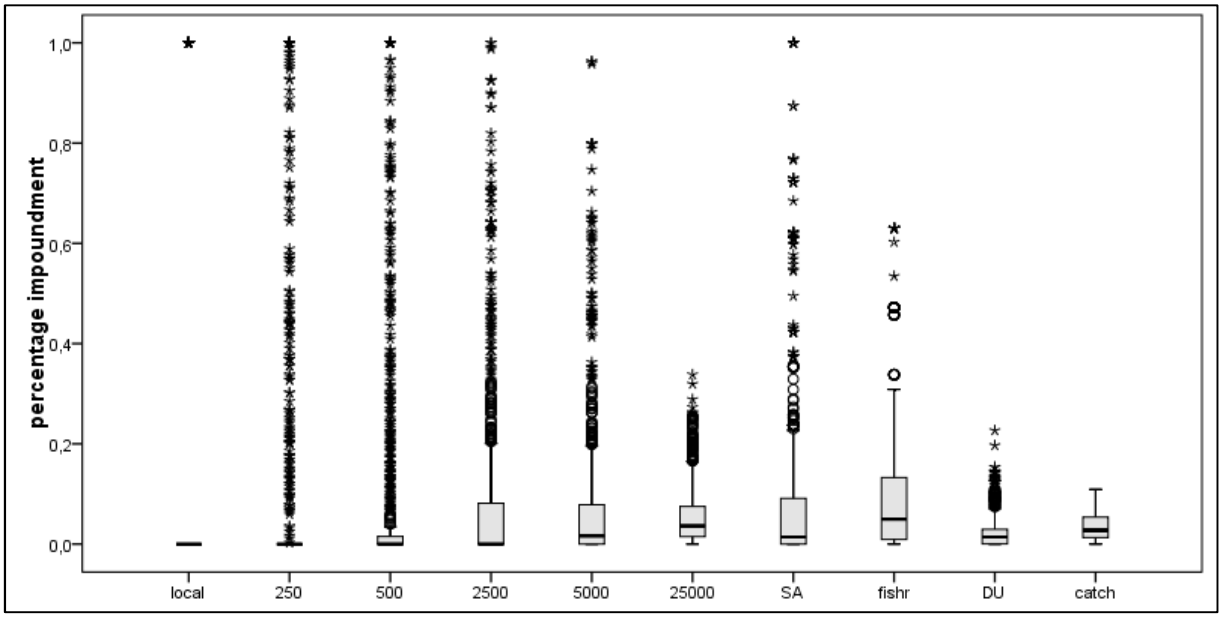

Figure A.2: Box-plots showing the percentage of impoundment length (inclusive 0 values) per buffer for sample sites with available fish metrics (875)

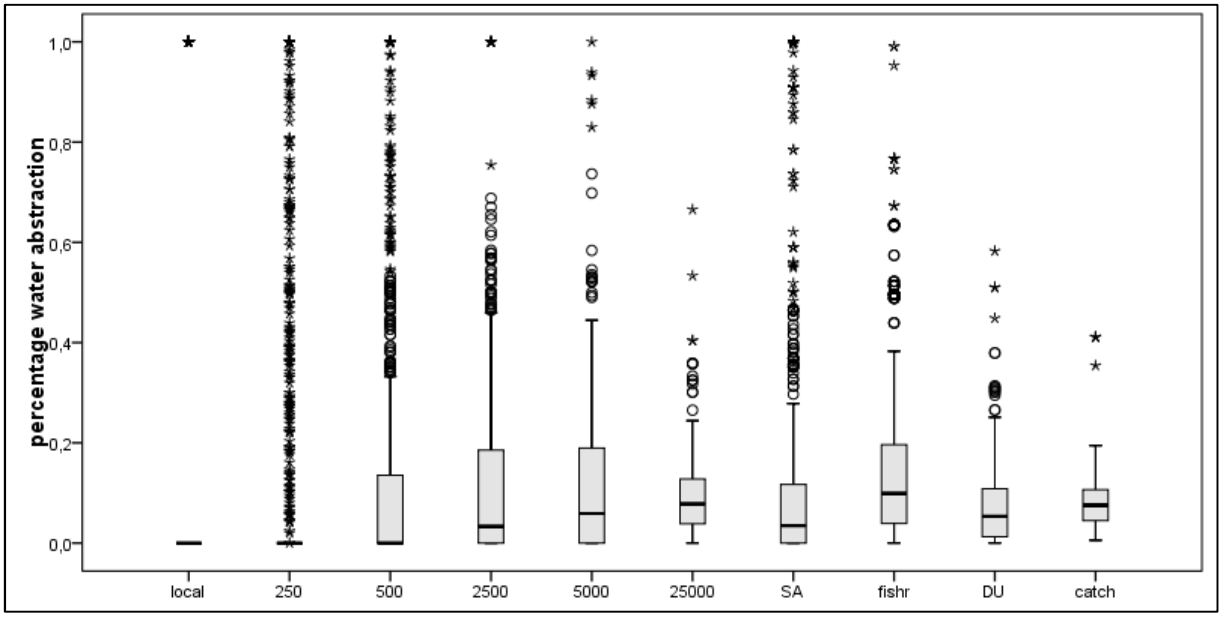

Figure A.3: Box-plots showing the percentage of water abstraction length (inclusive 0 values) per buffer for sample sites with available fish metrics (875)

B. Descriptive Analyses of all 1697 sample sites

Table B.1: Descriptive statistics of buffer length (1697 sample sites).

Descriptive Statistics: buffer-length (1697 sample sites)					
scale	N	minimum length [m]	maximum length [m]	mean length [m]	standard deviation
250	1697	280	945	527	67
500	1697	530	2116	1105	194
2500	1697	2609	15987	6799	1898
5000	1697	3346	46622	16246	5463
25000	1697	12170	513074	166442	73722
SA	875	49	343250	49683	76070
fishr	1467	834	628887	73752	119546
DU	1625	87	16828460	327197	1165071
catch	1697	43741	17040586	2041424	4012624

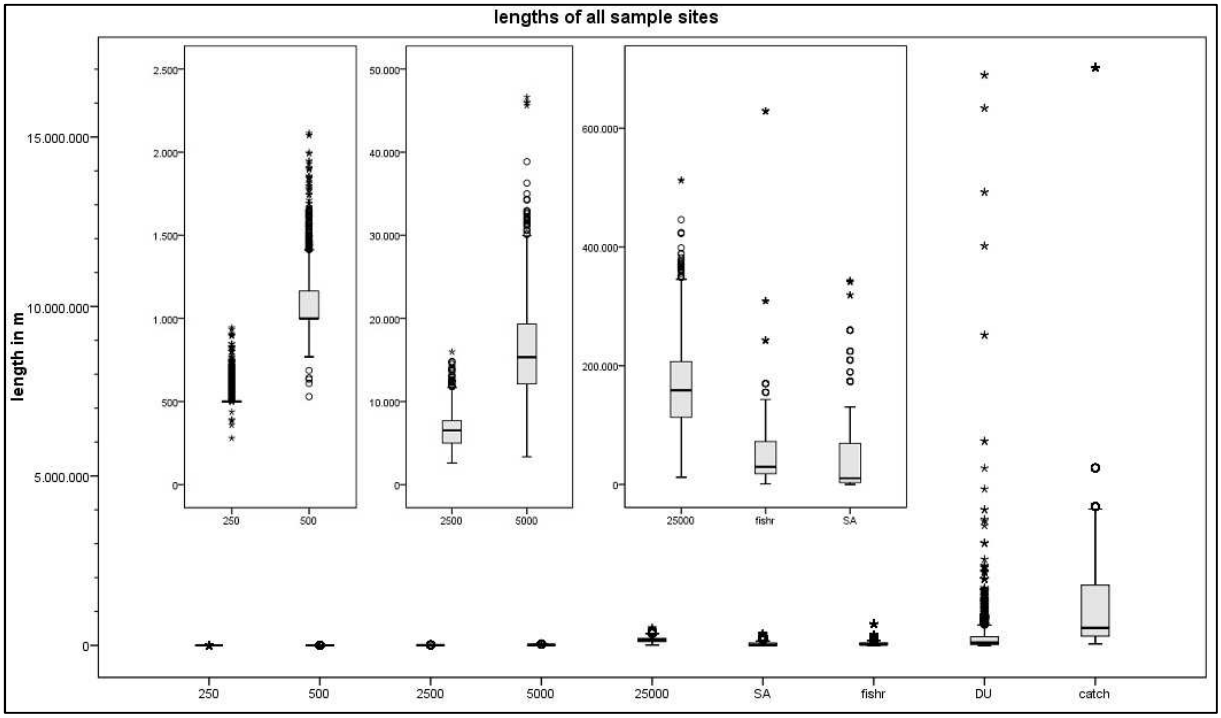

Figure B.1: Box-plots showing the length distribution of all (1697) sample site.

Table B.2: Descriptive statistics of morphological index (1697 sample sites).

Descriptive statistics of morphological index (all sample sites)									
scale	N	valid N	percent valid	N impacted	percent impacted	minimum morphological index	maximum morphological index	mean morphological index	standard deviation
local	1697	1210	71.3	529	31.2	1.00	5.00	2.35	1.00
250	1697	1416	83.4	725	42.7	1.00	5.00	2.37	0.96
500	1697	1504	88.6	836	49.3	1.00	5.00	2.37	0.91
2500	1697	1631	96.1	1014	59.8	1.00	4.23	2.30	0.75
5000	1697	1676	98.8	1027	60.5	1.00	4.42	2.24	0.65
25000	1697	1696	99.9	860	50.7	1.04	3.67	2.03	0.38
SA	875	852	97.4	550	62.9	1.00	4.82	2.27	0.72
fishr	1467	1463	99.7	966	65.8	1.00	4.93	2.40	0.66
DU	1625	1620	99.7	420	25.8	1.00	5.00	1.81	0.46
catch	1697	1697	100.0	443	26.1	1.10	3.37	1.92	0.34

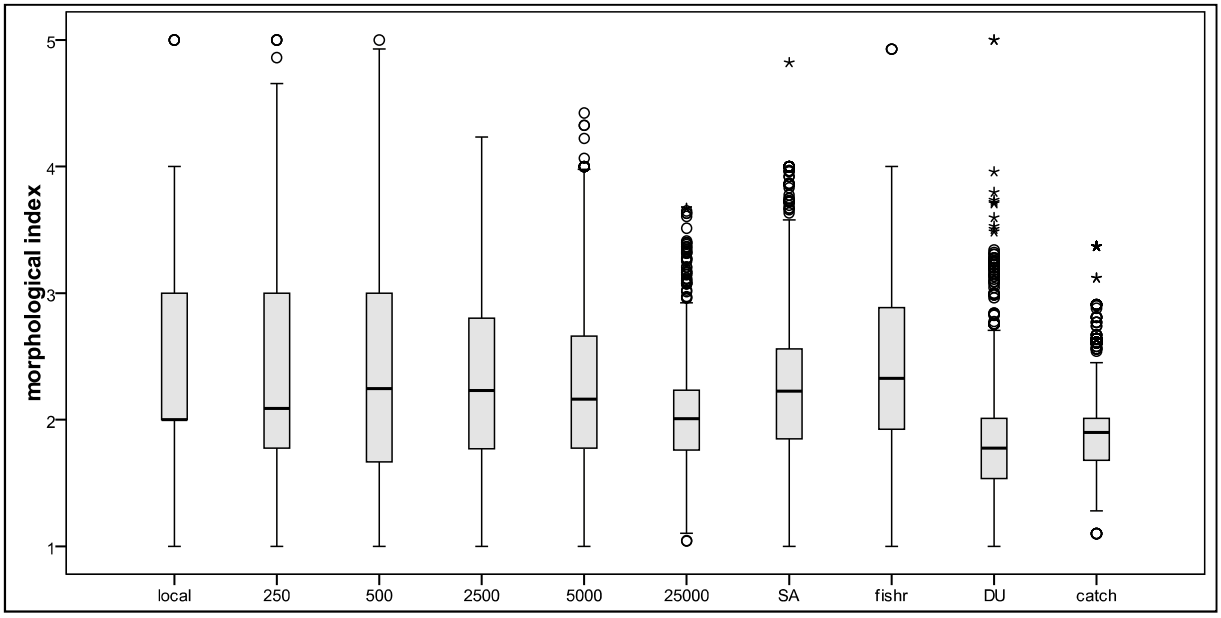

Figure B.2: Box-plots showing the morphological index per buffer for all (1697) sample sites.

Table B.3: Descriptive statistics of hydro peaking (all 1697 sample sites).

Descriptive statistics: hydro peaking (all 1697 sample sites)							
Scale	N	N with hydro peaking	Percent with hydro peaking	minimum percentage	maximum percentage	mean percentage	standard deviation
local	1697	95	5.6	0.00	1.00	0.06	0.23
250	1697	103	6.1	0.00	1.00	0.06	0.22
500	1697	113	6.7	0.00	1.00	0.06	0.22
2500	1697	150	8.8	0.00	1.00	0.05	0.19
5000	1697	196	11.5	0.00	1.00	0.05	0.16
25000	1697	424	25.0	0.00	0.54	0.03	0.08
SA	875	145	16.6	0.00	0.98	0.04	0.14
fishr	1467	348	23.7	0.00	1.00	0.06	0.18
DU	1625	324	19.9	0.00	0.59	0.01	0.04
catch	1697	765	45.1	0.00	0.25	0.02	0.03

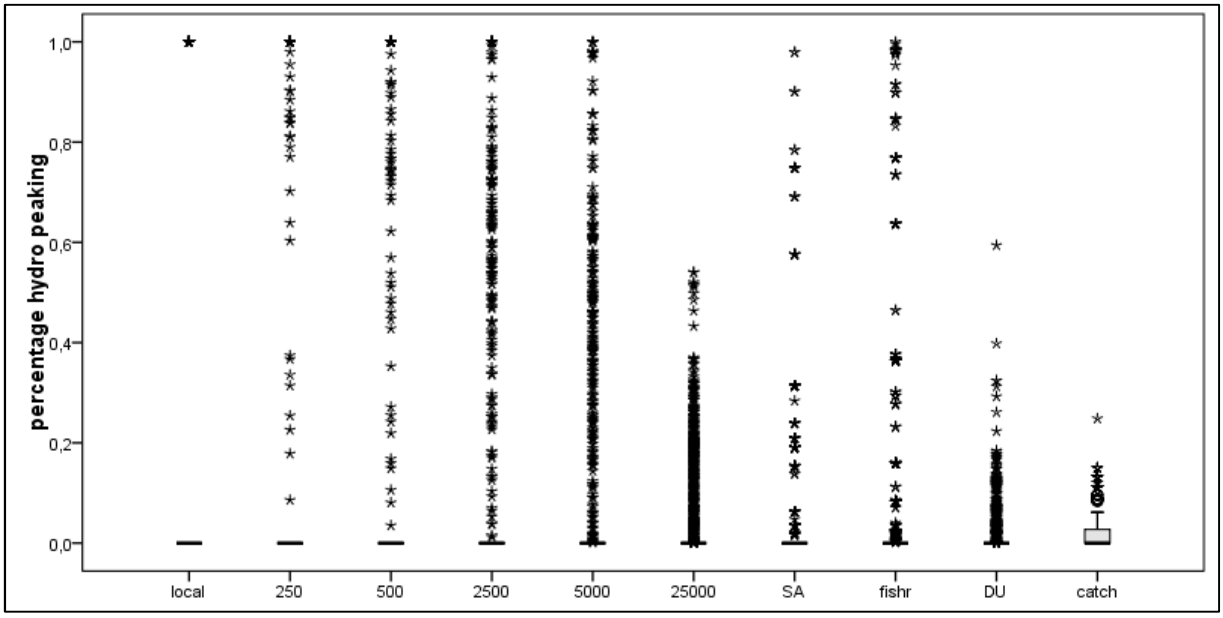

Figure B.3: Box-plots showing the percentage of hydro peaking length (inclusive 0 values) per buffer for all sample sites (1697).

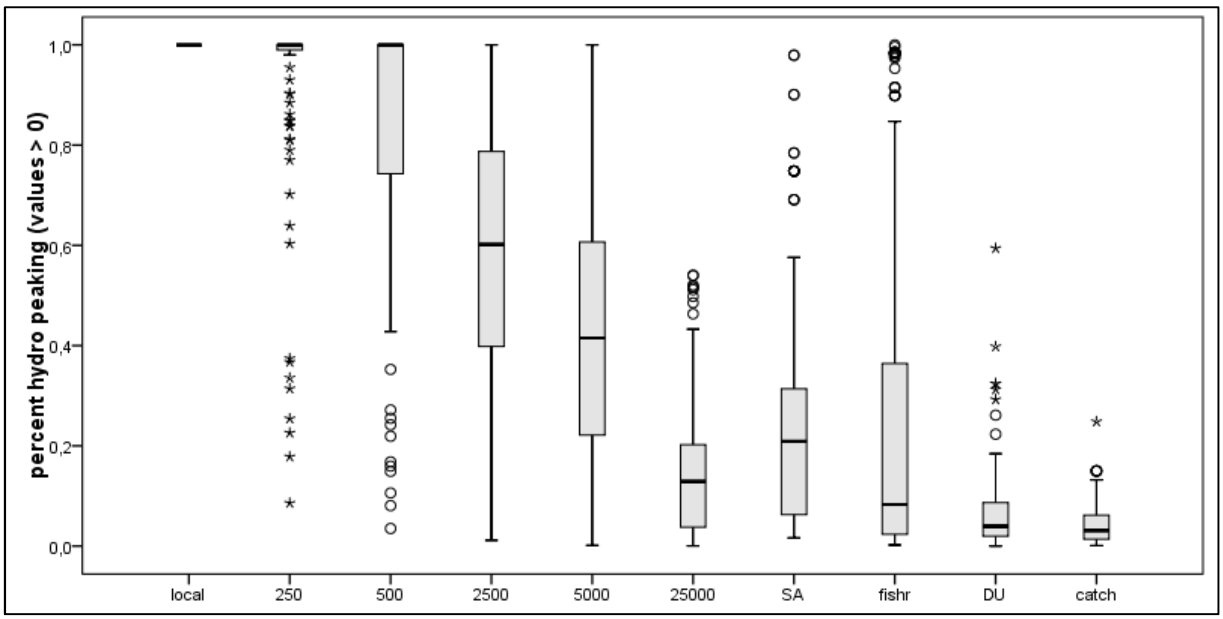

Figure B.4: Box-plots showing the percentage of hydro peaking length (> 0 percent) per buffer for all sample sites (1697).

Table B.4: Descriptive statistics of impoundment (all 1697 sample sites).

Descriptive statistics: impoundment (all 1697 sample sites)							
Scale	N	N with impoundment	Percent with impoundment	minimum percentage	maximum percentage	mean percentage	standard deviation
local	1697	162	9.5	0.00	1.00	0.10	0.29
250	1697	267	15.7	0.00	1.00	0.08	0.24
500	1697	350	20.6	0.00	1.00	0.08	0.22
2500	1697	731	43.1	0.00	1.00	0.08	0.17
5000	1697	960	56.6	0.00	1.00	0.07	0.14
25000	1697	1559	91.9	0.00	0.47	0.06	0.06
SA	875	552	63.1	0.00	1.00	0.09	0.18
fishr	1467	1031	70.3	0.00	0.63	0.10	0.15
DU	1625	1129	69.5	0.00	0.26	0.02	0.03
catch	1697	1503	88.6	0.00	0.11	0.03	0.02

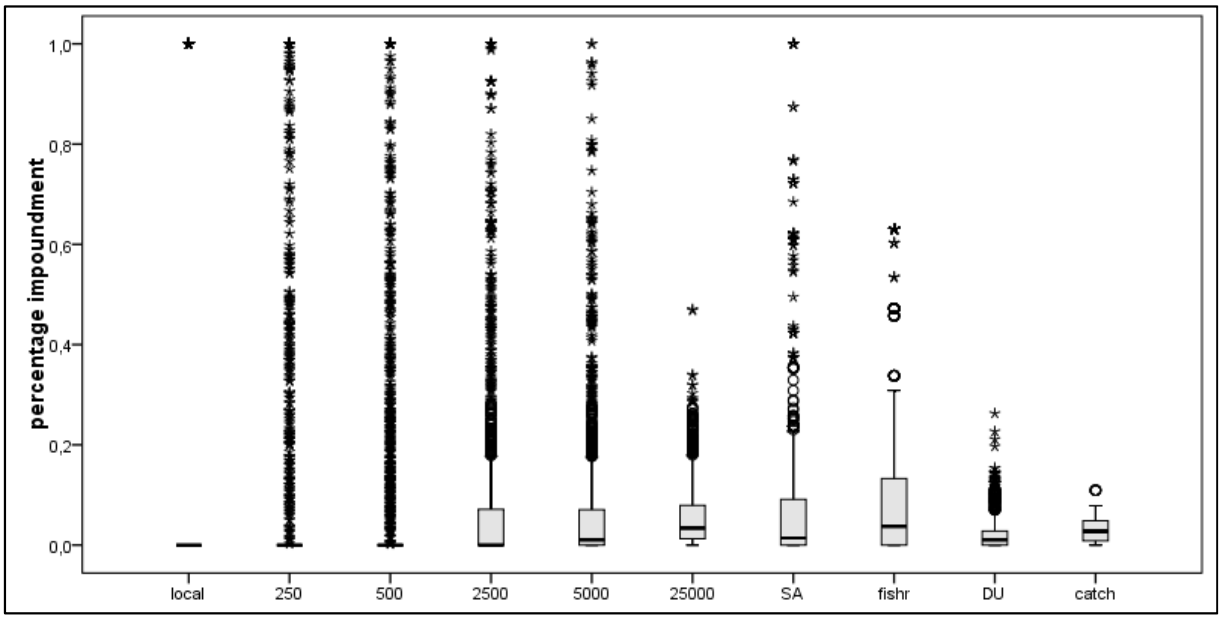

Figure B.5: Box-plots showing the percentage of impoundment length (inclusive 0 values) per buffer for all sample sites (1697).

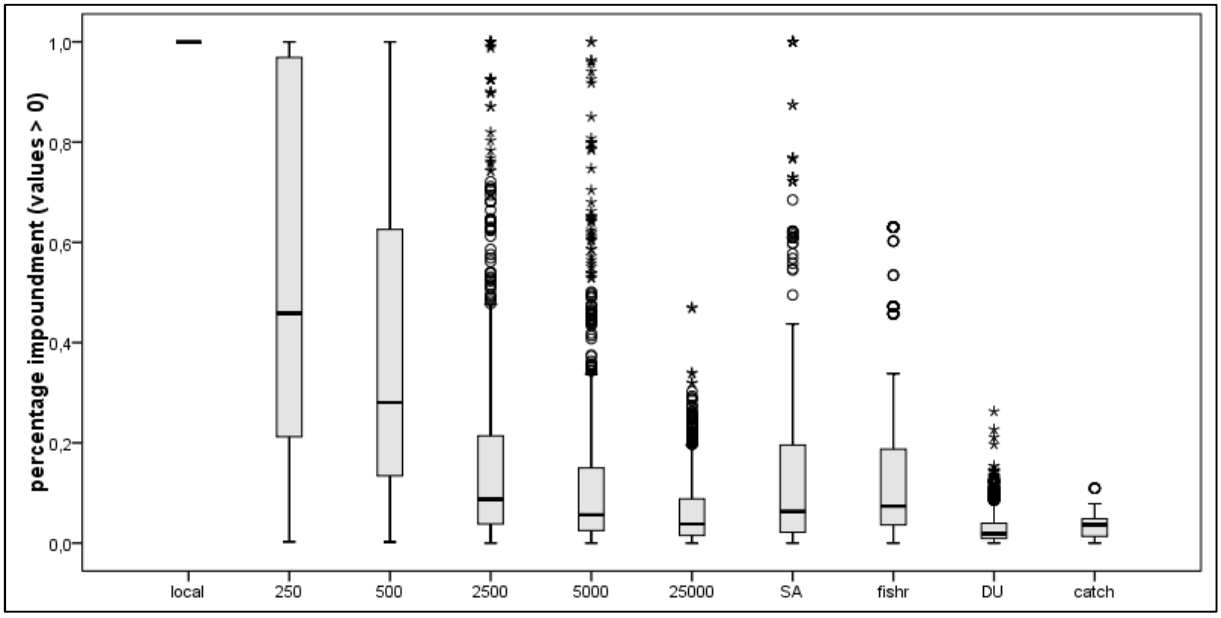

Figure B.6: Box-plots showing the percentage of impoundment length (> 0 percent) per buffer for all sample sites (1697).

Table B.5: Descriptive statistics of water abstraction (all 1697 sample sites).

Descriptive statistics: impoundment (all 1697 sample sites)							
Scale	N	N with impoundment	Percent with impoundment	minimum percentage	maximum percentage	mean percentage	standard deviation
local	1697	323	19.0	0.00	1.00	0.19	0.39
250	1697	463	27.3	0.00	1.00	0.18	0.34
500	1697	551	32.5	0.00	1.00	0.17	0.31
2500	1697	981	57.8	0.00	1.00	0.15	0.22
5000	1697	1245	73.4	0.00	1.00	0.14	0.18
25000	1697	1626	95.8	0.00	0.91	0.10	0.10
SA	875	602	68.8	0.00	1.00	0.11	0.21
fishr	1467	1283	87.5	0.00	1.00	0.17	0.21
DU	1625	1355	83.4	0.00	1.00	0.09	0.12
catch	1697	1670	98.4	0.00	0.56	0.09	0.07

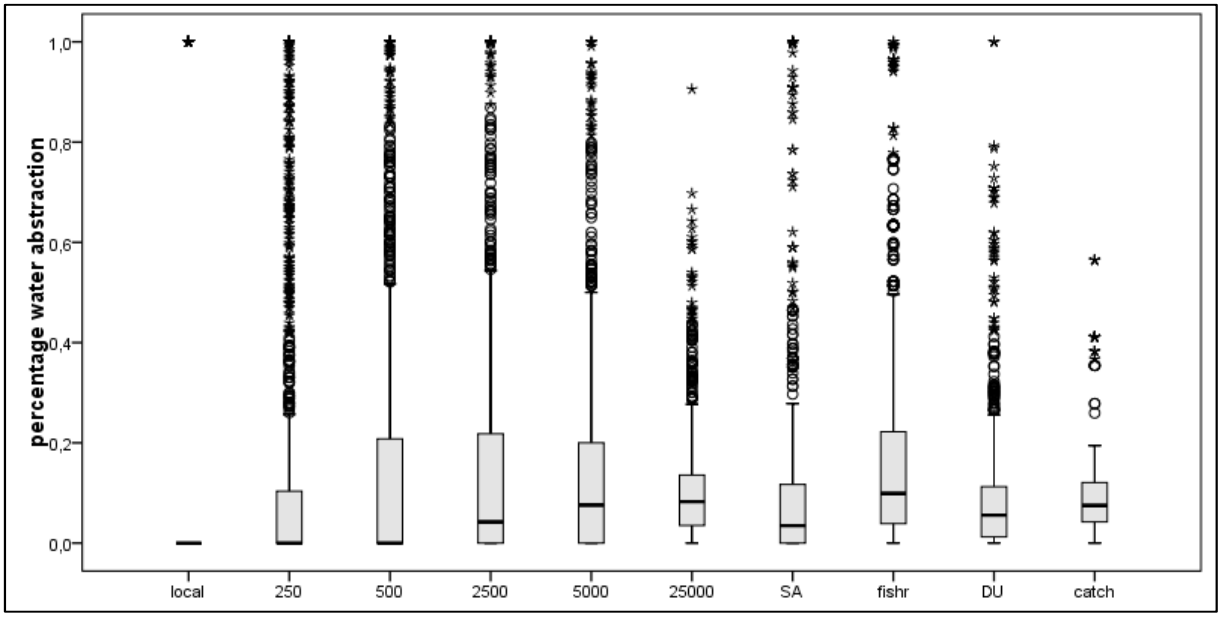

Figure B.7: Box-plots showing the percentage of water abstraction length (inclusive 0 values) per buffer for all sample sites (1697).

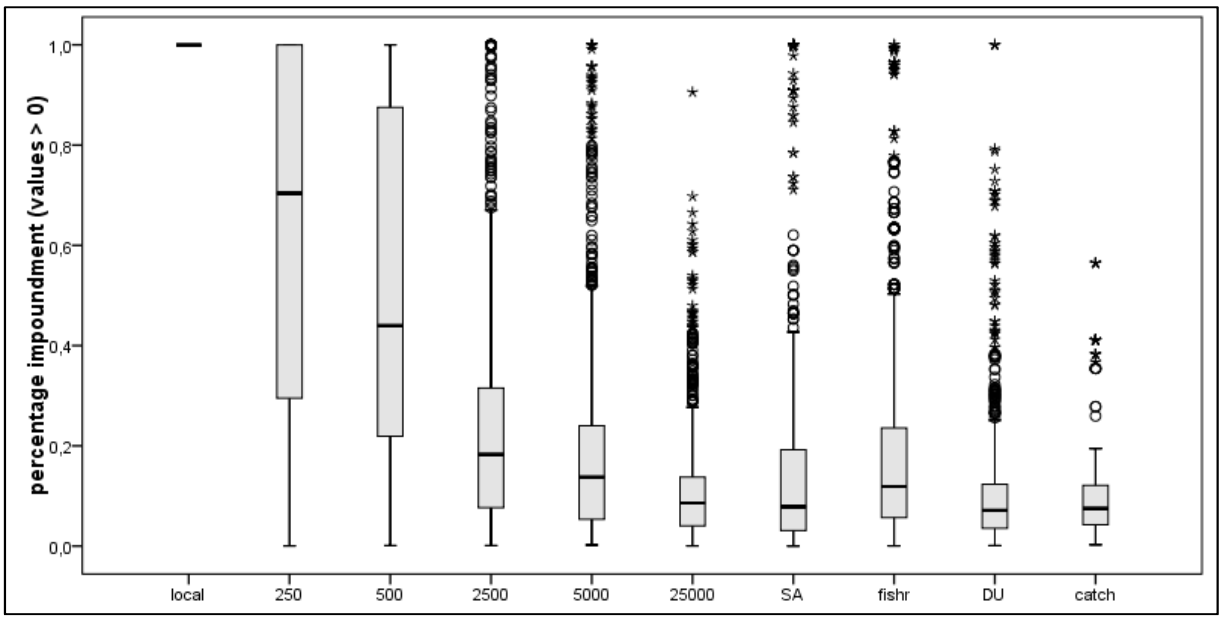

Figure B.8: Box-plots showing the percentage of water abstraction length (> 0 percnet) per buffer for all sample sites (1697).

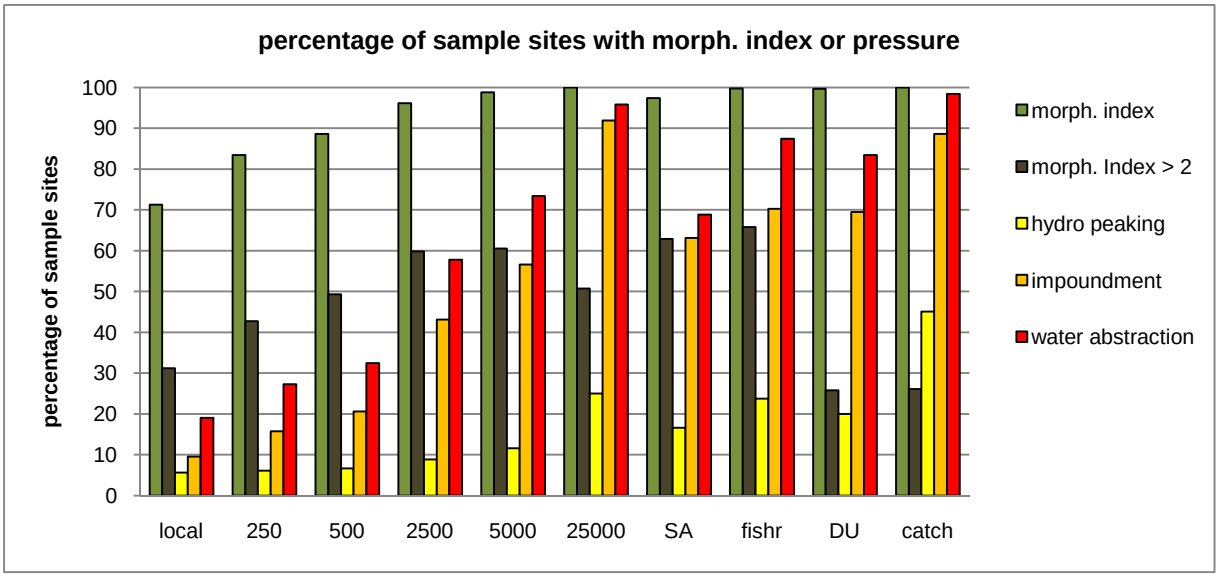

Figure B.9: Percentage of sample sites with available morphological index or impacted by pressure.

C. Fish metrics and pressures

Table C.1: Number of sample sites with single fish metrics available.

single metrics	N	N with values > 0	N with values = 0	single metrics	N	N with values > 0	N with values = 0
N_sp_all	875	875	0	n_ha_Hab_RH	862	861	1
Density_sp_all	862	862	0	perc_nha_Hab_RH	862	861	1
Biom_sp_all	862	862	0	n_sp_Hab_RH	875	874	1
kg_ha_Repro_LITH	862	853	9	perc_sp_Hab_RH	875	874	1
perc_kgha_Repro_LITH	862	854	8	P-INSE (EFI)	800	800	0
n_ha_Repro_LITH	862	856	6	P-OMNI (EFI)	800	800	0
perc_nha_Repro_LITH	862	855	7	P-PHYT (EFI)	800	800	0
n_sp_Repro_LITH	875	868	7	P-BENT (EFI)	800	800	0
perc_sp_Repro_LITH	875	868	7	P-RHEO (EFI)	800	800	0
kg_ha_Atroph_OMNI	862	340	522	P-LONG (EFI)	800	800	0
perc_kgha_Atroph_OMNI	862	339	523	P-POTA (EFI)	800	800	0
n_ha_Atroph_OMNI	862	358	504	P-LITH (EFI)	800	800	0
perc_nha_Atroph_OMNI	862	349	513	P-INTO (EFI)	800	800	0
n_sp_Atroph_OMNI	875	364	511	P-TOLE (EFI)	800	800	0
perc_sp_Atroph_OMNI	875	364	511	EFI-Index	800	800	0
kg_ha_Mig_POTAD	862	858	4	EFI-Class	800	800	0
perc_kgha_Mig_POTAD	862	858	4	MetHINTOL150 (EFIplus)	512	465	47
n_ha_Mig_POTAD	862	859	3	MetO2INTOL (EFIplus)	512	484	28
perc_nha_Mig_POTAD	862	859	3	MetRHPAR (EFIplus)	85	85	0
n_sp_Mig_POTAD	875	872	3	MetLITH (EFIplus)	85	76	9
perc_sp_Mig_POTAD	875	872	3	EFIplus-Index	597	580	17
kg_ha_Hab_RH	862	860	2	EFIplus-Class	597	597	0
perc_kgha_Hab_RH	862	860	2				

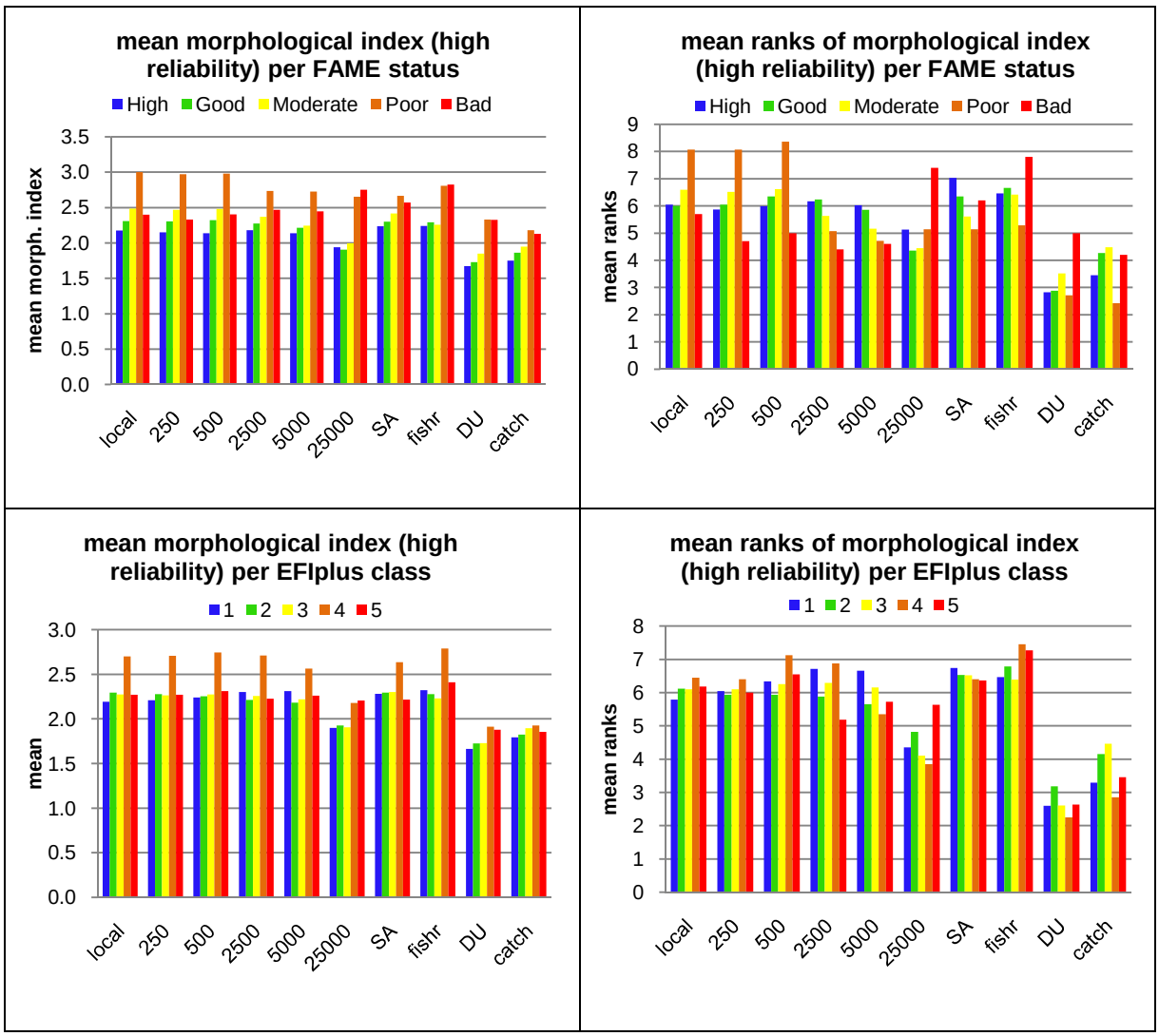

Figure C.1: Mean values and mean ranks for morphological index with high reliability per FAME status and EFIplus class.

D. Correlations

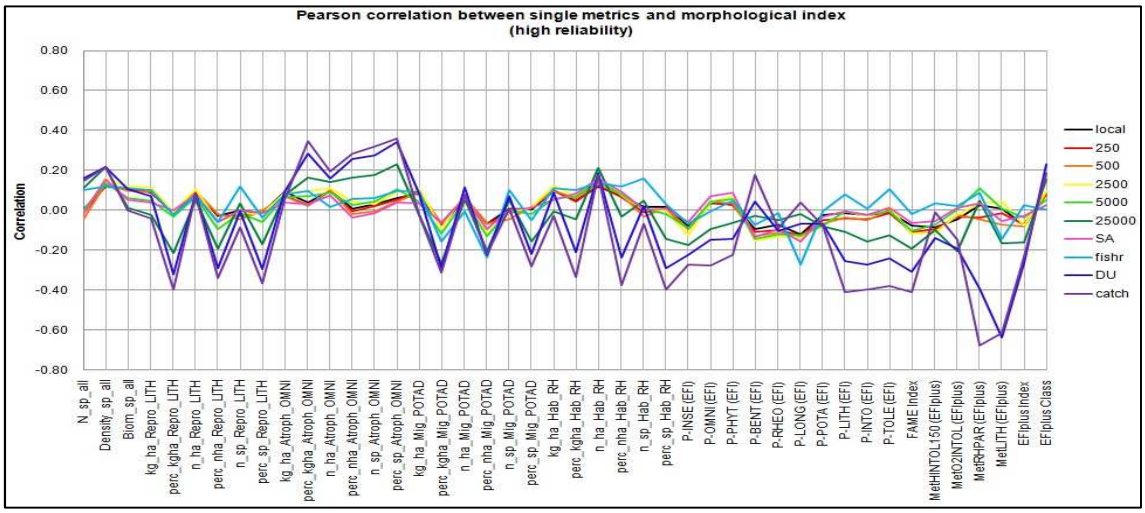

Figure D.1: Morphological index (high reliability) – Pearson correlation.

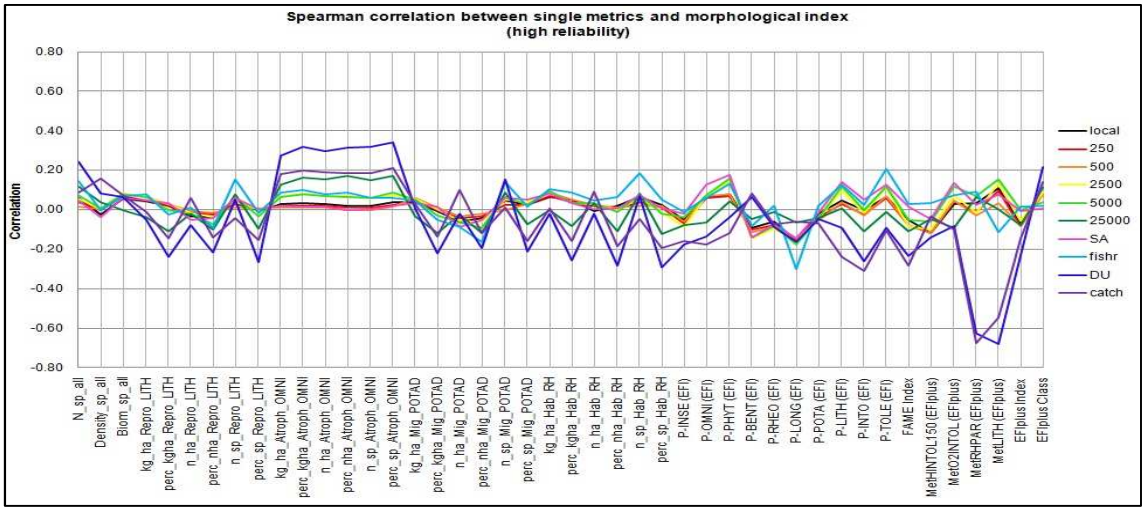

Figure D.2: Morphological index (high reliability) – Spearman correlation.

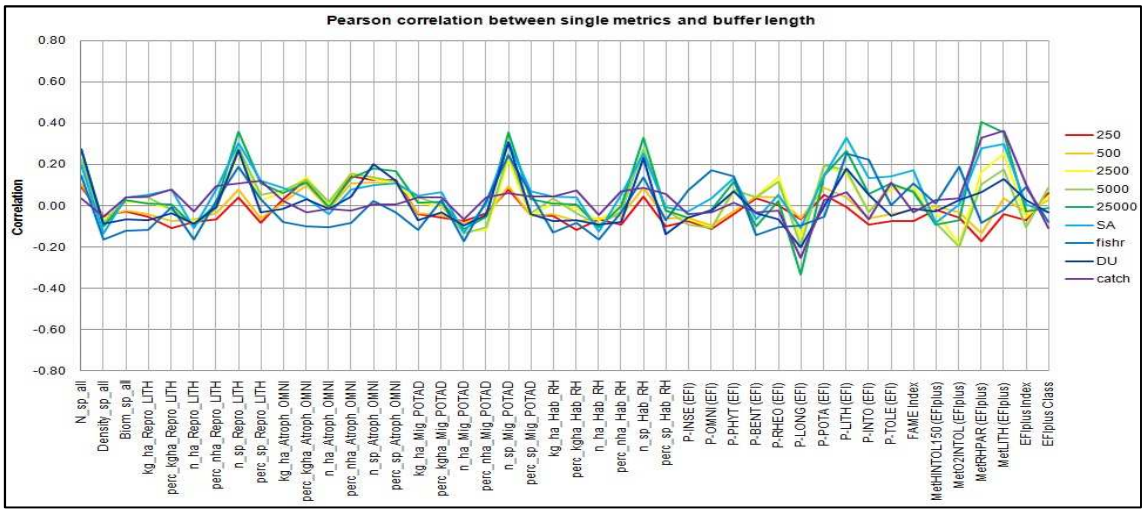

Figure D.3: Buffer length – Pearson correlation.

Table D.1: Spearman Correlation of morphological index (* = 0.05 significance; ** = 0.01 significance)

Morphological Index - Spearman Correlation																				
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
N_sp_all	0.06		0.05		0.03		0.05		0.09	**	0.14	**	0.03		0.09	*	0.25	**	0.10	**
Density_sp_all	-0.03		-0.03		-0.01		-0.04		-0.05		0.02		-0.11	**	-0.03		0.06		0.14	**
Biom_sp_all	0.06		0.03		0.05		0.04		0.04		-0.02		0.02		0.01		0.04		0.05	
kg_ha_Repro_LITH	0.04		0.00		0.03		0.03		0.04		-0.06		0.02		0.04		-0.07	*	-0.03	
perc_kgha_Repro_LITH	0.02		0.00		0.02		0.05		0.04		-0.12	**	0.08	*	0.01		-0.24	**	-0.17	**
n_ha_Repro_LITH	-0.03		-0.05		-0.03		-0.05		-0.05		-0.04		-0.10	**	0.00		-0.09	**	0.03	
perc_nha_Repro_LITH	-0.04		-0.02		-0.01		0.01		-0.02		-0.11	**	0.02		-0.03		-0.22	**	-0.17	**
n_sp_Repro_LITH	0.05		0.02		0.02		0.08		0.13	**	0.10	**	0.07	*	0.15	**	0.06		-0.03	
perc_sp_Repro_LITH	-0.01		-0.01		0.01		0.03		0.02		-0.10	**	0.05		0.02		-0.26	**	-0.17	**
kg_ha_Atroph_OMNI	0.03		0.03		0.01		0.02		0.07	*	0.13	**	-0.02		0.03		0.28	**	0.19	**
perc_kgha_Atroph_OMNI	0.03		0.04		0.02		0.04		0.09	**	0.18	**	-0.02		0.05		**0.33**	**	0.22	**
n_ha_Atroph_OMNI	0.03		0.03		0.01		0.01		0.06		0.16	**	-0.03		0.04		**0.30**	**	0.20	**
perc_nha_Atroph_OMNI	0.02		0.03		0.02		0.02		0.07	*	0.18	**	-0.03		0.05		**0.33**	**	0.21	**
n_sp_Atroph_OMNI	0.02		0.03		0.01		0.01		0.07	*	0.17	**	-0.04		0.04		**0.32**	**	0.19	**
perc_sp_Atroph_OMNI	0.04		0.05		0.02		0.03		0.09	**	0.18	**	-0.02		0.03		**0.34**	**	0.22	**
kg_ha_Mig_POTAD	0.04		0.01		0.04		0.03		0.03		-0.05		0.01		0.00		-0.02		0.01	
perc_kgha_Mig_POTAD	-0.01		-0.01		0.01		0.04		0.01		-0.13	**	0.06		-0.01		-0.22	**	-0.16	**
n_ha_Mig_POTAD	-0.06		-0.06		-0.03		-0.06		-0.08	*	-0.05		-0.14	**	-0.07	*	-0.04		0.07	*
perc_nha_Mig_POTAD	-0.04		-0.02		0.00		0.01		-0.04		-0.13	**	0.01		-0.09	*	-0.20	**	-0.15	**
n_sp_Mig_POTAD	0.05		0.04		0.04		0.08	*	0.10	**	0.10	**	0.07	*	0.10	**	0.16	**	0.02	
perc_sp_Mig_POTAD	0.03		0.02		0.04		0.07		0.03		-0.09	**	0.10	**	0.03		-0.22	**	-0.18	**
kg_ha_Hab_RH	0.06		0.01		0.05		0.05		0.07		-0.03		0.04		0.05		-0.04		-0.01	
perc_kgha_Hab_RH	0.05		-0.01		0.02		0.02		0.03		-0.09	**	0.07	*	0.10	**	-0.25	**	-0.16	**
n_ha_Hab_RH	-0.01		-0.03		-0.01		-0.02		-0.01		0.01		-0.07	*	0.02		-0.04		0.07	*
perc_nha_Hab_RH	0.02		-0.02		0.01		0.00		0.00		-0.12	**	0.06		0.07		-0.28	**	-0.19	**
n_sp_Hab_RH	0.07		0.02		0.02		0.07	*	0.13	**	0.10	**	0.07	*	0.17	**	0.08	*	-0.02	
perc_sp_Hab_RH	0.02		-0.03		-0.01		0.00		0.00		-0.13	**	0.05		0.07	*	-0.29	**	-0.20	**
P-INSE (EFI)	-0.05		-0.09	*	-0.06		-0.04		-0.03		-0.10	**	-0.05		-0.02		-0.19	**	-0.18	**
P-OMNI (EFI)	0.06		0.04		0.06		0.13	**	0.10	**	-0.04		0.13	**	0.04		-0.14	**	-0.17	**
P-PHYT (EFI)	0.08		0.03		0.04		0.12	**	0.18	**	0.07	*	0.17	**	0.10	**	-0.02		-0.09	*
P-BENT (EFI)	-0.09	*	-0.09	*	-0.11	**	-0.16	**	-0.15	**	-0.05		-0.17	**	-0.12	**	0.07		0.10	**
P-RHEO (EFI)	-0.06		-0.10	**	-0.10	**	-0.11	**	-0.07		-0.03		-0.07	*	0.01		-0.09	*	-0.07	*
P-LONG (EFI)	-0.16	**	-0.11	**	-0.10	**	-0.15	**	-0.18	**	-0.09	*	-0.12	**	-0.23	**	-0.16	**	-0.07	
P-POTA (EFI)	-0.02		-0.04		-0.05		-0.04		-0.03		-0.05		-0.01		-0.01		-0.04		-0.06	
P-LITH (EFI)	0.05		0.02		0.03		0.15	**	0.19	**	0.03		0.19	**	0.15	**	-0.09	*	-0.23	**
P-INTO (EFI)	0.00		-0.04		-0.02		0.05		0.04		-0.10	**	0.09	*	0.05		-0.26	**	**-0.31**	**
P-TOLE (EFI)	0.06		0.02		0.04		0.12	**	0.14	**	0.01		0.14	**	0.14	**	-0.08	*	-0.09	*
FAME Index	-0.05		-0.10	**	-0.07	*	-0.03		-0.01		-0.11	**	0.04		0.01		-0.23	**	-0.27	**
MetHINTOL150 (EFIplus)	-0.12	*	-0.11	*	-0.12	*	-0.14	**	-0.13	**	-0.04		-0.05		0.02		-0.12	**	-0.01	
MetO2INTOL (EFIplus)	0.03		0.06		0.08		0.15	**	0.15	**	-0.08		0.15	**	0.06		-0.10	*	-0.13	**
MetRHPAR (EFIplus)	0.03		-0.30	*	-0.21		0.01		0.16		0.08		0.03		0.29	**	**-0.63**	**	**-0.67**	**
MetLITH (EFIplus)	0.11		-0.16		-0.12		0.00		0.15		0.02		0.08		0.18		**-0.68**	**	**-0.54**	**
EFIplus Index	-0.08		-0.10	*	-0.09	*	-0.06		-0.04		-0.07		0.00		0.04		-0.22	**	-0.13	**
EFIplus Class	0.08		0.10	*	0.09	*	0.07		0.06		0.11	*	0.02		-0.02		0.21	**	0.14	**

Table D.2: Spearman Correlation for morphological index (significance level: * = 0.05; ** = 0.01)

Morphological Index - Pearson Correlation																						
	local		**250**		**500**		**2500**		**5000**		**25000**		**SA**		**fishr**		**DU**		**catch**	
N_sp_all	0.00		0.01		-0.01		-0.01		0.02		0.13	**	-0.03		0.08	*	0.17	**	0.16	**
Density_sp_all	0.12	**	0.10	**	0.11	**	0.12	**	0.10	**	0.20	**	0.09	*	0.07		0.21	**	0.20	**
Biom_sp_all	0.11	**	0.06		0.06		0.06		0.04		0.00		0.03		0.04		0.09	*	-0.01	
kg_ha_Repro_LITH	0.09	*	0.05		0.05		0.05		0.04		-0.04		0.02		0.04		0.06		-0.05	
perc_kgha_Repro_LITH	-0.01		-0.06		-0.04		0.02		0.01		-0.21	**	0.02		0.05		**-0.32**	**	**-0.40**	**
n_ha_Repro_LITH	0.09	*	0.06		0.07	*	0.07	*	0.05		0.03		0.03		0.04		0.07	*	0.06	
perc_nha_Repro_LITH	-0.03		-0.04		-0.03		-0.01		-0.03		-0.19		0.00		0.01		-0.29	**	**-0.35**	
n_sp_Repro_LITH	0.00		-0.02		-0.03		0.01		0.04		0.06		0.02		0.14	**	0.00		-0.07	*
perc_sp_Repro_LITH	-0.02		-0.04		-0.02		0.01		0.00		-0.18	**	0.03		0.03		-0.29	**	**-0.37**	**
kg_ha_Atroph_OMNI	0.10	*	0.07		0.06		0.06		0.06		0.07	*	0.02		0.04		0.10	**	0.06	
perc_kgha_Atroph_OMNI	0.04		0.07	*	0.06		0.06		0.08	*	0.16	**	0.00		0.03		0.29	**	**0.36**	**
n_ha_Atroph_OMNI	0.10	*	0.10	**	0.11	**	0.09	**	0.06		0.14	**	0.03		-0.02		0.16	**	0.20	**
perc_nha_Atroph_OMNI	0.01		0.05		0.04		0.02		0.03		0.17	**	-0.03		0.01		0.26	**	0.30	**
n_sp_Atroph_OMNI	0.03		0.06		0.03		0.01		0.05		0.19	**	-0.05		0.03		0.28	**	**0.33**	**
perc_sp_Atroph_OMNI	0.06		0.08	*	0.06		0.05		0.10	**	0.23	**	-0.01		0.04		**0.34**	**	**0.36**	**
kg_ha_Mig_POTAD	0.09	*	0.05		0.05		0.05		0.03		-0.04		0.01		0.03		0.07		-0.04	
perc_kgha_Mig_POTAD	-0.08	*	-0.07	*	-0.05		-0.04		-0.07	*	-0.26	**	-0.01		-0.05		-0.29	**	**-0.32**	**
n_ha_Mig_POTAD	0.06		0.04		0.06		0.06		0.03		0.03		0.01		-0.02		0.10	**	0.06	
perc_nha_Mig_POTAD	-0.07		-0.03		-0.02		-0.03		-0.06		-0.21	**	-0.03		-0.12	**	-0.23	**	-0.24	**
n_sp_Mig_POTAD	0.01		0.02		0.01		0.02		0.04		0.08	*	0.03		0.12	**	0.08	*	0.02	
perc_sp_Mig_POTAD	0.00		0.01		0.03		0.03		0.00		-0.17	**	0.06		-0.01		-0.22	**	-0.29	**
kg_ha_Hab_RH	0.10	*	0.06		0.06		0.06		0.04		-0.03		0.02		0.04		0.07	*	-0.04	
perc_kgha_Hab_RH	0.05		-0.02		-0.01		0.06		0.09	**	-0.06		0.07	*	0.09	*	-0.21	**	**-0.33**	**
n_ha_Hab_RH	0.12	**	0.09	*	0.10	**	0.12	**	0.11	**	0.19	**	0.10	**	0.09	*	0.18	**	0.16	
perc_nha_Hab_RH	0.07		-0.01		0.00		0.05		0.08	*	-0.04		0.09	**	0.11	**	-0.24	**	**-0.37**	
n_sp_Hab_RH	0.02		-0.02		-0.02		0.01		0.04		0.07	*	0.02		0.14	**	0.03		-0.05	
perc_sp_Hab_RH	0.02		-0.06		-0.03		0.01		0.01		-0.15	**	0.04		0.06		-0.29	**	**-0.40**	
P-INSE (EFI)	-0.08		-0.12	**	-0.10	**	-0.07		-0.07	*	-0.19	**	-0.07	*	-0.05		-0.24	**	-0.29	
P-OMNI (EFI)	0.04		0.02		0.04		0.10	**	0.07	*	-0.08	*	0.10	**	0.02		-0.15	**	-0.27	
P-PHYT (EFI)	0.03		-0.02		0.00		0.07		0.10	**	-0.04		0.10	**	0.06		-0.14	**	-0.20	
P-BENT (EFI)	-0.10	*	-0.10	**	-0.11	**	-0.16	**	-0.16	**	-0.03		-0.17	**	-0.11	**	0.05		0.18	
P-RHEO (EFI)	-0.07		-0.12	**	-0.11	**	-0.12	**	-0.10	**	-0.07		-0.10	**	-0.02		-0.10	**	-0.09	
P-LONG (EFI)	-0.12	**	-0.06		-0.07		-0.12	**	-0.13	**	-0.04		-0.10	**	-0.20	**	-0.07		0.04	
P-POTA (EFI)	-0.02		-0.04		-0.05		-0.07		-0.06		-0.08	*	-0.03		-0.01		-0.06		-0.07	
P-LITH (EFI)	-0.01		-0.04		-0.04		0.06		0.09	*	-0.08	*	0.06		0.14	**	-0.25	**	**-0.40**	
P-INTO (EFI)	-0.02		-0.06		-0.04		0.04		0.03		-0.15	**	0.03		0.05		-0.27	**	**-0.39**	
P-TOLE (EFI)	-0.01		-0.06		-0.03		0.03		0.04		-0.11	**	0.05		0.12	**	-0.24	**	**-0.37**	
FAME Index	-0.08		-0.13	**	-0.11	**	-0.05		-0.04		-0.18	**	-0.03		0.01		**-0.31**	**	**-0.40**	
MetHINTOL150 (EFIplus)	-0.09		-0.09		-0.11	*	-0.15	**	-0.13	**	-0.08		-0.04		0.03		-0.12	**	0.01	
MetO2INTOL (EFIplus)	-0.05		-0.02		0.00		0.03		0.02		-0.19	**	0.06		0.04		-0.20	**	-0.17	
MetRHPAR (EFIplus)	0.02		**-0.34**	**	-0.17		0.02		0.18		0.06		0.01		0.24	*	**-0.39**	**	**-0.68**	
MetLITH (EFIplus)	0.01		-0.21		-0.18		-0.06		0.11		-0.14		-0.07		0.10		**-0.64**	**	**-0.61**	
EFIplus Index	-0.07		-0.10	*	-0.10	*	-0.08		-0.04		-0.14	**	0.00		0.07		-0.26	**	-0.23	
EFIplus Class	0.08		0.11	*	0.10	*	0.08	*	0.06		0.14	**	0.02		-0.03		0.23	**	0.19	

Table D.3: Spearman Correlation for mophological index (high reliability) (significance level: * = 0.05; ** = 0.01)

Morphological Index (high reliability) - Spearman Correlation																						
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
N_sp_all	0.06		0.04		0.02		0.05		0.07		0.12	**	0.05		0.15	**	0.24	**	0.09	*
Density_sp_all	-0.03		0.00		0.00		0.00		0.01		0.04		-0.04		0.00		0.08	*	0.16	**
Biom_sp_all	0.06		0.07		0.08	*	0.08	*	0.08	*	0.00		0.06		0.07		0.07		0.07	*
kg_ha_Repro_LITH	0.04		0.05		0.06		0.07		0.07		-0.04		0.05		0.08		-0.05		-0.01	
perc_kgha_Repro_LITH	0.02		0.02		0.03		0.03		0.00		-0.11	**	0.04		-0.02		-0.24	**	-0.15	**
n_ha_Repro_LITH	-0.03		-0.01		-0.01		-0.01		-0.02		-0.02		-0.05		0.01		-0.08	*	0.06	
perc_nha_Repro_LITH	-0.04		-0.02		-0.02		-0.04		-0.07		-0.10	**	-0.04		-0.09	*	-0.22	**	-0.14	**
n_sp_Repro_LITH	0.05		0.03		0.01		0.05		0.06		0.08	*	0.06		0.16	**	0.05		-0.04	
perc_sp_Repro_LITH	-0.01		0.00		0.01		0.00		-0.03		-0.10	**	0.00		-0.01		-0.26	**	-0.15	**
kg_ha_Atroph_OMNI	0.03		0.02		0.01		0.07		0.07		0.13	**	0.02		0.09		0.27	**	0.18	**
perc_kgha_Atroph_OMNI	0.03		0.02		0.01		0.08	*	0.08	*	0.16	**	0.01		0.10	*	**0.32**	**	0.20	**
n_ha_Atroph_OMNI	0.03		0.02		0.01		0.07		0.07		0.16	**	0.01		0.08		0.30	**	0.19	**
perc_nha_Atroph_OMNI	0.02		0.01		0.00		0.07		0.07		0.17	**	0.00		0.09		**0.32**	**	0.19	**
n_sp_Atroph_OMNI	0.02		0.01		0.00		0.05		0.06		0.15	**	0.00		0.06		**0.32**	**	0.18	**
perc_sp_Atroph_OMNI	0.04		0.03		0.01		0.07		0.09	*	0.17	**	0.02		0.06		**0.34**	**	0.21	**
kg_ha_Mig_POTAD	0.04		0.05		0.06		0.06		0.05		-0.03		0.03		0.05		0.01		0.03	
perc_kgha_Mig_POTAD	-0.01		0.00		0.01		0.00		-0.03		-0.12	**	0.02		-0.05		-0.22	**	-0.14	**
n_ha_Mig_POTAD	-0.06		-0.04		-0.03		-0.05		-0.06		-0.02		-0.09	*	-0.09		-0.02		0.10	**
perc_nha_Mig_POTAD	-0.04		-0.03		-0.02		-0.06		-0.09	*	-0.12	**	-0.05		-0.16	**	-0.19	**	-0.12	**
n_sp_Mig_POTAD	0.05		0.02		0.00		0.05		0.06		0.09	*	0.06		0.14	**	0.16	**	0.01	
perc_sp_Mig_POTAD	0.03		0.02		0.03		0.04		0.02		-0.07	*	0.05		0.01		-0.21	**	-0.16	**
kg_ha_Hab_RH	0.06		0.07		0.09	*	0.09	*	0.09	*	0.00		0.08	*	0.10	*	-0.02		0.01	
perc_kgha_Hab_RH	0.05		0.04		0.05		0.03		0.03		-0.08	*	0.03		0.09		-0.26	**	-0.16	**
n_ha_Hab_RH	-0.01		0.02		0.03		0.03		0.03		0.03		0.00		0.05		-0.02		0.09	**
perc_nha_Hab_RH	0.02		0.01		0.01		0.00		-0.01		-0.11	**	0.01		0.07		-0.28	**	-0.19	**
n_sp_Hab_RH	0.07		0.04		0.02		0.06		0.08	*	0.08	*	0.07		0.18	**	0.07		-0.05	
perc_sp_Hab_RH	0.02		0.01		0.02		-0.01		-0.02		-0.12	**	0.01		0.05		-0.29	**	-0.20	**
P-INSE (EFI)	-0.05		-0.07		-0.06		-0.09	*	-0.04		-0.08	*	-0.02		-0.01		-0.18	**	-0.16	**
P-OMNI (EFI)	0.06		0.06		0.07		0.07		0.08		-0.06		0.13	**	0.06		-0.13	**	-0.18	**
P-PHYT (EFI)	0.08		0.07		0.08		0.14	**	0.16	**	0.04		0.18	**	0.13	**	-0.04		-0.12	**
P-BENT (EFI)	-0.09	*	-0.10	*	-0.12	**	-0.15	**	-0.14	**	-0.05		-0.14	**	-0.08		0.06		0.08	*
P-RHEO (EFI)	-0.06		-0.08		-0.09	*	-0.10	*	-0.08	*	-0.01		-0.07		0.02		-0.09	*	-0.07	*
P-LONG (EFI)	-0.16	**	-0.15	**	-0.14	**	-0.16	**	-0.18	**	-0.07		-0.15	**	-0.30	**	-0.16	**	-0.06	
P-POTA (EFI)	-0.02		-0.04		-0.06		-0.04		-0.04		-0.04		-0.01		0.02		-0.05		-0.07	
P-LITH (EFI)	0.05		0.03		0.04		0.10	*	0.12	**	0.01		0.14	**	0.13	**	-0.09	*	-0.24	**
P-INTO (EFI)	0.00		-0.02		-0.03		-0.02		0.00		-0.11	**	0.05		0.02		-0.26	**	**-0.31**	**
P-TOLE (EFI)	0.06		0.06		0.07		0.12	**	0.12	**	-0.01		0.13	**	0.21	**	-0.09	*	-0.10	**
FAME Index	-0.05		-0.08		-0.08		-0.08	*	-0.05		-0.11	**	0.02		0.03		-0.23	**	-0.28	**
MetHINTOL150 (EFIplus)	-0.12	*	-0.12	*	-0.12	*	-0.10	*	-0.06		-0.05		-0.05		0.03		-0.14	**	-0.03	
MetO2INTOL (EFIplus)	0.03		0.04		0.05		0.07		0.12	*	-0.09	*	0.14	**	0.07		-0.08		-0.10	*
MetRHPAR (EFIplus)	0.03		-0.01		-0.03		-0.02		0.07		0.07		0.03		0.09		**-0.63**	**	**-0.67**	**
MetLITH (EFIplus)	0.11		0.10		0.04		0.14		0.15		0.00		0.08		-0.11		**-0.68**	**	**-0.54**	**
EFIplus Index	-0.08		-0.08		-0.08		-0.05		0.00		-0.08		-0.01		0.01		-0.23	**	-0.14	**
EFIplus Class	0.08		0.08		0.08		0.09		0.04		0.11	**	0.01		0.02		0.22	**	0.14	**

Table D.4: Pearson Correlation for morphological index (high reliability) (significance level: * = 0.05; ** = 0.01)

Morphological Index (high relibability) - Pearson Correlation																						
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
N_sp_all	0.00		-0.01		-0.05		-0.01		0.00		0.11	**	-0.02		0.10	*	0.16	**	0.15	**
Density_sp_all	0.12	**	0.12	**	0.13	**	0.16	**	0.14	**	0.22	**	0.16	**	0.12	**	0.22	**	0.22	**
Biom_sp_all	0.11	**	0.11	**	0.10	*	0.12	**	0.06		0.01		0.05		0.11	*	0.11	**	0.00	
kg_ha_Repro_LITH	0.09	*	0.10	*	0.09	*	0.11	**	0.05		-0.02		0.04		0.10	*	0.07	*	-0.04	
perc_kgha_Repro_LITH	-0.01		-0.02		-0.01		-0.01		-0.03		-0.21	**	0.00		-0.02		**-0.32**	**	**-0.40**	**
n_ha_Repro_LITH	0.09	*	0.09	*	0.10	*	0.11	**	0.07		0.05		0.08	*	0.07		0.08	*	0.08	*
perc_nha_Repro_LITH	-0.03		-0.02		-0.02		-0.06		-0.10	*	-0.19	**	-0.06		-0.06		-0.29	**	**-0.34**	**
n_sp_Repro_LITH	0.00		-0.03		-0.04		-0.01		-0.01		0.04		0.00		0.12	**	0.00		-0.09	*
perc_sp_Repro_LITH	-0.02		-0.01		0.00		-0.02		-0.06		-0.17	**	-0.01		-0.04		-0.29	**	**-0.36**	**
kg_ha_Atroph_OMNI	0.10	*	0.08		0.07		0.09	*	0.07		0.08	*	0.04		0.08		0.09	*	0.05	
perc_kgha_Atroph_OMNI	0.04		0.03		0.02		0.10	*	0.07		0.16	**	0.03		0.10	*	0.28	**	**0.35**	**
n_ha_Atroph_OMNI	0.10	*	0.10	*	0.10	*	0.11	**	0.09	*	0.14	**	0.08		0.02		0.16	**	0.20	**
perc_nha_Atroph_OMNI	0.01		-0.01		-0.02		0.04		0.03		0.17	**	-0.04		0.06		0.26	**	0.29	**
n_sp_Atroph_OMNI	0.03		0.02		0.00		0.03		0.04		0.18	**	-0.01		0.06		0.28	**	**0.32**	**
perc_sp_Atroph_OMNI	0.06		0.05		0.05		0.09	*	0.11	**	0.23	**	0.04		0.10	*	**0.34**	**	**0.36**	**
kg_ha_Mig_POTAD	0.09	*	0.09	*	0.09	*	0.11	**	0.05		-0.02		0.04		0.09	*	0.08	*	-0.02	
perc_kgha_Mig_POTAD	-0.08	*	-0.07		-0.06		-0.09	*	-0.11	**	-0.27	**	-0.06		-0.16	**	-0.29	**	**-0.31**	**
n_ha_Mig_POTAD	0.06		0.06		0.07		0.08	*	0.05		0.06		0.06		0.00		0.11	**	0.08	*
perc_nha_Mig_POTAD	-0.07		-0.07		-0.06		-0.11	**	-0.13	**	-0.20	**	-0.09	*	-0.24	**	-0.22	**	-0.22	**
n_sp_Mig_POTAD	0.01		-0.01		-0.04		-0.01		0.00		0.06		0.00		0.10	*	0.07	*	0.01	
perc_sp_Mig_POTAD	0.00		0.01		0.02		0.01		-0.02		-0.15	**	0.02		-0.05		-0.22	**	-0.28	**
kg_ha_Hab_RH	0.10	*	0.10	*	0.10	*	0.12	**	0.06		-0.01		0.05		0.11	*	0.09	*	-0.03	
perc_kgha_Hab_RH	0.05		0.04		0.06		0.07		0.07		-0.04		0.09	*	0.10	*	-0.21	**	**-0.33**	**
n_ha_Hab_RH	0.12	**	0.13	**	0.14	**	0.16	**	0.15	**	0.21	**	0.16	**	0.14	**	0.19	**	0.18	**
perc_nha_Hab_RH	0.07		0.07		0.08	*	0.08		0.08	*	-0.03		0.09	*	0.12	**	-0.24	**	**-0.37**	**
n_sp_Hab_RH	0.02		-0.01		-0.03		0.00		0.01		0.05		0.00		0.16	**	0.02		-0.07	
perc_sp_Hab_RH	0.02		0.01		0.01		0.00		-0.02		-0.14	**	0.01		0.03		-0.29	**	**-0.40**	**
P-INSE (EFI)	-0.08		-0.09	*	-0.09	*	-0.12	**	-0.09	*	-0.17	**	-0.06		-0.07		-0.22	**	-0.27	**
P-OMNI (EFI)	0.04		0.04		0.04		0.04		0.05		-0.09	*	0.07		0.00		-0.15	**	-0.28	**
P-PHYT (EFI)	0.03		0.03		0.04		0.07		0.06		-0.06		0.09	*	0.05		-0.14	**	-0.22	**
P-BENT (EFI)	-0.10	*	-0.11	**	-0.13	**	-0.15	**	-0.14	**	-0.03		-0.13	**	-0.07		0.04		0.18	**
P-RHEO (EFI)	-0.07		-0.10	*	-0.11	**	-0.13	**	-0.12	**	-0.05		-0.10	*	-0.01		-0.10	**	-0.09	*
P-LONG (EFI)	-0.12	**	-0.12	**	-0.13	**	-0.14	**	-0.12	**	-0.02		-0.16	**	-0.27	**	-0.07		0.04	
P-POTA (EFI)	-0.02		-0.05		-0.07		-0.08		-0.08		-0.08	*	-0.03		-0.01		-0.07		-0.08	*
P-LITH (EFI)	-0.01		-0.04		-0.03		0.00		0.00		-0.11	**	-0.01		0.08		-0.25	**	**-0.41**	**
P-INTO (EFI)	-0.02		-0.04		-0.05		-0.03		-0.02		-0.16	**	-0.02		0.01		-0.27	**	**-0.40**	**
P-TOLE (EFI)	-0.01		-0.01		0.00		0.02		0.00		-0.12	**	0.01		0.11	*	-0.24	**	**-0.38**	**
FAME Index	-0.08		-0.11	**	-0.12	**	-0.12	**	-0.10	*	-0.19	**	-0.06		-0.02		**-0.31**	**	**-0.41**	**
MetHINTOL150 (EFIplus)	-0.09		-0.09		-0.11	*	-0.11	*	-0.07		-0.10	*	-0.06		0.04		-0.14	**	-0.01	
MetO2INTOL (EFIplus)	-0.05		-0.03		-0.02		-0.02		0.01		-0.20	**	0.01		0.02		-0.19	**	-0.15	**
MetRHPAR (EFIplus)	0.02		-0.04		-0.05		0.04		0.11		0.05		0.03		0.09		**-0.39**	**	**-0.68**	**
MetLITH (EFIplus)	0.01		-0.02		-0.07		0.04		0.01		-0.16		-0.05		-0.14		**-0.64**	**	**-0.61**	**
EFIplus Index	-0.07		-0.07		-0.08		-0.08		-0.04		-0.16	**	-0.03		0.03		-0.26	**	-0.23	**
EFIplus Class	0.08		0.08		0.09		0.10	*	0.05		0.15	**	0.03		0.00		0.23	**	0.19	**

Table D.5: Spearman Correlation for hydro peaking (significance level: * = 0.05; ** = 0.01)

Percentage Hydro peaking - Spearman Correlation																								
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
N_sp_all	0.03		0.02		0.01		0.01		0.00		-0.05		0.05		0.04		0.21	**	0.08	*
Density_sp_all	-0.18	**	-0.18	**	-0.16	**	-0.15	**	-0.19	**	-0.27	**	-0.19	**	**-0.34**	**	**-0.36**	**	-0.28	**
Biom_sp_all	-0.15	**	-0.17	**	-0.15	**	-0.13	**	-0.15	**	-0.21	**	-0.11	**	-0.23	**	-0.20	**	-0.22	**
kg_ha_Repro_LITH	-0.13	**	-0.15	**	-0.13	**	-0.11	**	-0.12	**	-0.17	**	-0.08	*	-0.18	**	-0.16	**	-0.23	**
perc_kgha_Repro_LITH	0.02		0.00		0.03		0.04		0.06		0.09	**	0.06		0.18	**	0.10	**	0.00	
n_ha_Repro_LITH	-0.16	**	-0.16	**	-0.14	**	-0.12	**	-0.15	**	-0.20	**	-0.15	**	-0.26	**	-0.30	**	-0.27	**
perc_nha_Repro_LITH	0.01		0.00		0.02		0.03		0.07		0.13	**	0.08	*	0.19	**	0.13	**	0.07	*
n_sp_Repro_LITH	0.04		0.04		0.04		0.04		0.04		0.03		0.12	**	0.15	**	0.29	**	0.09	**
perc_sp_Repro_LITH	0.00		0.01		0.02		0.03		0.07	*	0.13	**	0.10	**	0.17	**	0.10	**	0.06	
kg_ha_Atroph_OMNI	-0.12	**	-0.12	**	-0.13	**	-0.11	**	-0.13	**	-0.16	**	-0.08	*	-0.22	**	-0.07	*	-0.03	
perc_kgha_Atroph_OMNI	-0.12	**	-0.11	**	-0.13	**	-0.11	**	-0.14	**	-0.15	**	-0.09	**	-0.22	**	-0.06		-0.03	
n_ha_Atroph_OMNI	-0.11	**	-0.11	**	-0.11	**	-0.10	**	-0.12	**	-0.15	**	-0.07	*	-0.21	**	-0.07		-0.03	
perc_nha_Atroph_OMNI	-0.09	**	-0.09	**	-0.10	**	-0.10	**	-0.12	**	-0.13	**	-0.07		-0.20	**	-0.05		-0.02	
n_sp_Atroph_OMNI	-0.09	*	-0.08	*	-0.09	**	-0.08	*	-0.11	**	-0.14	**	-0.05		-0.17	**	-0.02		0.00	
perc_sp_Atroph_OMNI	-0.08	*	-0.08	*	-0.09	*	-0.08	*	-0.11	**	-0.13	**	-0.05		-0.19	**	-0.04		0.00	
kg_ha_Mig_POTAD	-0.14	**	-0.16	**	-0.14	**	-0.12	**	-0.13	**	-0.19	**	-0.09	**	-0.20	**	-0.18	**	-0.22	**
perc_kgha_Mig_POTAD	0.01		-0.02		0.00		0.02		0.04		0.06		0.03		0.17	**	0.12	**	0.01	
n_ha_Mig_POTAD	-0.16	**	-0.17	**	-0.15	**	-0.14	**	-0.17	**	-0.23	**	-0.16	**	-0.29	**	**-0.33**	**	-0.27	**
perc_nha_Mig_POTAD	0.01		-0.01		0.01		0.02		0.06		0.12	**	0.07	*	0.18	**	0.10	**	0.06	
n_sp_Mig_POTAD	0.04		0.03		0.02		0.04		0.03		0.00		0.11	**	0.14	**	0.30	**	0.12	**
perc_sp_Mig_POTAD	0.03		0.03		0.03		0.06		0.09	*	0.13	**	0.12	**	0.19	**	0.12	**	0.04	
kg_ha_Hab_RH	-0.13	**	-0.15	**	-0.13	**	-0.11	**	-0.13	**	-0.18	**	-0.10	**	-0.19	**	-0.18	**	-0.23	**
perc_kgha_Hab_RH	0.06		0.07		0.07	*	0.05		0.05		0.04		-0.01		0.08	*	-0.05		-0.06	
n_ha_Hab_RH	-0.16	**	-0.16	**	-0.14	**	-0.13	**	-0.16	**	-0.22	**	-0.16	**	-0.29	**	**-0.32**	**	-0.27	**
perc_nha_Hab_RH	0.04		0.04		0.06		0.03		0.04		0.04		-0.02		0.10	**	-0.02		-0.05	
n_sp_Hab_RH	0.05		0.04		0.04		0.04		0.02		-0.02		0.07	*	0.12	**	0.25	**	0.05	
perc_sp_Hab_RH	0.02		0.03		0.04		0.02		0.03		0.02		-0.03		0.08	*	-0.05		-0.07	*
P-INSE (EFI)	0.08	*	0.06		0.06		0.07		0.06		-0.02		0.08	*	0.13	**	0.08	*	-0.14	**
P-OMNI (EFI)	0.26	**	0.24	**	0.21	**	0.20	**	0.21	**	0.18	**	0.19	**	**0.33**	**	0.26	**	0.06	
P-PHYT (EFI)	0.22	**	0.18	**	0.14	**	0.13	**	0.13	**	0.07	*	0.13	**	0.23	**	0.25	**	-0.01	
P-BENT (EFI)	-0.16	**	-0.17	**	-0.16	**	-0.15	**	-0.16	**	-0.16	**	-0.16	**	-0.22	**	-0.15	**	-0.09	*
P-RHEO (EFI)	-0.13	**	-0.12	**	-0.10	**	-0.09	*	-0.10	**	-0.09	**	-0.04		-0.11	**	-0.07		-0.13	**
P-LONG (EFI)	0.01		0.02		0.03		0.02		0.03		0.10	**	0.04		-0.02		-0.08	*	-0.07	*
P-POTA (EFI)	-0.16	**	-0.14	**	-0.12	**	-0.09	*	-0.09	**	-0.08	*	0.01		-0.12	**	-0.05		-0.09	*
P-LITH (EFI)	0.27	**	0.25	**	0.22	**	0.22	**	0.23	**	0.25	**	0.29	**	**0.42**	**	**0.44**	**	0.10	**
P-INTO (EFI)	0.24	**	0.23	**	0.21	**	0.20	**	0.20	**	0.22	**	0.21	**	**0.36**	**	0.26	**	0.05	
P-TOLE (EFI)	0.09	*	0.07	*	0.05		0.04		0.03		-0.02		0.03		0.10	**	0.11	**	-0.07	*
FAME Index	0.11	**	0.10	**	0.08	*	0.08	*	0.08	*	0.08	*	0.15	**	0.22	**	0.19	**	-0.11	**
MetHINTOL150 (EFIplus)	0.05		0.06		0.05		0.05		0.03		0.04		0.03		0.05		0.00		0.04	
MetO2INTOL (EFIplus)	**0.30**	**	0.29	**	0.29	**	0.27	**	0.29	**	0.20	**	**0.32**	**	**0.46**	**	**0.36**	**	0.20	**
MetRHPAR (EFIplus)	0.17		0.12		0.12		0.06		0.06		0.06		0.02		0.07		0.07		-0.17	
MetLITH (EFIplus)	0.03		0.11		0.11		0.10		0.10		0.10		0.14		0.14		0.18		-0.03	
EFIplus Index	0.13	**	0.14	**	0.13	**	0.12	**	0.11	**	0.09	*	0.11	**	0.18	**	0.11	*	0.04	
EFIplus Class	-0.11	**	-0.12	**	-0.11	*	-0.11	**	-0.11	**	-0.09	*	-0.12	**	-0.17	**	-0.09	*	-0.05	

Table D.6: Pearson Correlation for hydro peaking (significance level: * = 0.05; ** = 0.01)

Percentage Hydro peaking - Pearson Correlation																								
	local		250		500		2500		5000		25000		SA		fishr		DU		catch					
N_sp_all	-0.02		-0.03		-0.03		-0.03		-0.03		-0.09	**	-0.03		-0.05		0.01		-0.03					
Density_sp_all	-0.08	*	-0.08	*	-0.09	*	-0.09	**	-0.10	**	-0.12	**	-0.10	**	-0.11	**	-0.14	**	-0.12	**				
Biom_sp_all	-0.07	*	-0.07	*	-0.08	*	-0.08	*	-0.08	*	-0.09	**	-0.07	*	-0.08	*	-0.07	*	-0.08	*				
kg_ha_Repro_LITH	-0.07		-0.07	*	-0.07	*	-0.07	*	-0.08	*	-0.08	*	-0.07	*	-0.08	*	-0.06		-0.09	*				
perc_kgha_Repro_LITH	0.05		0.05		0.05		0.05		0.05		0.07	*	0.04		0.09	*	0.08	*	0.02					
n_ha_Repro_LITH	-0.07	*	-0.08	*	-0.08	*	-0.08	*	-0.09	*	-0.10	**	-0.09	**	-0.10	**	-0.12	**	-0.12	**				
perc_nha_Repro_LITH	0.02		0.02		0.02		0.02		0.02		0.08	*	0.03		0.10	**	0.12	**	0.05					
n_sp_Repro_LITH	0.01		0.00		0.00		0.00		0.00		-0.04		0.00		0.03		0.09	*	0.00					
perc_sp_Repro_LITH	0.02		0.02		0.03		0.04		0.04		0.10	**	0.07		0.12	**	0.09	*	0.05					
kg_ha_Atroph_OMNI	-0.04		-0.04		-0.04		-0.04		-0.04		-0.05		-0.04		-0.06		-0.07		-0.04					
perc_kgha_Atroph_OMNI	-0.10	**	-0.10	**	-0.11	**	-0.10	**	-0.11	**	-0.15	**	-0.12	**	-0.14	**	-0.15	**	-0.09	**				
n_ha_Atroph_OMNI	-0.06		-0.06		-0.06		-0.05		-0.06		-0.07	*	-0.05		-0.08	*	-0.08	*	-0.05					
perc_nha_Atroph_OMNI	-0.09	**	-0.09	**	-0.09	**	-0.08	*	-0.09	*	-0.12	**	-0.11	**	-0.14	**	-0.13	**	-0.06					
n_sp_Atroph_OMNI	-0.09	**	-0.09	*	-0.09	**	-0.09	**	-0.09	**	-0.13	**	-0.09	**	-0.12	**	-0.11	**	-0.05					
perc_sp_Atroph_OMNI	-0.09	**	-0.08	*	-0.09	**	-0.09	**	-0.10	**	-0.14	**	-0.11	**	-0.13	**	-0.13	**	-0.07	*				
kg_ha_Mig_POTAD	-0.07	*	-0.07	*	-0.08	*	-0.08	*	-0.08	*	-0.08	*	-0.07	*	-0.08	*	-0.07		-0.09	*				
perc_kgha_Mig_POTAD	0.01		0.01		0.01		0.01		0.01		0.04		-0.01		0.04		0.07	*	-0.02					
n_ha_Mig_POTAD	-0.07	*	-0.08	*	-0.08	*	-0.08	*	-0.09	**	-0.10	**	-0.09	**	-0.11	**	-0.13	**	-0.14	**				
perc_nha_Mig_POTAD	0.02		0.01		0.01		0.00		0.00		0.06		0.02		0.08	*	0.10	**	0.01					
n_sp_Mig_POTAD	0.02		0.01		0.00		0.01		0.01		-0.04		0.01		0.04		0.11	**	-0.01					
perc_sp_Mig_POTAD	0.02		0.02		0.02		0.03		0.04		0.09	**	0.05		0.10	**	0.08	*	0.02					
kg_ha_Hab_RH	-0.07		-0.07	*	-0.07	*	-0.08	*	-0.08	*	-0.09	*	-0.07	*	-0.08	*	-0.07	*	-0.09	**				
perc_kgha_Hab_RH	0.06		0.06		0.06		0.06		0.06		0.07	*	0.04		0.09	*	0.05		0.01					
n_ha_Hab_RH	-0.08	*	-0.08	*	-0.08	*	-0.08	*	-0.09	**	-0.11	**	-0.09	**	-0.10	**	-0.13	**	-0.12	**				
perc_nha_Hab_RH	0.06		0.07		0.07	*	0.07	*	0.07	*	0.10	**	0.08	*	0.10	**	0.08	*	0.04					
n_sp_Hab_RH	0.01		0.01		0.00		0.00		-0.01		-0.07		-0.01		0.00		0.07		-0.03					
perc_sp_Hab_RH	0.04		0.05		0.05		0.05		0.05		0.07	*	0.06		0.09	*	0.06		0.03					
P-INSE (EFI)	0.07		0.06		0.05		0.05		0.05		0.02		0.04		0.04		0.09	*	-0.12	**				
P-OMNI (EFI)	0.25	**	0.24	**	0.24	**	0.22	**	0.23	**	0.22	**	0.24	**	0.28	**	0.24	**	0.13	**				
P-PHYT (EFI)	0.19	**	0.18	**	0.17	**	0.15	**	0.15	**	0.10	**	0.12	**	0.16	**	0.15	**	0.00					
P-BENT (EFI)	-0.17	**	-0.18	**	-0.18	**	-0.17	**	-0.17	**	-0.17	**	-0.17	**	-0.20	**	-0.15	**	-0.14	**				
P-RHEO (EFI)	-0.13	**	-0.13	**	-0.12	**	-0.11	**	-0.11	**	-0.11	**	-0.09	*	-0.15	**	-0.06		-0.15	**				
P-LONG (EFI)	0.03		0.02		0.03		0.04		0.05		0.08	*	0.04		-0.04		-0.01		-0.05					
P-POTA (EFI)	-0.18	**	-0.17	**	-0.16	**	-0.15	**	-0.14	**	-0.14	**	-0.11	**	-0.17	**	-0.09	*	-0.15	**				
P-LITH (EFI)	0.23	**	0.23	**	0.22	**	0.22	**	0.22	**	0.19	**	0.20	**	0.26	**	0.27	**	0.11	**				
P-INTO (EFI)	0.23	**	0.23	**	0.23	**	0.22	**	0.22	**	0.22	**	0.23	**	0.28	**	0.24	**	0.13	**				
P-TOLE (EFI)	0.05		0.06		0.06		0.06		0.05		0.06		0.07	*	0.14	**	0.07		0.00					
FAME Index	0.11	**	0.11	**	0.11	**	0.10	**	0.11	**	0.09	*	0.11	**	0.13	**	0.16	**	-0.05					
MetHINTOL150 (EFIplus)	0.01		0.02		0.02		0.02		0.02		0.01		-0.02		-0.06		-0.05		0.02					
MetO2INTOL (EFIplus)	0.19	**	0.19	**	0.19	**	0.18	**	0.18	**	0.17	**	0.21	**	0.20	**	0.21	**	0.14	**				
MetRHPAR (EFIplus)	0.13		0.13		0.12		0.11		0.10		0.11		0.07		0.14		0.05		-0.06					
MetLITH (EFIplus)	0.07		0.10		0.10		0.12		0.12		0.11		0.15		0.08		0.17		0.10					
EFIplus Index	0.11	**	0.12	**	0.12	**	0.12	**	0.12	**	0.11	**	0.11	**	0.08		0.09	*	0.08	*				
EFIplus Class	-0.11	**	-0.11	**	-0.11	**	-0.11	**	-0.11	**	-0.10	*	-0.11	**	-0.05		-0.07		-0.10					

Table D.7: Spearman Correlation for impoundment (significance level: * = 0.05; ** = 0.01)

Percentage Impoundment - Spearman Correlation																						
	local		**250**		**500**		**2500**		**5000**		**25000**		**SA**		**fishr**		**DU**		**catch**	
N_sp_all	0.17	**	0.21	**	0.22	**	0.26	**	0.27	**	**0.32**	**	**0.43**	**	**0.38**	**	**0.35**	**	0.17	**
Density_sp_all	-0.12	**	-0.12	**	-0.08	*	-0.05		0.00		-0.01		-0.17	**	-0.14	**	-0.04		0.00	
Biom_sp_all	-0.08	*	-0.07	*	-0.04		0.00		0.02		-0.01		0.00		-0.11	**	-0.04		-0.02	
kg_ha_Repro_LITH	-0.15	**	-0.14	**	-0.11	**	-0.07	*	-0.06		-0.07	*	-0.07		-0.18	**	-0.14	**	-0.06	
perc_kgha_Repro_LITH	-0.11	**	-0.12	**	-0.13	**	-0.14	**	-0.17	**	-0.23	**	-0.13	**	-0.23	**	-0.28	**	-0.20	**
n_ha_Repro_LITH	-0.20	**	-0.20	**	-0.17	**	-0.13	**	-0.09	**	-0.09	*	-0.24	**	-0.24	**	-0.18	**	-0.06	
perc_nha_Repro_LITH	-0.07	*	-0.10	**	-0.12	**	-0.14	**	-0.15	**	-0.20	**	-0.11	**	-0.24	**	-0.27	**	-0.24	**
n_sp_Repro_LITH	0.03		0.08	*	0.11	**	0.17	**	0.17	**	0.20	**	**0.35**	**	0.24	**	0.18	**	0.09	*
perc_sp_Repro_LITH	-0.09	**	-0.10	**	-0.09	*	-0.07	*	-0.10	**	-0.13	**	-0.08	*	-0.19	**	-0.23	**	-0.09	*
kg_ha_Atroph_OMNI	0.11	**	0.15	**	0.15	**	0.21	**	0.24	**	0.30	**	**0.32**	**	0.21	**	**0.30**	**	0.12	**
perc_kgha_Atroph_OMNI	0.15	**	0.19	**	0.19	**	0.24	**	0.27	**	**0.33**	**	**0.34**	**	0.27	**	**0.35**	**	0.14	**
n_ha_Atroph_OMNI	0.12	**	0.15	**	0.16	**	0.21	**	0.24	**	0.30	**	**0.31**	**	0.23	**	**0.31**	**	0.13	**
perc_nha_Atroph_OMNI	0.16	**	0.19	**	0.19	**	0.23	**	0.26	**	**0.33**	**	**0.34**	**	0.27	**	**0.34**	**	0.13	**
n_sp_Atroph_OMNI	0.17	**	0.21	**	0.20	**	0.23	**	0.25	**	**0.31**	**	**0.34**	**	**0.30**	**	**0.34**	**	0.12	**
perc_sp_Atroph_OMNI	0.17	**	0.20	**	0.19	**	0.22	**	0.24	**	0.29	**	**0.32**	**	0.27	**	**0.33**	**	0.11	**
kg_ha_Mig_POTAD	-0.10	**	-0.09	*	-0.06		-0.01		-0.01		-0.03		-0.01		-0.12	**	-0.07	*	-0.05	
perc_kgha_Mig_POTAD	-0.07	*	-0.08		-0.10		-0.10		-0.13		-0.20		-0.11		-0.16		-0.22		-0.16	
n_ha_Mig_POTAD	-0.12	**	-0.12		-0.10		-0.08	*	-0.05		-0.06		-0.22		-0.18		-0.11		-0.08	
perc_nha_Mig_POTAD	-0.02		-0.04		-0.08		-0.12		-0.14		-0.24		-0.15		-0.20		-0.23		-0.23	
n_sp_Mig_POTAD	0.15	**	0.19		0.20		0.25		0.23		0.26		**0.44**		**0.36**		0.28		0.13	
perc_sp_Mig_POTAD	-0.06		-0.07	*	-0.08	*	-0.09	**	-0.12	**	-0.17	**	-0.09	**	-0.14	**	-0.20	**	-0.06	
kg_ha_Hab_RH	-0.17	**	-0.15	**	-0.13	**	-0.08	*	-0.06		-0.08	*	-0.08	*	-0.20	**	-0.13	**	-0.06	
perc_kgha_Hab_RH	-0.23	**	-0.23	**	-0.23	**	-0.24	**	-0.23	**	-0.25	**	-0.24	**	**-0.33**	**	**-0.31**	**	-0.13	**
n_ha_Hab_RH	-0.22	**	-0.21	**	-0.18	**	-0.14	**	-0.09	*	-0.09	**	-0.25	**	-0.25	**	-0.15	**	-0.03	
perc_nha_Hab_RH	-0.21	**	-0.21	**	-0.21	**	-0.21	**	-0.22	**	-0.25	**	-0.24	**	**-0.32**	**	**-0.31**	**	-0.11	**
n_sp_Hab_RH	0.00		0.06		0.09	**	0.16	**	0.16	**	0.20	**	**0.33**	**	0.24	**	0.19	**	0.11	**
perc_sp_Hab_RH	-0.22	**	-0.22	**	-0.22	**	-0.21	**	-0.22	**	-0.24	**	-0.24	**	**-0.31**	**	-0.30	**	-0.10	**
P-INSE (EFI)	-0.15	**	-0.15	**	-0.13	**	-0.14	**	-0.15	**	-0.17	**	-0.12	**	-0.10	**	-0.19	**	-0.11	**
P-OMNI (EFI)	-0.04		-0.07	*	-0.09	*	-0.13	**	-0.16	**	-0.21	**	-0.10	**	-0.09	*	-0.17	**	-0.08	*
P-PHYT (EFI)	-0.05		-0.02		-0.01		0.02		0.00		-0.02		0.15	**	0.07		0.03		0.04	
P-BENT (EFI)	-0.06		-0.02		0.00		0.06		0.09	*	0.11	**	0.04		0.08	*	0.11	**	0.05	
P-RHEO (EFI)	-0.20	**	-0.14	**	-0.09	**	0.00		0.01		0.05		0.07		0.02		-0.02		0.03	
P-LONG (EFI)	-0.20	**	-0.24	**	-0.24	**	-0.25	**	-0.28	**	**-0.35**	**	-0.29	**	-0.18	**	-0.25	**	-0.06	
P-POTA (EFI)	-0.07		-0.03		-0.01		0.06		0.06		0.10	**	0.19	**	0.08		0.04		0.08	*
P-LITH (EFI)	0.03		0.02		0.01		-0.01		-0.01		-0.05		0.22	**	0.05		-0.05		-0.09	**
P-INTO (EFI)	-0.08	*	-0.13	**	-0.15	**	-0.20	**	-0.23	**	-0.27	**	-0.10	**	-0.12	**	-0.25	**	-0.18	**
P-TOLE (EFI)	-0.06		-0.06		-0.05		0.00		-0.01		-0.04		0.07		-0.12	**	-0.10	**	-0.04	
FAME Index	-0.17	**	-0.18	**	-0.16	**	-0.13	**	-0.16	**	-0.17	**	0.01		-0.07		-0.18	**	-0.05	
MetHINTOL150 (EFIplus)	-0.06		-0.06		-0.06		-0.02		0.01		0.05		-0.08		0.01		0.03		0.10	*
MetO2INTOL (EFIplus)	0.11	*	0.08		0.07		0.09	*	0.06		-0.08		0.13	**	0.08		0.02		0.10	*
MetRHPAR (EFIplus)	**-0.57**	**	**-0.53**	**	**-0.52**	**	**-0.50**	**	**-0.44**	**	**-0.50**	**	**-0.44**	**	**-0.53**	**	**-0.47**	**	**-0.56**	**
MetLITH (EFIplus)	**-0.48**	**	**-0.47**	**	**-0.47**	**	**-0.42**	**	**-0.36**	**	**-0.33**	**	**-0.31**	**	**-0.43**	**	**-0.48**	**	**-0.47**	**
EFIplus Index	-0.16	**	-0.13	**	-0.12	**	-0.05		-0.03		-0.07		-0.09	*	-0.05		-0.03		0.04	
EFIplus Class	0.12	**	0.10	*	0.10	*	0.04		0.02		0.07		0.06		0.05		0.04		-0.03	

Table D.8: Pearson Correlation for impoundment (significance level: * = 0.05; ** = 0.01)

Percentage Impoundment - Pearson Correlation																						
	local		**250**		**500**		**2500**		**5000**		**25000**		**SA**		**fishr**		**DU**		**catch**	
N_sp_all	0.14	**	0.17	**	0.19	**	0.22	**	0.23	**	0.27	**	0.21	**	**0.35**	**	0.28	**	0.08	*
Density_sp_all	-0.06		-0.06		-0.06		-0.05		-0.05		-0.05		-0.08	*	-0.07		0.11	**	0.02	
Biom_sp_all	-0.06		-0.05		-0.06		-0.04		-0.04		-0.06		0.00		-0.10	**	-0.06		-0.09	*
kg_ha_Repro_LITH	-0.07	*	-0.07	*	-0.08	*	-0.06		-0.07		-0.07	*	-0.02		-0.13	**	-0.12	**	-0.10	**
perc_kgha_Repro_LITH	-0.25	**	-0.24	**	-0.25	**	-0.29	**	-0.27	**	-0.25	**	-0.21	**	**-0.38**	**	**-0.49**	**	-0.12	**
n_ha_Repro_LITH	-0.10	**	-0.10	**	-0.11	**	-0.11	**	-0.10	**	-0.06		-0.12	**	-0.13	**	-0.07	*	-0.03	
perc_nha_Repro_LITH	-0.18	**	-0.19	**	-0.21	**	-0.24	**	-0.22	**	-0.21	**	-0.19	**	**-0.36**	**	**-0.45**	**	-0.19	**
n_sp_Repro_LITH	0.01		0.05		0.07	*	0.08	*	0.09	**	0.13	**	0.10	**	0.14	**	-0.01		0.03	
perc_sp_Repro_LITH	-0.17	**	-0.19	**	-0.20	**	-0.21	**	-0.22	**	-0.22	**	-0.18	**	**-0.34**	**	**-0.41**	**	-0.08	*
kg_ha_Atroph_OMNI	0.01		0.00		0.01		0.03		0.02		0.04		0.06		0.01		0.13	**	0.00	
perc_kgha_Atroph_OMNI	0.18	**	0.19	**	0.22	**	0.25	**	0.27	**	**0.33**	**	0.29	**	**0.34**	**	**0.49**	**	0.15	**
n_ha_Atroph_OMNI	0.07	*	0.08	*	0.10	**	0.11	**	0.09	**	0.09	**	0.08	*	0.10	**	0.25	**	0.09	**
perc_nha_Atroph_OMNI	0.19	**	0.21	**	0.23	**	0.26	**	0.25	**	**0.31**	**	0.28	**	**0.32**	**	**0.46**	**	0.08	*
n_sp_Atroph_OMNI	0.22	**	0.22	**	0.23	**	0.26	**	0.27	**	**0.32**	**	0.23	**	**0.40**	**	**0.46**	**	0.10	**
perc_sp_Atroph_OMNI	0.21	**	0.21	**	0.22	**	0.24	**	0.26	**	0.29	**	0.24	**	**0.34**	**	**0.46**	**	0.11	**
kg_ha_Mig_POTAD	-0.06		-0.05		-0.06		-0.04		-0.05		-0.06		0.00		-0.10	**	-0.09	*	-0.10	**
perc_kgha_Mig_POTAD	-0.12	**	-0.10	**	-0.11	**	-0.13	**	-0.13	**	-0.14	**	-0.07	*	-0.20	**	**-0.31**	**	-0.11	**
n_ha_Mig_POTAD	-0.07	*	-0.06		-0.06		-0.06		-0.07	*	-0.10	**	-0.10	*	-0.12	**	-0.04		-0.11	**
perc_nha_Mig_POTAD	-0.02		-0.02		-0.04		-0.06		-0.08	*	-0.17	**	-0.05		-0.22	**	-0.25	**	-0.21	**
n_sp_Mig_POTAD	0.14	**	0.17	**	0.19	**	0.22	**	0.22	**	0.22	**	0.20	**	**0.31**	**	0.14	**	0.06	
perc_sp_Mig_POTAD	-0.05		-0.06		-0.07	*	-0.09	*	-0.11	**	-0.15	**	-0.10	**	-0.20	**	-0.27	**	-0.05	
kg_ha_Hab_RH	-0.08	*	-0.08	*	-0.09	*	-0.07	*	-0.07	*	-0.08	*	-0.02		-0.13	**	-0.11	**	-0.10	**
perc_kgha_Hab_RH	-0.30	**	-0.30	**	**-0.32**	**	**-0.36**	**	**-0.35**	**	**-0.31**	**	-0.26	**	**-0.44**	**	**-0.50**	**	-0.12	**
n_ha_Hab_RH	-0.11	**	-0.11	**	-0.11	**	-0.11	**	-0.10	**	-0.08	*	-0.12	**	-0.13	**	0.03		0.01	
perc_nha_Hab_RH	**-0.32**	**	**-0.32**	**	**-0.34**	**	**-0.39**	**	**-0.37**	**	**-0.32**	**	**-0.32**	**	**-0.47**	**	**-0.55**	**	-0.11	**
n_sp_Hab_RH	-0.01		0.03		0.05		0.06		0.07	*	0.12	**	0.10	**	0.13	**	0.02		0.05	
perc_sp_Hab_RH	-0.29	**	-0.29	**	**-0.31**	**	**-0.35**	**	**-0.35**	**	**-0.33**	**	-0.28	**	**-0.46**	**	**-0.48**	**	-0.11	**
P-INSE (EFI)	-0.19	**	-0.20	**	-0.21	**	-0.22	**	-0.21	**	-0.22	**	-0.23	**	-0.20	**	**-0.31**	**	-0.10	**
P-OMNI (EFI)	-0.06		-0.06		-0.08	*	-0.12	**	-0.14	**	-0.23	**	-0.13	**	-0.20	**	**-0.33**	**	-0.09	*
P-PHYT (EFI)	-0.13	**	-0.12	**	-0.13	**	-0.13	**	-0.13	**	-0.14	**	-0.08	*	-0.15	**	-0.23	**	0.01	
P-BENT (EFI)	-0.07		-0.06		-0.05		-0.01		0.02		0.07	*	0.01		0.08	*	0.18	**	0.03	
P-RHEO (EFI)	-0.21	**	-0.19	**	-0.18	**	-0.16	**	-0.14	**	-0.07	*	-0.10	**	-0.10	*	-0.09	*	0.02	
P-LONG (EFI)	-0.13	**	-0.17	**	-0.17	**	-0.15	**	-0.16	**	-0.21	**	-0.18	**	-0.07		-0.03		-0.05	
P-POTA (EFI)	-0.06		-0.06		-0.05		-0.03		-0.03		0.02		0.02		0.00		-0.03		0.09	*
P-LITH (EFI)	-0.06		-0.06		-0.07		-0.13	**	-0.13	**	-0.17	**	-0.07	*	-0.20	**	**-0.41**	**	-0.12	**
P-INTO (EFI)	-0.09	*	-0.08	*	-0.08	*	-0.12	**	-0.15	**	-0.23	**	-0.15	**	-0.19	**	**-0.39**	**	-0.18	**
P-TOLE (EFI)	-0.17	**	-0.18	**	-0.19	**	-0.23	**	-0.24	**	-0.24	**	-0.16	**	**-0.37**	**	**-0.41**	**	-0.06	
FAME Index	-0.25	**	-0.24	**	-0.24	**	-0.27	**	-0.27	**	-0.29	**	-0.21	**	-0.29	**	**-0.42**	**	-0.09	**
MetHINTOL150 (EFIplus)	-0.08		-0.09	*	-0.10	*	-0.10	*	-0.09	*	0.04		-0.06		0.01		-0.01		0.10	*
MetO2INTOL (EFIplus)	0.06		0.07		0.05		0.05		0.04		-0.07		0.00		-0.03		-0.14	**	0.15	**
MetRHPAR (EFIplus)	**-0.61**	**	**-0.53**	**	**-0.53**	**	**-0.58**	**	**-0.47**	**	**-0.56**	**	**-0.39**	**	**-0.62**	**	**-0.46**	**	-0.28	*
MetLITH (EFIplus)	**-0.51**	**	**-0.50**	**	**-0.51**	**	**-0.51**	**	**-0.42**	**	**-0.35**	**	**-0.40**	**	**-0.46**	**	**-0.50**	**	-0.12	
EFIplus Index	-0.17	**	-0.17	**	-0.17	**	-0.18	**	-0.16	**	-0.12	**	-0.16	**	-0.16	**	-0.22	**	0.07	
EFIplus Class	0.12	**	0.12	**	0.12	**	0.14	**	0.12	**	0.08	*	0.11	**	0.10	*	0.15	**	-0.05	

Table D.9: Spearman Correlation for water abstraction (significance level: * = 0.05; ** = 0.01)

Percentage Water abstraction - Spearman Correlation																				
	local		**250**		**500**		**2500**		**5000**		**25000**		**SA**		**fishr**		**DU**		**catch**	
N_sp_all	0.01		0.02		0.00		-0.07	*	-0.12	**	-0.22	**	0.11	**	-0.11	**	0.10	**	-0.21	**
Density_sp_all	-0.01		-0.08	*	-0.09	**	-0.10	**	-0.12	**	-0.18	**	-0.22	**	-0.16	**	**-0.35**	**	-0.11	**
Biom_sp_all	0.01		-0.02		-0.03		-0.05		-0.03		-0.04		-0.10	**	-0.01		-0.13	**	0.01	
kg_ha_Repro_LITH	0.01		-0.02		-0.03		0.00		0.03		0.06		-0.06		0.08	*	-0.05		0.11	**
perc_kgha_Repro_LITH	0.04		0.05		0.06		0.14	**	0.21	**	**0.31**	**	0.08	*	0.22	**	0.22	**	0.27	**
n_ha_Repro_LITH	-0.01		-0.07	*	-0.08	*	-0.04		-0.02		-0.05		-0.15	**	-0.03		-0.21	**	0.02	
perc_nha_Repro_LITH	0.01		0.02		0.02		0.11	**	0.19	**	0.26	**	0.06		0.16	**	0.24	**	0.20	**
n_sp_Repro_LITH	0.03		0.02		0.00		0.01		0.02		0.00		0.20	**	0.08	*	0.28	**	0.00	
perc_sp_Repro_LITH	0.02		0.04		0.03		0.16	**	0.24	**	**0.33**	**	0.09	**	0.24	**	0.24	**	0.28	**
kg_ha_Atroph_OMNI	0.04		0.03		0.01		-0.08	*	-0.17	**	**-0.34**	**	0.00		-0.15	**	-0.10	**	**-0.30**	**
perc_kgha_Atroph_OMNI	0.02		0.02		-0.01		-0.10	**	-0.19	**	**-0.37**	**	-0.02		-0.18	**	-0.11	**	**-0.34**	**
n_ha_Atroph_OMNI	0.02		0.02		-0.01		-0.10	**	-0.19	**	**-0.37**	**	-0.02		-0.19	**	-0.11	**	**-0.32**	**
perc_nha_Atroph_OMNI	0.02		0.02		0.00		-0.10	**	-0.19	**	**-0.37**	**	-0.02		-0.18	**	-0.09	*	**-0.32**	**
n_sp_Atroph_OMNI	0.02		0.02		-0.01		-0.10	**	-0.18	**	**-0.37**	**	-0.01		-0.19	**	-0.07	*	**-0.32**	**
perc_sp_Atroph_OMNI	0.02		0.02		0.00		-0.09	**	-0.16	**	**-0.36**	**	-0.02		-0.18	**	-0.08	*	**-0.32**	**
kg_ha_Mig_POTAD	0.02		-0.02		-0.03		-0.02		0.00		0.00		-0.07	*	0.04		-0.08	*	0.06	
perc_kgha_Mig_POTAD	0.04		0.03		0.04		0.10	**	0.15	**	0.26	**	0.06		0.19	**	0.20	**	0.23	**
n_ha_Mig_POTAD	-0.02		-0.08	*	-0.09	**	-0.07	*	-0.06		-0.12	**	-0.20	**	-0.11	**	-0.29	**	-0.04	
perc_nha_Mig_POTAD	0.01		0.00		0.01		0.09	*	0.15	**	0.23	**	0.02		0.10	**	0.17	**	0.17	**
n_sp_Mig_POTAD	0.02		0.04		0.02		-0.02		-0.05		-0.07	*	0.19	**	-0.01		0.24	**	-0.08	*
perc_sp_Mig_POTAD	0.01		0.02		0.02		0.09	**	0.16	**	**0.30**	**	0.08	*	0.18	**	0.20	**	0.26	**
kg_ha_Hab_RH	0.02		-0.02		-0.03		-0.01		0.02		0.05		-0.07	*	0.07	*	-0.07	*	0.09	**
perc_kgha_Hab_RH	0.06		0.05		0.08	*	0.21	**	**0.31**	**	**0.44**	**	0.09	**	**0.33**	**	0.14	**	**0.36**	**
n_ha_Hab_RH	-0.01		-0.08	*	-0.09	*	-0.06		-0.05		-0.07	*	-0.18	**	-0.06		-0.27	**	0.00	
perc_nha_Hab_RH	0.08	*	0.07	*	0.09	**	0.21	**	**0.32**	**	**0.44**	**	0.09	**	**0.34**	**	0.14	**	**0.36**	**
n_sp_Hab_RH	0.04		0.02		0.01		0.00		0.00		-0.02		0.19	**	0.08	*	0.22	**	-0.02	
perc_sp_Hab_RH	0.06		0.05		0.08	*	0.20	**	0.28	**	**0.42**	**	0.08	*	**0.33**	**	0.12	**	**0.35**	**
P-INSE (EFI)	-0.06		-0.10	**	-0.10	**	-0.05		0.04		0.14	**	0.02		0.03		0.08	*	0.06	
P-OMNI (EFI)	-0.06		-0.05		-0.04		0.04		0.17	**	**0.36**	**	0.10	**	0.18	**	0.26	**	0.29	**
P-PHYT (EFI)	-0.01		0.00		-0.01		0.03		0.09	*	0.17	**	0.11	**	0.14	**	0.23	**	0.08	*
P-BENT (EFI)	0.04		0.01		0.01		-0.07		-0.17	**	**-0.31**	**	-0.04		-0.12	**	-0.20	**	-0.29	**
P-RHEO (EFI)	0.04		-0.01		-0.01		0.00		-0.03		-0.04		0.06		0.00		-0.01		-0.03	
P-LONG (EFI)	-0.14	**	-0.17	**	-0.17	**	-0.15	**	-0.16	**	0.03		-0.18	**	-0.19	**	-0.22	**	-0.04	
P-POTA (EFI)	0.02		0.00		-0.01		-0.01		-0.04		-0.06		0.10	**	0.00		0.04		-0.03	
P-LITH (EFI)	0.01		0.03		0.03		0.08	*	0.19	**	**0.33**	**	0.26	**	0.23	**	**0.47**	**	0.21	**
P-INTO (EFI)	-0.03		-0.02		-0.02		0.04		0.15	**	**0.38**	**	0.13	**	0.21	**	0.23	**	0.26	**
P-TOLE (EFI)	0.02		0.04		0.04		0.13	**	0.22	**	0.30	**	0.11	**	0.27	**	0.24	**	0.27	**
FAME Index	-0.03		-0.06		-0.05		0.01		0.08	*	0.27	**	0.14	**	0.14	**	0.21	**	0.16	**
MetHINTOL150 (EFIplus)	0.03		0.01		0.00		0.05		0.06		0.08		0.06		0.08		0.07		0.04	
MetO2INTOL (EFIplus)	0.01		0.01		0.04		0.12	**	0.23	**	**0.39**	**	0.19	**	0.14	**	**0.33**	**	0.29	**
MetRHPAR (EFIplus)	0.24	*	0.19		0.14		**0.33**	**	**0.46**	**	**0.62**	**	**0.40**	**	**0.42**	**	**0.71**	**	**0.64**	**
MetLITH (EFIplus)	0.18		0.26	*	0.24	**	**0.38**	**	**0.49**	**	**0.65**	**	**0.44**	**	**0.42**	**	**0.70**	**	**0.65**	**
EFIplus Index	0.07		0.05		0.05		0.15	**	0.21	**	0.28	**	0.17	**	0.23	**	0.24	**	0.22	**
EFIplus Class	-0.05		-0.03		-0.04		-0.14	**	-0.19	**	-0.26	**	-0.15	**	-0.21	**	-0.23	**	-0.20	**

Table D.10: Pearson Correlation for water abstraction (significance level: * = 0.05; ** = 0.01)

Percentage Water abstraction - Pearson Correlation																						
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
N_sp_all	-0.01		-0.02		-0.04		-0.11	**	-0.16	**	-0.26	**	-0.05		-0.08	*	-0.03		-0.22	**
Density_sp_all	-0.04		-0.08	*	-0.09	**	-0.13	**	-0.14	**	-0.13	**	-0.10	**	-0.15	**	-0.20	*	-0.12	**
Biom_sp_all	0.02		0.01		0.00		-0.04		-0.04		-0.03		-0.07	*	-0.01		-0.06		0.01	
kg_ha_Repro_LITH	0.02		0.02		0.02		-0.02		-0.01		0.01		-0.06		0.02		-0.04		0.04	
perc_kgha_Repro_LITH	0.06		0.10	**	0.10	**	0.15	**	0.18	**	0.27	**	0.12	**	0.20	**	0.22	**	**0.32**	**
n_ha_Repro_LITH	-0.04		-0.06		-0.08	*	-0.10	**	-0.09	**	-0.08	*	-0.08	*	-0.11	**	-0.13	**	-0.05	
perc_nha_Repro_LITH	0.04		0.08	*	0.08	*	0.15	**	0.18	**	0.26	**	0.11	**	0.15	**	0.25	**	0.26	**
n_sp_Repro_LITH	0.04		0.04		0.03		-0.01		-0.03		-0.08	*	0.01		0.07		0.13	**	-0.05	
perc_sp_Repro_LITH	0.03		0.07	*	0.08	*	0.16	**	0.21	**	**0.31**	**	0.10	**	0.20	**	0.25	**	**0.31**	**
kg_ha_Atroph_OMNI	0.00		-0.01		-0.02		-0.05		-0.07	*	-0.11	**	-0.04		-0.05		-0.06		-0.10	**
perc_kgha_Atroph_OMNI	0.00		-0.02		-0.04		-0.13	**	-0.18	**	**-0.32**	**	-0.06		-0.12	**	-0.21	**	**-0.32**	**
n_ha_Atroph_OMNI	-0.02		-0.07		-0.08	*	-0.12	**	-0.15	**	-0.20	**	-0.06		-0.15	**	-0.15	**	-0.19	**
perc_nha_Atroph_OMNI	0.00		-0.04		-0.05		-0.15	**	-0.20	**	**-0.34**	**	-0.08	*	-0.15	**	-0.19	**	**-0.31**	**
n_sp_Atroph_OMNI	-0.02		-0.06		-0.06		-0.14	**	-0.20	**	**-0.35**	**	-0.10	**	-0.15	**	-0.15	**	**-0.31**	**
perc_sp_Atroph_OMNI	0.01		-0.03		-0.04		-0.11	**	-0.16	**	**-0.33**	**	-0.09	**	-0.12	**	-0.15	**	**-0.32**	**
kg_ha_Mig_POTAD	0.03		0.01		0.01		-0.03		-0.02		0.00		-0.06		0.02		-0.05		0.03	
perc_kgha_Mig_POTAD	0.06		0.05		0.06		0.10	**	0.12	**	0.18	**	0.08	*	0.14	**	0.18	**	0.23	**
n_ha_Mig_POTAD	-0.04		-0.08	*	-0.10	**	-0.12	**	-0.09	**	-0.07	*	-0.10	**	-0.14	**	-0.15	**	-0.05	
perc_nha_Mig_POTAD	0.00		-0.01		0.01		0.07	*	0.14	**	0.21	**	0.06		0.04		0.17	**	0.17	*
n_sp_Mig_POTAD	0.01		0.00		-0.01		-0.06		-0.08	*	-0.13	**	-0.02		0.00		0.10	**	-0.11	**
perc_sp_Mig_POTAD	0.02		0.03		0.05		0.11	**	0.16	**	0.27	**	0.07		0.11	**	0.20	**	0.24	**
kg_ha_Hab_RH	0.02		0.02		0.01		-0.03		-0.02		0.00		-0.06		0.02		-0.05		0.03	
perc_kgha_Hab_RH	0.06		0.09	**	0.10	**	0.16	**	0.20	**	**0.30**	**	0.12	**	0.22	**	0.19	**	0.30	**
n_ha_Hab_RH	-0.04		-0.07	*	-0.08	*	-0.12	**	-0.12	**	-0.10	**	-0.09	**	-0.13	**	-0.17	**	-0.08	*
perc_nha_Hab_RH	0.04		0.09	**	0.10	**	0.16	**	0.21	**	**0.32**	**	0.11	**	0.21	**	0.21	**	**0.32**	**
n_sp_Hab_RH	0.05		0.05		0.04		-0.01		-0.04		-0.11	**	0.02		0.08	*	0.09	*	-0.07	
perc_sp_Hab_RH	0.07	*	0.11	**	0.12	**	0.19	**	0.24	**	**0.35**	**	0.14	**	0.26	**	0.18	**	**0.34**	**
P-INSE (EFI)	-0.06		-0.05		-0.06		-0.03		0.03		0.15	**	-0.02		-0.02		0.07		0.12	**
P-OMNI (EFI)	-0.06		-0.04		-0.03		0.04		0.13		**0.32**		0.03		0.06		0.26	**	0.28	
P-PHYT (EFI)	0.01		0.02		0.03		0.07		0.09	*	0.20	**	0.01		0.15	**	0.18	**	0.15	**
P-BENT (EFI)	0.04		0.03		0.01		-0.07		-0.15	**	**-0.30**	**	-0.01		-0.04		-0.24	**	-0.27	**
P-RHEO (EFI)	0.03		0.03		0.02		-0.01		-0.05		-0.09	**	0.03		0.03		-0.07		-0.03	
P-LONG (EFI)	-0.13	**	-0.14	**	-0.15	**	-0.12	**	-0.12	**	0.00		-0.06		-0.15	**	-0.12	**	-0.04	
P-POTA (EFI)	0.02		0.02		0.00		-0.03		-0.05		-0.10	**	0.02		0.04		-0.03		-0.05	
P-LITH (EFI)	0.02		0.07	*	0.08	*	0.13	**	0.20	**	**0.33**	**	0.09	**	0.23	**	**0.38**	**	0.28	**
P-INTO (EFI)	-0.02		0.00		0.02		0.07	*	0.15	**	**0.35**	**	0.02		0.16	**	0.24	**	0.29	**
P-TOLE (EFI)	0.06		0.09	**	0.10	**	0.15	**	0.19	**	0.30	**	0.08	*	0.24	**	0.21	**	**0.31**	**
FAME Index	-0.01		0.02		0.01		0.05		0.10	**	0.23	**	0.05		0.16	**	0.19	**	0.22	**
MetHINTOL150 (EFIplus)	0.05		0.03		0.02		0.07		0.07		0.02		0.03		0.13	**	0.00		0.02	
MetO2INTOL (EFIplus)	0.05		0.03		0.05		0.14	**	0.20	**	**0.35**	**	0.03		0.10	*	0.25	**	0.29	**
MetRHPAR (EFIplus)	0.20		0.26	*	0.25	*	**0.39**	**	**0.44**	**	**0.49**	**	0.30	**	**0.42**	**	**0.51**	**	**0.52**	**
MetLITH (EFIplus)	0.10		**0.34**	**	**0.34**	**	**0.42**	**	**0.46**	**	**0.54**	**	0.30	**	**0.45**	**	**0.55**	**	**0.59**	**
EFIplus Index	0.07		0.08	*	0.08		0.18	*	0.20	**	0.27	**	0.07		0.20	**	0.20	**	0.25	**
EFIplus Class	-0.06		-0.07		-0.06		-0.15	**	-0.18	**	-0.22	**	-0.05		-0.20	**	-0.17	**	-0.20	**

Table D.11: Spearman Correlation for buffer length (significance level: * = 0.05; ** = 0.01)

Buffer length - Spearman Correlation																				
	250		500		2500		5000		25000		SA		fishr		DU		catch	
N_sp_all	0.15	**	0.15	**	0.21	**	0.23	**	**0.34**	**	0.29	**	0.24	**	**0.55**	**	0.22	**
Density_sp_all	0.10	**	0.08	*	-0.07	*	-0.13	**	-0.21	**	-0.30	**	-0.29	**	**-0.41**	**	-0.22	**
Biom_sp_all	0.04		0.04		-0.01		-0.04		-0.07	*	-0.13	**	-0.22	**	-0.19	**	-0.12	**
kg_ha_Repro_LITH	-0.04		-0.01		-0.02		-0.05		-0.07		-0.11	**	-0.21	**	-0.22	**	-0.12	**
perc_kgha_Repro_LITH	-0.14	**	-0.12	**	-0.06		-0.03		-0.01		0.00		-0.02		-0.10	**	0.00	
n_ha_Repro_LITH	0.02		0.03		-0.07	*	-0.14	**	-0.22	**	-0.26	**	-0.28	**	**-0.43**	**	-0.21	**
perc_nha_Repro_LITH	-0.09	**	-0.08	*	-0.07		-0.05		0.00		0.02		0.00		-0.08	*	0.03	
n_sp_Repro_LITH	0.02		0.06		0.22	**	0.26	**	**0.39**	**	**0.36**	**	0.24	**	**0.52**	**	0.24	**
perc_sp_Repro_LITH	-0.13	**	-0.11	**	0.01		0.05		0.11	**	0.07	*	0.01		-0.05		0.06	
kg_ha_Atroph_OMNI	0.24	**	0.20	**	0.19	**	0.21	**	0.25	**	0.15	**	-0.04		0.29	**	0.13	**
perc_kgha_Atroph_OMNI	0.25	**	0.21	**	0.18	**	0.20	**	0.25	**	0.14	**	0.01		**0.31**	**	0.14	**
n_ha_Atroph_OMNI	0.26	**	0.21	**	0.18	**	0.20	**	0.23	**	0.15	**	-0.01		0.29	**	0.14	**
perc_nha_Atroph_OMNI	0.26	**	0.21	**	0.19	**	0.20	**	0.25	**	0.16	**	0.01		**0.32**	**	0.14	**
n_sp_Atroph_OMNI	0.25	**	0.21	**	0.18	**	0.19	**	0.27	**	0.18	**	0.08	*	**0.37**	**	0.15	**
perc_sp_Atroph_OMNI	0.26	**	0.21	**	0.15	**	0.16	**	0.25	**	0.15	**	0.04		**0.32**	**	0.13	**
kg_ha_Mig_POTAD	0.01		0.02		-0.01		-0.04		-0.06		-0.12	**	-0.20	**	-0.19	**	-0.12	**
perc_kgha_Mig_POTAD	-0.12	**	-0.11	**	-0.06		-0.04		-0.01		-0.02		0.04		-0.05		0.02	
n_ha_Mig_POTAD	0.06		0.05		-0.11	**	-0.17	**	-0.24	**	**-0.32**	**	-0.29	**	**-0.44**	**	-0.23	**
perc_nha_Mig_POTAD	-0.08	*	-0.09	**	-0.14	**	-0.12	**	-0.08	*	-0.06		0.01		-0.11	**	0.00	
n_sp_Mig_POTAD	0.07	*	0.09	**	0.21	**	0.25	**	**0.40**	**	**0.37**	**	**0.33**	**	**0.62**	**	0.28	**
perc_sp_Mig_POTAD	-0.16	**	-0.13	**	-0.06		-0.05		0.00		0.02		0.06		-0.05		0.03	
kg_ha_Hab_RH	-0.03		0.00		-0.02		-0.06		-0.07		-0.12	**	-0.24	**	-0.23	**	-0.14	**
perc_kgha_Hab_RH	-0.21	**	-0.16	**	-0.05		-0.07		-0.09	**	-0.11	**	-0.21	**	**-0.30**	**	-0.16	**
n_ha_Hab_RH	0.03		0.04		-0.07	*	-0.14	**	-0.21	**	-0.27	**	**-0.31**	**	**-0.45**	**	-0.22	**
perc_nha_Hab_RH	-0.24	**	-0.19	**	-0.07	*	-0.08	*	-0.10	**	-0.11	**	-0.17	**	-0.28	**	-0.15	**
n_sp_Hab_RH	0.03		0.07		0.22	**	0.24	**	**0.35**	**	**0.33**	**	0.21	**	**0.49**	**	0.19	**
perc_sp_Hab_RH	-0.23	**	-0.18	**	-0.06		-0.06		-0.10	**	-0.10	**	-0.18	**	-0.29	**	-0.16	**
P-INSE (EFI)	-0.09	**	-0.06		-0.07	*	-0.10	**	-0.02		0.00		0.15	**	0.00		-0.06	
P-OMNI (EFI)	-0.23	**	-0.18	**	-0.07		-0.07		0.02		0.05		0.19	**	0.07	*	-0.01	
P-PHYT (EFI)	-0.08	*	-0.08	*	0.07		0.10	**	0.22	**	0.18	**	0.20	**	0.30	**	0.09	*
P-BENT (EFI)	0.14	**	0.14	**	0.07		0.06		-0.07	*	-0.01		-0.10	**	-0.03		-0.02	
P-RHEO (EFI)	0.00		0.05		0.13	**	0.12	**	0.05		0.10	**	-0.11	**	-0.03		-0.03	
P-LONG (EFI)	-0.12	**	-0.08	*	-0.16	**	-0.21	**	**-0.43**	**	-0.15	**	-0.21	**	**-0.44**	**	-0.20	**
P-POTA (EFI)	0.01		0.07		0.18	**	0.19	**	0.15	**	0.17	**	-0.03		0.12	**	0.06	
P-LITH (EFI)	-0.12	**	-0.06		0.17	**	0.22	**	**0.38**	**	**0.37**	**	**0.34**	**	**0.48**	**	0.13	**
P-INTO (EFI)	-0.23	**	-0.17	**	-0.04		-0.04		0.05		0.16	**	0.20	**	0.09	*	-0.04	
P-TOLE (EFI)	-0.14	**	-0.12	**	0.06		0.10	**	0.18	**	0.10	**	0.01		0.08	*	0.01	
FAME Index	-0.18	**	-0.09	**	0.07	*	0.07	*	0.08	*	0.19	**	0.14	**	0.12	**	-0.04	
MetHINTOL150 (EFIplus)	-0.02		-0.04		-0.08		-0.11	*	-0.07		-0.03		0.01		-0.02		-0.07	
MetO2INTOL (EFIplus)	-0.05		-0.06		-0.11	*	-0.09	*	0.14	**	0.19	**	**0.35**	**	**0.36**	**	0.17	**
MetRHPAR (EFIplus)	**-0.41**	**	**-0.37**	**	-0.04		-0.03		**0.50**	**	**0.39**	**	0.01		0.07		-0.13	
MetLITH (EFIplus)	**-0.33**	**	-0.27	*	0.11		0.10		**0.42**	**	**0.36**	**	-0.02		0.14		0.02	
EFIplus Index	-0.09	*	-0.09	*	-0.09	*	-0.11	**	0.02		0.05		0.07		0.05		-0.01	
EFIplus Class	0.08	*	0.09	*	0.07		0.09	*	-0.02		-0.06		-0.06		-0.08		0.01	

Table D.12: Pearson Correlation for buffer length (significance level: * = 0.05; ** = 0.01)

Buffer length - Pearson Correlation																				
	250		500		2500		5000		25000		SA		fishr		DU		catch	
N_sp_all	0.09	**	0.10	**	0.21	**	0.22	**	0.28	**	0.20	**	0.15	**	0.27	**	0.04	
Density_sp_all	-0.05		-0.05		-0.07	*	-0.09	*	-0.10	**	-0.14	**	-0.16	**	-0.09	*	-0.05	
Biom_sp_all	-0.03		-0.02		0.02		0.04		0.03		0.04		-0.12	**	-0.07		0.04	
kg_ha_Repro_LITH	-0.05		-0.04		0.01		0.04		0.01		0.05		-0.12	**	-0.07		0.05	
perc_kgha_Repro_LITH	-0.11	**	-0.07	*	-0.02		-0.02		0.01		0.08	*	0.00		-0.04		0.08	*
n_ha_Repro_LITH	-0.08	*	-0.07		-0.08	*	-0.09	**	-0.10	**	-0.11	**	-0.16	**	-0.09	*	-0.02	
perc_nha_Repro_LITH	-0.07		-0.04		-0.01		-0.01		0.01		0.08	*	0.02		-0.01		0.10	**
n_sp_Repro_LITH	0.04		0.08	*	0.26	**	0.28	**	**0.36**	**	**0.31**	**	0.19	**	0.27	**	0.11	**
perc_sp_Repro_LITH	-0.08	*	-0.06		0.03		0.05		0.11	**	0.12	**	0.03		-0.03		0.12	**
kg_ha_Atroph_OMNI	0.03		0.01		0.06		0.08	*	0.06		0.09	**	-0.08	*	-0.01		0.03	
perc_kgha_Atroph_OMNI	0.13	**	0.10	**	0.14	**	0.13	**	0.11	**	0.04		-0.10	**	0.03		-0.03	
n_ha_Atroph_OMNI	0.02		-0.01		0.01		0.02		-0.01		-0.04		-0.10	**	-0.01		-0.02	
perc_nha_Atroph_OMNI	0.14	**	0.11	**	0.16	**	0.16	**	0.14	**	0.08	*	-0.08	*	0.05		-0.02	
n_sp_Atroph_OMNI	0.13	**	0.11	**	0.13	**	0.14	**	0.18	**	0.10	**	0.02		0.20	**	0.01	
perc_sp_Atroph_OMNI	0.13	**	0.11	**	0.11	**	0.12	**	0.17	**	0.11	**	-0.03		0.12	**	0.01	
kg_ha_Mig_POTAD	-0.04		-0.04		0.01		0.04		0.01		0.05		-0.11	**	-0.07		0.04	
perc_kgha_Mig_POTAD	-0.05		-0.04		0.00		0.01		0.02		0.07	*	0.03		-0.03		0.04	
n_ha_Mig_POTAD	-0.07	*	-0.08	*	-0.12	**	-0.13	**	-0.11	**	-0.13	**	-0.17	**	-0.10	**	-0.06	
perc_nha_Mig_POTAD	-0.04		-0.05		-0.11	**	-0.10	**	-0.05		0.01		0.03		-0.04		0.04	
n_sp_Mig_POTAD	0.08	*	0.10	**	0.22	**	0.26	**	**0.36**	**	**0.31**	**	0.25	**	**0.31**	**	0.06	
perc_sp_Mig_POTAD	-0.04		-0.05		-0.05		-0.04		0.03		0.07	*	0.06		-0.04		0.05	
kg_ha_Hab_RH	-0.05		-0.04		0.01		0.04		0.01		0.05		-0.13	**	-0.07	*	0.04	
perc_kgha_Hab_RH	-0.11	**	-0.07	*	-0.02		-0.03		0.01		0.04		-0.08	*	-0.07	*	0.08	*
n_ha_Hab_RH	-0.07		-0.06		-0.07	*	-0.09	**	-0.10	**	-0.13	**	-0.16	**	-0.09	**	-0.05	
perc_nha_Hab_RH	-0.09	**	-0.05		0.00		-0.03		0.00		0.06		-0.03		-0.08	*	0.07	*
n_sp_Hab_RH	0.05		0.09	**	0.26	**	0.27	**	**0.33**	**	0.26	**	0.14	**	0.23	**	0.09	**
perc_sp_Hab_RH	-0.10	**	-0.06		0.00		-0.02		-0.02		0.00		-0.07		-0.14	**	0.06	
P-INSE (EFI)	-0.07	*	-0.06		-0.06		-0.09	*	-0.06		-0.03		0.07		-0.05		-0.04	
P-OMNI (EFI)	-0.11	**	-0.09	**	-0.11	**	-0.11	**	-0.02		0.04		0.17	**	-0.02		-0.03	
P-PHYT (EFI)	-0.04		-0.03		0.07		0.08	*	0.12	**	0.14	**	0.14	**	0.07		0.02	
P-BENT (EFI)	0.04		0.05		0.05		0.04		-0.10	**	-0.07		-0.14	**	-0.04		-0.03	
P-RHEO (EFI)	0.00		0.04		0.14	**	0.12	**	0.02		0.06		-0.11	**	-0.06		-0.02	
P-LONG (EFI)	-0.07		-0.06		-0.15	**	-0.19	**	**-0.33**	**	-0.11	**	-0.09	*	-0.20	**	-0.25	**
P-POTA (EFI)	0.05		0.09	*	0.20	**	0.20	**	0.15	**	0.15	**	-0.05		0.00		0.03	
P-LITH (EFI)	-0.01		0.04		0.16	**	0.17	**	0.27	**	**0.33**	**	0.25	**	0.18	**	0.07	
P-INTO (EFI)	-0.09	*	-0.06		-0.02		-0.03		0.06		0.14	**	0.22	**	0.05		-0.06	
P-TOLE (EFI)	-0.08	*	-0.04		0.08	*	0.10	**	0.11	**	0.14	**	0.00		-0.05		0.11	**
FAME Index	-0.07	*	-0.02		0.09	*	0.08	*	0.07		0.18	**	0.11	**	-0.01		-0.03	
MetHINTOL150 (EFIplus)	-0.02		0.00		-0.03		-0.08		-0.09	*	-0.08		0.01		-0.03		0.03	
MetO2INTOL (EFIplus)	-0.06		-0.03		-0.18	**	-0.20	**	-0.07		0.01		0.19	**	0.03		0.04	
MetRHPAR (EFIplus)	-0.17		-0.13		0.17		0.11		**0.41**	**	0.28	**	-0.08		0.07		**0.33**	**
MetLITH (EFIplus)	-0.04		0.04		0.25	*	0.18		**0.36**	**	**0.30**	**	-0.02		0.13		**0.37**	**
EFIplus Index	-0.07		-0.03		-0.06		-0.10	*	-0.02		0.01		0.09	*	0.03		0.10	*
EFIplus Class	0.06		0.03		0.05		0.09	*	-0.01		-0.03		-0.08		-0.03		-0.11	**

E. Curve fitting

Table E.1: Curve fitting for morphological index (part 1)

	Morphological Index																			
	local		**250**		**500**		**2500**		**5000**		**25000**		**SA**		**fishr**		**DU**		**catch**	
	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*
N_sp_all																				
linear	0.00	0.952	0.00	0.879	0.00	0.792	0.00	0.839	0.00	0.538	0.02	**0.000**	0.00	0.462	0.01	**0.021**	0.03	**0.000**	0.03	**0.000**
quadratic	0.01	0.164	0.00	0.860	0.00	0.510	0.01	**0.015**	0.02	**0.000**	0.02	**0.000**	0.04	**0.000**	0.01	**0.046**	0.09	**0.000**	0.03	**0.000**
cubic	0.01	0.262	0.00	0.881	0.00	0.553	0.01	**0.036**	0.02	**0.000**	0.03	**0.000**	0.05	**0.000**	0.02	**0.002**	0.09	**0.000**	0.03	**0.000**
exponential	0.00	0.351	0.00	0.364	0.00	0.563	0.00	0.332	0.01	**0.037**	0.02	**0.000**	0.00	0.586	0.01	**0.002**	0.03	**0.000**	0.03	**0.000**
logistic	0.00	0.351	0.00	0.364	0.00	0.563	0.00	0.332	0.01	**0.037**	0.02	**0.000**	0.00	0.586	0.01	**0.002**	0.03	**0.000**	0.03	**0.000**
Density_sp_all																				
linear	0.01	**0.003**	0.01	**0.009**	0.01	**0.002**	0.01	**0.001**	0.01	**0.003**	0.04	**0.000**	0.01	**0.012**	0.00	0.073	0.04	**0.000**	0.04	**0.000**
quadratic	0.04	**0.000**	0.02	**0.001**	0.02	**0.000**	0.03	**0.000**	0.02	**0.002**	0.09	**0.000**	0.04	**0.000**	0.01	0.136	**0.14**	**0.000**	0.07	**0.000**
cubic	0.04	**0.000**	0.02	**0.002**	0.02	**0.000**	0.03	**0.000**	0.02	**0.004**	0.09	**0.000**	0.04	**0.000**	0.01	0.261	**0.14**	**0.000**	0.07	**0.000**
exponential	0.00	0.748	0.00	0.394	0.00	0.899	0.00	0.469	0.00	0.225	0.00	0.140	0.00	0.165	0.00	0.082	0.01	**0.002**	0.03	**0.000**
logistic	0.00	0.748	0.00	0.394	0.00	0.899	0.00	0.469	0.00	0.225	0.00	0.140	0.00	0.165	0.00	0.082	0.01	**0.002**	0.03	**0.000**
Biom_sp_all																				
linear	0.01	**0.005**	0.00	0.086	0.00	0.074	0.00	0.070	0.00	0.204	0.00	0.916	0.00	0.434	0.00	0.275	0.01	**0.014**	0.00	0.665
quadratic	0.02	**0.009**	0.00	0.224	0.00	0.202	0.01	0.087	0.00	0.445	0.00	0.927	0.00	0.659	0.00	0.298	0.01	**0.003**	0.00	0.717
cubic	0.02	**0.006**	0.01	**0.014**	0.01	**0.028**	0.01	0.060	0.01	**0.007**	0.00	0.910	0.00	0.751	0.00	0.445	0.02	**0.005**	0.00	0.642
exponential	0.00	0.210	0.00	0.689	0.00	0.358	0.00	0.452	0.00	0.640	0.00	0.373	0.00	0.444	0.00	0.492	0.00	0.130	0.00	0.271
logistic	0.00	0.210	0.00	0.689	0.00	0.358	0.00	0.452	0.00	0.640	0.00	0.373	0.00	0.444	0.00	0.492	0.00	0.130	0.00	0.271
kg_ha_Repro_LITH																				
linear	0.01	**0.024**	0.00	0.166	0.00	0.133	0.00	0.119	0.00	0.306	0.00	0.242	0.00	0.604	0.00	0.314	0.00	0.123	0.00	0.108
quadratic	0.01	0.058	0.00	0.357	0.00	0.309	0.01	0.094	0.00	0.591	0.00	0.244	0.00	0.754	0.00	0.318	0.01	**0.031**	0.01	0.092
cubic	0.02	**0.020**	0.01	**0.029**	0.01	**0.039**	0.01	0.065	0.02	**0.005**	0.00	0.384	0.00	0.700	0.00	0.424	0.01	**0.040**	0.01	0.064
perc_kgha_Repro_LITH																				
linear	0.00	0.721	0.00	0.104	0.00	0.241	0.00	0.625	0.00	0.716	0.04	**0.000**	0.00	0.505	0.00	0.177	**0.10**	**0.000**	**0.16**	**0.000**
quadratic	0.00	0.323	0.01	**0.030**	0.00	0.279	0.00	0.881	0.00	0.929	0.10	**0.000**	0.00	0.192	0.00	0.199	**0.10**	**0.000**	**0.29**	**0.000**
cubic	0.00	0.502	0.01	**0.033**	0.01	0.172	0.01	0.223	0.01	**0.026**	**0.11**	**0.000**	0.01	0.212	0.02	**0.006**	**0.11**	**0.000**	**0.30**	**0.000**
n_ha_Repro_LITH																				
linear	0.01	**0.023**	0.00	0.087	0.01	**0.049**	0.01	**0.038**	0.00	0.159	0.00	0.318	0.00	0.382	0.00	0.324	0.01	**0.046**	0.00	0.071
quadratic	0.03	**0.000**	0.01	**0.016**	0.01	**0.007**	0.02	**0.002**	0.00	0.339	0.00	0.480	0.02	**0.000**	0.00	0.490	0.03	**0.000**	0.00	0.196
cubic	0.03	**0.000**	0.01	**0.033**	0.01	**0.012**	0.02	**0.005**	0.01	0.079	0.00	0.565	0.02	**0.001**	0.01	0.268	0.03	**0.000**	0.00	0.195
perc_nha_Repro_LITH																				
linear	0.00	0.486	0.00	0.330	0.00	0.419	0.00	0.721	0.00	0.458	0.04	**0.000**	0.00	0.947	0.00	0.877	0.09	**0.000**	**0.12**	**0.000**
quadratic	0.00	0.389	0.01	0.055	0.00	0.333	0.00	0.541	0.00	0.566	0.06	**0.000**	0.01	**0.024**	0.00	0.411	0.09	**0.000**	**0.21**	**0.000**
cubic	0.00	0.596	0.01	0.098	0.01	0.196	0.01	0.119	0.01	0.161	0.07	**0.000**	0.01	0.055	0.01	0.053	0.10	**0.000**	**0.22**	**0.000**
n_sp_Repro_LITH																				
linear	0.00	0.975	0.00	0.585	0.00	0.479	0.00	0.848	0.00	0.228	0.00	0.093	0.00	0.576	0.02	**0.000**	0.00	0.893	0.01	**0.033**
quadratic	0.01	0.050	0.00	0.247	0.00	0.199	0.01	**0.004**	0.03	**0.000**	0.04	**0.000**	0.08	**0.000**	0.02	**0.001**	0.07	**0.000**	0.03	**0.000**
cubic	0.01	0.084	0.00	0.399	0.00	0.337	0.01	**0.010**	0.03	**0.000**	0.04	**0.000**	0.09	**0.000**	0.03	**0.000**	0.09	**0.000**	0.03	**0.000**
perc_sp_Repro_LITH																				
linear	0.00	0.704	0.00	0.295	0.00	0.576	0.00	0.721	0.00	0.937	0.03	**0.000**	0.00	0.314	0.00	0.460	0.09	**0.000**	**0.14**	**0.000**
quadratic	0.00	0.869	0.00	0.534	0.00	0.815	0.00	0.938	0.00	0.961	0.06	**0.000**	0.00	0.305	0.00	0.700	0.09	**0.000**	**0.20**	**0.000**
cubic	0.00	0.586	0.00	0.558	0.00	0.939	0.00	0.880	0.00	0.464	0.07	**0.000**	0.00	0.472	0.01	0.087	0.10	**0.000**	**0.21**	**0.000**
kg_ha_Atroph_OMNI																				
linear	0.01	**0.017**	0.00	0.072	0.00	0.079	0.00	0.069	0.00	0.104	0.01	**0.035**	0.00	0.488	0.00	0.298	0.01	**0.007**	0.00	0.087
quadratic	0.01	**0.046**	0.01	0.177	0.00	0.190	0.00	0.189	0.00	0.176	0.01	0.096	0.00	0.333	0.00	0.312	0.01	**0.006**	0.00	0.227
cubic	0.01	0.076	0.01	0.057	0.01	0.104	0.01	0.145	0.01	0.116	0.01	0.192	0.00	0.504	0.00	0.498	0.01	**0.012**	0.00	0.223
perc_kgha_Atroph_OMNI																				
linear	0.00	0.295	0.01	**0.043**	0.00	0.083	0.00	0.071	0.01	**0.028**	0.03	**0.000**	0.00	0.895	0.00	0.367	0.08	**0.000**	**0.13**	**0.000**
quadratic	0.00	0.479	0.01	**0.031**	0.01	0.135	0.00	0.176	0.01	**0.026**	0.03	**0.000**	0.00	0.965	0.00	0.574	**0.10**	**0.000**	**0.15**	**0.000**
cubic	0.00	0.644	0.01	0.068	0.01	0.235	0.01	0.234	0.01	**0.049**	0.03	**0.000**	0.00	0.376	0.00	0.365	**0.12**	**0.000**	**0.15**	**0.000**
n_ha_Atroph_OMNI																				
linear	0.01	**0.014**	0.01	**0.007**	0.01	**0.002**	0.01	**0.009**	0.00	0.071	0.02	**0.000**	0.00	0.358	0.00	0.682	0.03	**0.000**	0.04	**0.000**
quadratic	0.02	**0.005**	0.01	**0.008**	0.02	**0.003**	0.01	**0.015**	0.00	0.187	0.02	**0.000**	0.00	0.215	0.00	0.912	0.03	**0.000**	0.05	**0.000**
cubic	0.02	**0.014**	0.01	**0.021**	0.02	**0.009**	0.01	**0.017**	0.00	0.340	0.02	**0.001**	0.01	0.124	0.00	0.975	0.04	**0.000**	0.05	**0.000**
perc_nha_Atroph_OMNI																				
linear	0.00	0.822	0.00	0.168	0.00	0.249	0.00	0.589	0.00	0.439	0.03	**0.000**	0.00	0.319	0.00	0.805	0.07	**0.000**	0.09	**0.000**
quadratic	0.00	0.809	0.01	0.151	0.00	0.401	0.00	0.468	0.01	0.092	0.03	**0.000**	0.00	0.472	0.00	0.951	0.09	**0.000**	**0.10**	**0.000**
cubic	0.00	0.842	0.01	0.278	0.00	0.572	0.00	0.657	0.01	0.152	0.03	**0.000**	0.01	0.137	0.00	0.687	**0.11**	**0.000**	**0.10**	**0.000**
n_sp_Atroph_OMNI																				
linear	0.00	0.452	0.00	0.120	0.00	0.389	0.00	0.822	0.00	0.180	0.03	**0.000**	0.00	0.139	0.00	0.377	0.08	**0.000**	**0.11**	**0.000**
quadratic	0.00	0.663	0.01	0.167	0.00	0.690	0.00	0.330	0.01	0.062	0.04	**0.000**	0.01	**0.049**	0.00	0.676	0.10	**0.000**	**0.12**	**0.000**
cubic	0.00	0.770	0.01	0.225	0.00	0.486	0.00	0.368	0.01	**0.010**	0.04	**0.000**	0.02	**0.002**	0.01	**0.044**	0.10	**0.000**	**0.12**	**0.000**
perc_sp_Atroph_OMNI																				
linear	0.00	0.123	0.01	**0.021**	0.00	0.102	0.00	0.160	0.01	**0.004**	0.06	**0.000**	0.00	0.831	0.00	0.222	**0.12**	**0.000**	**0.13**	**0.000**
quadratic	0.00	0.299	0.01	**0.017**	0.00	0.202	0.00	0.311	0.01	**0.006**	0.06	**0.000**	0.00	0.573	0.00	0.473	**0.13**	**0.000**	**0.16**	**0.000**
cubic	0.00	0.491	0.01	**0.041**	0.01	0.264	0.00	0.295	0.02	**0.003**	0.07	**0.000**	0.01	**0.017**	0.01	**0.019**	**0.13**	**0.000**	**0.16**	**0.000**
kg_ha_Mig_POTAD																				
linear	0.01	**0.031**	0.00	0.169	0.00	0.132	0.00	0.130	0.00	0.388	0.00	0.245	0.00	0.679	0.00	0.432	0.00	0.062	0.00	0.273
quadratic	0.01	0.073	0.00	0.363	0.00	0.309	0.01	0.110	0.00	0.688	0.00	0.231	0.00	0.829	0.00	0.388	0.01	**0.024**	0.00	0.299
cubic	0.02	**0.025**	0.01	**0.032**	0.01	**0.043**	0.01	0.089	0.01	**0.009**	0.00	0.355	0.00	0.725	0.00	0.527	0.01	**0.041**	0.00	0.229
perc_kgha_Mig_POTAD																				
linear	0.01	**0.048**	0.01	**0.047**	0.00	0.155	0.00	0.266	0.01	**0.036**	0.07	**0.000**	0.00	0.681	0.00	0.164	0.08	**0.000**	**0.10**	**0.000**
quadratic	0.01	0.092	0.01	0.066	0.00	0.266	0.00	0.468	0.01	0.051	**0.19**	**0.000**	0.00	0.422	0.01	0.100	**0.10**	**0.000**	**0.22**	**0.000**
cubic	0.01	0.189	0.01	0.100	0.01	0.219	0.00	0.335	0.01	**0.006**	**0.21**	**0.000**	0.00	0.604	0.01	**0.015**	**0.10**	**0.000**	**0.23**	**0.000**

Table E.1 Curve fitting for morphological index (part 2)

	Morphological Index																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*	R^2	*sig.*
n_ha_Mig_POTAD																				
linear	0.00	0.112	0.00	0.225	0.00	0.118	0.00	0.070	0.00	0.411	0.00	0.351	0.00	0.779	0.00	0.533	0.01	**0.007**	0.00	0.088
quadratic	0.03	**0.000**	0.01	**0.009**	0.01	**0.004**	0.01	**0.002**	0.00	0.602	0.00	0.533	0.04	**0.000**	0.00	0.824	0.05	**0.000**	0.00	0.221
cubic	0.03	**0.000**	0.01	**0.023**	0.02	**0.009**	0.02	**0.005**	0.01	0.172	0.00	0.656	0.04	**0.000**	0.00	0.503	0.05	**0.000**	0.00	0.209
perc_nha_Mig_POTAD																				
linear	0.01	0.089	0.00	0.353	0.00	0.540	0.00	0.397	0.00	0.079	0.04	**0.000**	0.00	0.453	0.01	**0.002**	0.05	**0.000**	0.06	**0.000**
quadratic	0.01	0.226	0.00	0.601	0.00	0.827	0.00	0.467	0.00	0.211	0.07	**0.000**	0.00	0.683	0.01	**0.007**	0.05	**0.000**	0.09	**0.000**
cubic	0.01	0.394	0.00	0.788	0.00	0.882	0.00	0.331	0.01	0.209	0.07	**0.000**	0.00	0.735	0.02	**0.010**	0.05	**0.000**	0.10	**0.000**
n_sp_Mig_POTAD																				
linear	0.00	0.820	0.00	0.531	0.00	0.674	0.00	0.501	0.00	0.258	0.01	**0.023**	0.00	0.458	0.01	**0.001**	0.01	**0.029**	0.00	0.591
quadratic	0.01	0.067	0.00	0.604	0.00	0.399	0.02	**0.001**	0.03	**0.000**	0.04	**0.000**	0.08	**0.000**	0.01	**0.004**	**0.10**	**0.000**	0.01	**0.042**
cubic	0.01	0.115	0.00	0.601	0.00	0.404	0.02	**0.002**	0.03	**0.000**	0.05	**0.000**	0.09	**0.000**	0.04	**0.000**	**0.12**	**0.000**	0.01	**0.042**
perc_sp_Mig_POTAD																				
linear	0.00	0.950	0.00	0.741	0.00	0.420	0.00	0.355	0.00	0.892	0.03	**0.000**	0.00	0.082	0.00	0.842	0.05	**0.000**	0.09	**0.000**
quadratic	0.00	0.399	0.00	0.544	0.00	0.364	0.00	0.631	0.00	0.827	0.05	**0.000**	0.00	0.219	0.00	0.783	0.05	**0.000**	**0.11**	**0.000**
cubic	0.00	0.539	0.00	0.623	0.00	0.563	0.00	0.467	0.00	0.364	0.05	**0.000**	0.01	0.160	0.00	0.700	0.05	**0.000**	**0.11**	**0.000**
kg_ha_Hab_RH																				
linear	0.01	**0.016**	0.00	0.130	0.00	0.097	0.00	0.082	0.00	0.200	0.00	0.439	0.00	0.491	0.00	0.277	0.00	**0.050**	0.00	0.210
quadratic	0.01	**0.038**	0.00	0.288	0.00	0.236	0.01	0.070	0.00	0.436	0.00	0.636	0.00	0.748	0.00	0.301	0.01	**0.004**	0.00	0.252
cubic	0.02	**0.013**	0.01	**0.025**	0.01	**0.031**	0.01	0.058	0.02	**0.006**	0.00	0.681	0.00	0.705	0.00	0.424	0.02	**0.004**	0.00	0.206
perc_kgha_Hab_RH																				
linear	0.00	0.207	0.00	0.510	0.00	0.811	0.00	0.061	0.01	**0.009**	0.00	0.089	0.01	**0.033**	0.01	**0.011**	0.04	**0.000**	**0.11**	**0.000**
quadratic	0.00	0.449	0.00	0.429	0.00	0.959	0.01	0.106	0.01	**0.015**	0.00	0.182	0.01	0.101	0.01	**0.023**	0.05	**0.000**	**0.15**	**0.000**
cubic	0.01	0.403	0.01	0.285	0.00	0.525	0.01	0.057	0.02	**0.001**	0.01	0.275	0.01	**0.021**	0.02	**0.007**	0.07	**0.000**	**0.15**	**0.000**
n_ha_Hab_RH																				
linear	0.01	**0.003**	0.01	**0.012**	0.01	**0.004**	0.01	**0.001**	0.01	**0.001**	0.04	**0.000**	0.01	**0.005**	0.01	**0.017**	0.03	**0.000**	0.03	**0.000**
quadratic	0.04	**0.000**	0.02	**0.002**	0.02	**0.000**	0.03	**0.000**	0.02	**0.001**	0.08	**0.000**	0.04	**0.000**	0.01	**0.048**	**0.13**	**0.000**	0.05	**0.000**
cubic	0.04	**0.000**	0.02	**0.005**	0.02	**0.001**	0.03	**0.000**	0.02	**0.001**	0.09	**0.000**	0.04	**0.000**	0.01	0.106	**0.14**	**0.000**	0.05	**0.000**
perc_nha_Hab_RH																				
linear	0.01	0.081	0.00	0.797	0.00	0.960	0.00	0.149	0.01	**0.019**	0.00	0.224	0.01	**0.007**	0.01	**0.004**	0.06	**0.000**	**0.14**	**0.000**
quadratic	0.01	0.217	0.00	0.242	0.00	0.977	0.00	0.187	0.01	**0.019**	0.00	0.457	0.01	**0.019**	0.01	**0.013**	0.07	**0.000**	**0.19**	**0.000**
cubic	0.01	0.164	0.01	0.140	0.00	0.345	0.01	**0.041**	0.02	**0.000**	0.00	0.557	0.02	**0.002**	0.02	**0.001**	0.10	**0.000**	**0.19**	**0.000**
n_sp_Hab_RH																				
linear	0.00	0.631	0.00	0.660	0.00	0.569	0.00	0.779	0.00	0.190	0.01	**0.039**	0.00	0.617	0.02	**0.000**	0.00	0.405	0.00	0.153
quadratic	0.01	**0.038**	0.00	0.184	0.00	0.180	0.01	**0.006**	0.02	**0.000**	0.03	**0.000**	0.07	**0.000**	0.03	**0.000**	0.07	**0.000**	0.02	**0.000**
cubic	0.01	0.085	0.01	0.327	0.00	0.330	0.01	**0.014**	0.02	**0.000**	0.04	**0.000**	0.08	**0.000**	0.03	**0.000**	0.09	**0.000**	0.02	**0.000**
perc_sp_Hab_RH																				
linear	0.00	0.650	0.00	0.127	0.00	0.389	0.00	0.823	0.00	0.714	0.02	**0.000**	0.00	0.226	0.00	0.086	0.08	**0.000**	**0.16**	**0.000**
quadratic	0.00	0.899	0.01	0.094	0.00	0.649	0.00	0.749	0.00	0.372	0.03	**0.000**	0.00	0.481	0.01	0.110	0.09	**0.000**	**0.20**	**0.000**
cubic	0.00	0.816	0.01	0.088	0.00	0.322	0.01	0.212	0.01	**0.006**	0.04	**0.000**	0.01	**0.012**	0.02	**0.001**	**0.10**	**0.000**	**0.20**	**0.000**
P-INSE (EFI)																				
linear	0.01	0.055	0.01	**0.001**	0.01	**0.009**	0.01	0.056	0.01	**0.043**	0.04	**0.000**	0.01	**0.049**	0.00	0.211	0.06	**0.000**	0.08	**0.000**
quadratic	0.01	0.153	0.02	**0.002**	0.01	**0.025**	0.01	0.149	0.01	**0.032**	0.06	**0.000**	0.01	0.105	0.01	0.135	0.06	**0.000**	0.10	**0.000**
cubic	0.01	0.236	0.02	**0.006**	0.01	0.059	0.01	0.130	0.01	**0.027**	0.06	**0.000**	0.01	0.179	0.01	**0.037**	0.07	**0.000**	**0.10**	**0.000**
exponential	0.00	0.245	0.01	**0.014**	0.01	**0.019**	0.00	0.089	0.01	**0.044**	0.06	**0.000**	0.00	0.125	0.00	0.972	0.10	**0.000**	**0.15**	**0.000**
logistic	0.00	0.245	0.01	**0.014**	0.01	**0.019**	0.00	0.089	0.01	**0.044**	0.06	**0.000**	0.00	0.125	0.00	0.972	0.10	**0.000**	**0.15**	**0.000**
P-OMNI (EFI)																				
linear	0.00	0.386	0.00	0.578	0.00	0.331	0.01	**0.004**	0.01	**0.046**	0.01	**0.029**	0.01	**0.006**	0.00	0.593	0.02	**0.000**	0.07	**0.000**
quadratic	0.00	0.373	0.01	0.125	0.00	0.461	0.01	**0.014**	0.01	0.135	0.01	0.055	0.01	**0.022**	0.00	0.763	0.02	**0.000**	0.09	**0.000**
cubic	0.00	0.578	0.01	0.232	0.00	0.637	0.01	**0.035**	0.01	0.206	0.01	0.120	0.01	**0.013**	0.00	0.646	0.04	**0.000**	0.09	**0.000**
exponential	0.00	0.253	0.00	0.198	0.00	0.168	0.00	0.929	0.00	0.604	0.02	**0.000**	0.00	0.867	0.00	0.649	0.04	**0.000**	0.07	**0.000**
logistic	0.00	0.253	0.00	0.198	0.00	0.168	0.00	0.929	0.00	0.604	0.02	**0.000**	0.00	0.867	0.00	0.649	0.04	**0.000**	0.07	**0.000**
P-PHYT (EFI)																				
linear	0.00	0.438	0.00	0.690	0.00	0.965	0.00	0.069	0.01	**0.007**	0.00	0.257	0.01	**0.006**	0.00	0.109	0.02	**0.000**	0.04	**0.000**
quadratic	0.01	**0.047**	0.01	0.093	0.00	0.269	0.01	0.095	0.01	**0.015**	0.03	**0.000**	0.02	**0.000**	0.01	**0.016**	0.03	**0.000**	0.06	**0.000**
cubic	0.01	0.087	0.01	0.068	0.01	0.120	0.01	0.155	0.01	**0.024**	0.04	**0.000**	0.02	**0.001**	0.02	**0.003**	0.04	**0.000**	0.06	**0.000**
exponential	0.01	0.068	0.01	**0.022**	0.01	0.051	0.00	0.368	0.00	0.316	0.04	**0.000**	0.00	0.713	0.00	0.232	0.06	**0.000**	0.05	**0.000**
logistic	0.01	0.068	0.01	**0.022**	0.01	0.051	0.00	0.368	0.00	0.316	0.04	**0.000**	0.00	0.713	0.00	0.232	0.06	**0.000**	0.05	**0.000**
P-BENT (EFI)																				
linear	0.01	**0.022**	0.01	**0.008**	0.01	**0.002**	0.03	**0.000**	0.02	**0.000**	0.00	0.425	0.03	**0.000**	0.01	**0.006**	0.00	0.179	0.03	**0.000**
quadratic	0.01	0.050	0.01	**0.025**	0.02	**0.004**	0.03	**0.000**	0.03	**0.000**	0.00	0.216	0.03	**0.000**	0.01	**0.021**	0.00	0.173	0.04	**0.000**
cubic	0.01	0.104	0.01	0.056	0.02	**0.009**	0.03	**0.000**	0.03	**0.000**	0.01	0.302	0.03	**0.000**	0.02	**0.011**	0.01	0.194	0.04	**0.000**
exponential	0.01	**0.018**	0.01	**0.003**	0.01	**0.001**	0.04	**0.000**	0.03	**0.000**	0.01	**0.011**	0.03	**0.000**	0.02	**0.002**	0.00	0.889	0.01	**0.014**
logistic	0.01	**0.018**	0.01	**0.003**	0.01	**0.001**	0.04	**0.000**	0.03	**0.000**	0.01	**0.011**	0.03	**0.000**	0.02	**0.002**	0.00	0.889	0.01	**0.014**
P-RHEO (EFI)																				
linear	0.01	0.085	0.02	**0.001**	0.01	**0.002**	0.02	**0.000**	0.01	**0.005**	0.00	0.060	0.01	**0.006**	0.00	0.686	0.01	**0.005**	0.01	**0.010**
quadratic	0.01	0.055	0.02	**0.001**	0.02	**0.001**	0.02	**0.000**	0.02	**0.000**	0.03	**0.000**	0.03	**0.000**	0.01	0.065	0.02	**0.001**	0.02	**0.001**
cubic	0.01	0.104	0.02	**0.002**	0.02	**0.002**	0.02	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.01	0.088	0.03	**0.000**	0.02	**0.001**
exponential	0.01	0.083	0.02	**0.000**	0.01	**0.003**	0.01	**0.004**	0.01	0.052	0.01	**0.013**	0.01	**0.023**	0.00	0.686	0.03	**0.000**	0.05	**0.000**
logistic	0.01	0.083	0.02	**0.000**	0.01	**0.003**	0.01	**0.004**	0.01	0.052	0.01	**0.013**	0.01	**0.023**	0.00	0.686	0.03	**0.000**	0.05	**0.000**
P-LONG (EFI)																				
linear	0.02	**0.003**	0.00	0.088	0.00	0.069	0.02	**0.001**	0.02	**0.000**	0.00	0.250	0.01	**0.004**	0.04	**0.000**	0.00	0.069	0.00	0.313
quadratic	0.02	**0.011**	0.00	0.224	0.01	0.176	0.02	**0.001**	0.02	**0.001**	0.01	**0.023**	0.01	**0.007**	0.05	**0.000**	0.01	**0.004**	0.01	**0.006**
cubic	0.02	**0.024**	0.01	0.349	0.01	0.318	0.02	**0.002**	0.02	**0.004**	0.01	**0.019**	0.02	**0.002**	0.06	**0.000**	0.03	**0.000**	0.01	**0.007**
exponential	0.02	**0.002**	0.00	0.078	0.00	0.083	0.01	**0.002**	0.02	**0.000**	0.01	**0.029**	0.01	**0.011**	0.06	**0.000**	0.01	**0.048**	0.00	0.724
logistic	0.02	**0.002**	0.00	0.078	0.00	0.083	0.01	**0.002**	0.02	**0.000**	0.01	**0.029**	0.01	**0.011**	0.06	**0.000**	0.01	**0.048**	0.00	0.724

Table E.1 Curve fitting for morphological index (part 3)

	Morphological Index																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
P-POTA (EFI)																				
linear	0.00	0.618	0.00	0.235	0.00	0.191	0.00	0.068	0.00	0.098	0.01	**0.034**	0.00	0.473	0.00	0.767	0.00	0.089	0.01	0.051
quadratic	0.00	0.324	0.01	0.185	0.01	0.061	0.03	**0.000**	0.04	**0.000**	0.04	**0.000**	0.06	**0.000**	0.01	**0.047**	0.03	**0.000**	0.01	**0.003**
cubic	0.00	0.519	0.01	0.323	0.01	0.133	0.03	**0.000**	0.04	**0.000**	0.06	**0.000**	0.07	**0.000**	0.01	0.062	0.03	**0.000**	0.01	**0.004**
exponential	0.00	0.641	0.00	0.370	0.00	0.353	0.00	0.176	0.00	0.289	0.01	**0.013**	0.00	0.639	0.00	0.846	0.01	**0.030**	0.01	**0.030**
logistic	0.00	0.641	0.00	0.370	0.00	0.353	0.00	0.176	0.00	0.289	0.01	**0.013**	0.00	0.639	0.00	0.846	0.01	**0.030**	0.01	**0.030**
P-LITH (EFI)																				
linear	0.00	0.770	0.00	0.235	0.00	0.321	0.00	0.073	0.01	**0.013**	0.01	**0.017**	0.00	0.078	0.02	**0.000**	0.06	**0.000**	**0.16**	**0.000**
quadratic	0.02	**0.001**	0.03	**0.000**	0.01	**0.009**	0.02	**0.001**	0.02	**0.000**	0.06	**0.000**	0.07	**0.000**	0.02	**0.001**	**0.11**	**0.000**	**0.24**	**0.000**
cubic	0.02	**0.003**	0.03	**0.000**	0.01	**0.015**	0.02	**0.001**	0.02	**0.001**	0.06	**0.000**	0.07	**0.000**	0.02	**0.002**	**0.15**	**0.000**	**0.24**	**0.000**
exponential	0.00	0.431	0.01	0.057	0.01	**0.044**	0.00	0.533	0.00	0.914	0.04	**0.000**	0.00	0.801	0.01	**0.004**	**0.12**	**0.000**	**0.15**	**0.000**
logistic	0.00	0.431	0.01	0.057	0.01	**0.044**	0.00	0.533	0.00	0.914	0.04	**0.000**	0.00	0.801	0.01	**0.004**	**0.12**	**0.000**	**0.15**	**0.000**
P-INTO (EFI)																				
linear	0.00	0.564	0.00	0.127	0.00	0.281	0.00	0.231	0.00	0.454	0.02	**0.000**	0.00	0.359	0.00	0.229	0.07	**0.000**	**0.15**	**0.000**
quadratic	0.01	0.089	0.02	**0.004**	0.01	0.094	0.00	0.473	0.00	0.523	0.03	**0.000**	0.01	**0.028**	0.00	0.319	0.08	**0.000**	**0.16**	**0.000**
cubic	0.01	0.127	0.02	**0.007**	0.01	0.160	0.00	0.684	0.00	0.606	0.03	**0.000**	0.02	**0.001**	0.01	0.124	0.10	**0.000**	**0.17**	**0.000**
exponential	0.00	0.242	0.01	**0.037**	0.01	0.065	0.00	0.910	0.00	0.968	0.03	**0.000**	0.00	0.979	0.01	**0.008**	**0.11**	**0.000**	**0.19**	**0.000**
logistic	0.00	0.242	0.01	**0.037**	0.01	0.065	0.00	0.910	0.00	0.968	0.03	**0.000**	0.00	0.979	0.01	**0.008**	**0.11**	**0.000**	**0.19**	**0.000**
P-TOLE (EFI)																				
linear	0.00	0.825	0.00	0.120	0.00	0.403	0.00	0.436	0.00	0.295	0.01	**0.003**	0.00	0.144	0.01	**0.002**	0.06	**0.000**	**0.13**	**0.000**
quadratic	0.00	0.774	0.01	0.115	0.00	0.647	0.00	0.725	0.00	0.575	0.02	**0.000**	0.01	**0.015**	0.01	**0.008**	0.06	**0.000**	**0.19**	**0.000**
cubic	0.00	0.911	0.01	0.217	0.00	0.642	0.00	0.790	0.00	0.579	0.02	**0.001**	0.01	**0.026**	0.02	**0.005**	0.08	**0.000**	**0.19**	**0.000**
exponential	0.00	0.223	0.02	**0.001**	0.01	**0.043**	0.00	0.734	0.00	0.858	0.01	**0.027**	0.00	0.858	0.02	**0.001**	0.08	**0.000**	**0.19**	**0.000**
logistic	0.00	0.223	0.02	**0.001**	0.01	**0.043**	0.00	0.734	0.00	0.858	0.01	**0.027**	0.00	0.858	0.02	**0.001**	0.08	**0.000**	**0.19**	**0.000**
FAME Index																				
linear	0.01	0.066	0.02	**0.000**	0.01	**0.002**	0.00	0.179	0.00	0.256	0.03	**0.000**	0.00	0.477	0.00	0.755	0.09	**0.000**	**0.16**	**0.000**
quadratic	0.02	**0.001**	0.04	**0.000**	0.03	**0.000**	0.01	**0.007**	0.02	**0.003**	0.08	**0.000**	0.05	**0.000**	0.01	0.185	**0.11**	**0.000**	**0.21**	**0.000**
cubic	0.02	**0.002**	0.04	**0.000**	0.03	**0.000**	0.02	**0.004**	0.02	**0.004**	0.08	**0.000**	0.05	**0.000**	0.01	0.057	**0.15**	**0.000**	**0.21**	**0.000**
exponential	0.01	0.089	0.02	**0.001**	0.01	**0.003**	0.00	0.224	0.00	0.351	0.04	**0.000**	0.00	0.355	0.00	0.445	**0.11**	**0.000**	**0.17**	**0.000**
logistic	0.01	0.089	0.02	**0.001**	0.01	**0.003**	0.00	0.224	0.00	0.351	0.04	**0.000**	0.00	0.355	0.00	0.445	**0.11**	**0.000**	**0.17**	**0.000**
MetHINTOL150 (EFIplus)																				
linear	0.01	0.093	0.01	0.061	0.01	**0.017**	0.02	**0.001**	0.02	**0.003**	0.01	0.071	0.00	0.332	0.00	0.461	0.02	**0.007**	0.00	0.774
quadratic	0.01	0.217	0.01	0.173	0.01	0.053	0.02	**0.004**	0.02	**0.014**	0.02	**0.006**	0.01	0.272	0.00	0.692	0.02	**0.019**	0.01	0.238
cubic	0.01	0.227	0.01	0.315	0.01	0.118	0.03	**0.003**	0.02	**0.034**	0.02	**0.008**	0.01	0.157	0.01	0.522	0.03	**0.005**	0.01	0.151
MetO2INTOL (EFIplus)																				
linear	0.00	0.362	0.00	0.700	0.00	0.989	0.00	0.438	0.00	0.604	0.04	**0.000**	0.00	0.170	0.00	0.360	0.04	**0.000**	0.03	**0.000**
quadratic	0.00	0.628	0.00	0.905	0.00	0.680	0.01	0.211	0.01	0.249	0.04	**0.000**	0.01	0.276	0.00	0.657	0.04	**0.000**	0.03	**0.001**
cubic	0.00	0.704	0.00	0.952	0.00	0.856	0.01	0.291	0.01	0.395	0.04	**0.000**	0.01	0.344	0.00	0.654	0.07	**0.000**	0.03	**0.001**
MetRHPAR (EFIplus)																				
linear	0.00	0.881	**0.12**	**0.007**	0.03	0.163	0.00	0.867	0.03	0.109	0.00	0.570	0.00	0.952	0.06	**0.030**	**0.15**	**0.000**	**0.46**	**0.000**
quadratic	0.01	0.792	**0.13**	**0.015**	0.03	0.378	0.00	0.983	0.03	0.243	0.03	0.347	0.05	0.154	0.07	0.063	**0.30**	**0.000**	**0.47**	**0.000**
cubic	0.03	0.827	**0.14**	**0.035**	0.04	0.492	0.01	0.824	0.04	0.354	0.04	0.409	0.05	0.240	0.07	0.059	**0.30**	**0.000**	**0.47**	**0.000**
exponential	0.00	0.884	**0.11**	**0.008**	0.01	0.367	0.00	0.628	0.05	**0.049**	0.02	0.256	0.01	0.448	0.06	**0.023**	0.08	**0.011**	**0.34**	**0.000**
logistic	0.00	0.884	**0.11**	**0.008**	0.01	0.367	0.00	0.628	0.05	**0.049**	0.02	0.256	0.01	0.448	0.06	**0.023**	0.08	**0.011**	**0.34**	**0.000**
MetLITH (EFIplus)																				
linear	0.00	0.959	0.04	0.105	0.03	0.150	0.00	0.587	0.01	0.305	0.02	0.192	0.01	0.514	0.01	0.375	**0.41**	**0.000**	**0.38**	**0.000**
quadratic	0.02	0.763	0.06	0.185	0.04	0.291	0.02	0.449	0.04	0.178	0.05	0.121	**0.12**	**0.007**	**0.12**	**0.007**	**0.46**	**0.000**	**0.41**	**0.000**
cubic	0.02	0.906	0.08	0.163	0.07	0.214	0.06	0.193	0.08	0.098	0.05	0.241	**0.12**	**0.018**	**0.12**	**0.005**	**0.46**	**0.000**	**0.40**	**0.000**
EFIplus Index																				
linear	0.01	0.151	0.01	**0.019**	0.01	**0.025**	0.01	0.063	0.00	0.281	0.02	**0.001**	0.00	0.951	0.00	0.122	0.07	**0.000**	0.05	**0.000**
quadratic	0.01	0.355	0.01	0.057	0.01	0.076	0.01	0.173	0.00	0.456	0.03	**0.000**	0.00	0.982	0.01	0.226	0.07	**0.000**	0.06	**0.000**
cubic	0.01	0.323	0.01	0.126	0.01	0.150	0.01	**0.040**	0.00	0.494	0.04	**0.000**	0.00	0.997	0.01	0.338	**0.10**	**0.000**	0.06	**0.000**
EFIplus Class																				
linear	0.01	0.097	0.01	**0.017**	0.01	**0.019**	0.01	**0.042**	0.00	0.168	0.02	**0.001**	0.00	0.660	0.00	0.488	0.05	**0.000**	0.03	**0.000**
quadratic	0.01	0.251	0.01	0.052	0.01	0.060	0.01	0.127	0.00	0.368	0.03	**0.000**	0.00	0.905	0.00	0.524	0.05	**0.000**	0.04	**0.000**
cubic	0.01	0.287	0.01	0.111	0.01	0.111	0.01	0.057	0.00	0.521	0.04	**0.000**	0.00	0.885	0.00	0.558	0.07	**0.000**	0.04	**0.000**
exponential	0.01	0.131	0.01	**0.037**	0.01	**0.038**	0.00	0.131	0.00	0.398	0.01	**0.011**	0.00	0.968	0.00	0.716	0.03	**0.000**	0.03	**0.000**
logistic	0.01	0.131	0.01	**0.037**	0.01	**0.038**	0.00	0.131	0.00	0.398	0.01	**0.011**	0.00	0.968	0.00	0.716	0.03	**0.000**	0.03	**0.000**

Table E.2: Curve fitting for morphological index with high reliability (part 1)

	Morphological Index (high relyability)																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
N_sp_all																				
linear	0.00	0.952	0.00	0.715	0.00	0.263	0.00	0.746	0.00	0.993	0.01	**0.001**	0.00	0.632	0.01	**0.019**	0.02	**0.000**	0.02	**0.000**
quadratic	0.01	0.164	0.01	0.055	0.01	**0.020**	0.02	**0.006**	0.03	**0.000**	0.02	**0.001**	0.05	**0.000**	0.01	0.051	0.09	**0.000**	0.02	**0.000**
cubic	0.01	0.262	0.01	0.100	0.01	**0.046**	0.02	**0.017**	0.03	**0.000**	0.02	**0.000**	0.07	**0.000**	0.02	**0.014**	0.09	**0.000**	0.02	**0.000**
exponential	0.00	0.351	0.00	0.801	0.00	0.729	0.00	0.529	0.00	0.196	0.02	**0.000**	0.00	0.556	0.02	**0.001**	0.03	**0.000**	0.03	**0.000**
logistic	0.00	0.351	0.00	0.801	0.00	0.729	0.00	0.529	0.00	0.196	0.02	**0.000**	0.00	0.556	0.02	**0.001**	0.03	**0.000**	0.03	**0.000**
Density_sp_all																				
linear	0.01	**0.003**	0.02	**0.002**	0.02	**0.001**	0.03	**0.000**	0.02	**0.000**	0.05	**0.000**	0.02	**0.000**	0.01	**0.007**	0.05	**0.000**	0.05	**0.000**
quadratic	0.04	**0.000**	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.03	**0.000**	0.09	**0.000**	0.08	**0.000**	0.03	**0.001**	**0.14**	**0.000**	0.07	**0.000**
cubic	0.04	**0.000**	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.03	**0.000**	0.09	**0.000**	0.09	**0.000**	0.04	**0.000**	**0.15**	**0.000**	0.07	**0.000**
exponential	0.00	0.748	0.00	0.870	0.00	0.664	0.00	0.621	0.00	0.625	0.01	**0.026**	0.00	0.342	0.00	0.703	0.02	**0.000**	0.03	**0.000**
logistic	0.00	0.748	0.00	0.870	0.00	0.664	0.00	0.621	0.00	0.625	0.01	**0.026**	0.00	0.342	0.00	0.703	0.02	**0.000**	0.03	**0.000**
Biom_sp_all																				
linear	0.01	**0.005**	0.01	**0.010**	0.01	**0.015**	0.01	**0.002**	0.00	0.100	0.00	0.686	0.00	0.170	0.01	**0.015**	0.01	**0.004**	0.00	0.996
quadratic	0.01	**0.009**	0.01	**0.032**	0.01	0.052	0.02	**0.007**	0.00	0.245	0.00	0.704	0.00	0.250	0.01	**0.050**	0.02	**0.002**	0.00	0.344
cubic	0.02	**0.006**	0.03	**0.001**	0.03	**0.001**	0.03	**0.000**	0.02	**0.005**	0.00	0.715	0.00	0.389	0.02	**0.048**	0.02	**0.003**	0.00	0.326
exponential	0.00	0.210	0.00	0.170	0.00	0.149	0.00	0.134	0.00	0.219	0.00	0.727	0.01	0.066	0.00	0.544	0.01	**0.035**	0.00	0.087
logistic	0.00	0.210	0.00	0.170	0.00	0.149	0.00	0.134	0.00	0.219	0.00	0.727	0.01	0.066	0.00	0.544	0.01	**0.035**	0.00	0.087
kg_ha_Repro_LITH																				
linear	0.01	**0.024**	0.01	**0.019**	0.01	**0.023**	0.01	**0.004**	0.00	0.200	0.00	0.518	0.00	0.317	0.01	**0.025**	0.01	**0.045**	0.00	0.259
quadratic	0.01	0.058	0.01	0.051	0.01	0.068	0.01	**0.011**	0.00	0.405	0.00	0.230	0.00	0.328	0.01	0.073	0.01	**0.024**	0.01	**0.035**
cubic	0.02	**0.020**	0.02	**0.003**	0.03	**0.001**	0.03	**0.001**	0.02	**0.006**	0.00	0.319	0.00	0.380	0.02	**0.046**	0.01	**0.034**	0.01	**0.027**
perc_kgha_Repro_LITH																				
linear	0.00	0.721	0.00	0.639	0.00	0.853	0.00	0.858	0.00	0.402	0.05	**0.000**	0.00	0.986	0.00	0.617	**0.10**	**0.000**	**0.16**	**0.000**
quadratic	0.00	0.323	0.00	0.442	0.00	0.491	0.00	0.838	0.00	0.508	**0.10**	**0.000**	0.00	0.822	0.02	**0.004**	**0.10**	**0.000**	**0.29**	**0.000**
cubic	0.00	0.502	0.00	0.588	0.00	0.542	0.00	0.489	0.02	**0.007**	**0.11**	**0.000**	0.00	0.384	0.06	**0.000**	**0.11**	**0.000**	**0.30**	**0.000**
n_ha_Repro_LITH																				
linear	0.01	**0.023**	0.01	**0.025**	0.01	**0.017**	0.01	**0.008**	0.00	0.077	0.00	0.118	0.01	**0.046**	0.01	0.101	0.01	**0.022**	0.01	**0.022**
quadratic	0.03	**0.000**	0.02	**0.002**	0.02	**0.001**	0.02	**0.001**	0.01	0.152	0.00	0.166	0.05	**0.000**	0.01	0.211	0.03	**0.000**	0.01	0.052
cubic	0.03	**0.000**	0.02	**0.004**	0.03	**0.001**	0.02	**0.002**	0.01	0.105	0.01	0.253	0.07	**0.000**	0.01	0.179	0.04	**0.000**	0.01	**0.046**
perc_nha_Repro_LITH																				
linear	0.00	0.486	0.00	0.598	0.00	0.636	0.00	0.161	0.01	**0.014**	0.04	**0.000**	0.00	0.138	0.00	0.197	0.08	**0.000**	**0.11**	**0.000**
quadratic	0.00	0.389	0.00	0.262	0.00	0.335	0.01	0.094	0.01	**0.009**	0.07	**0.000**	0.01	0.102	0.02	**0.004**	0.09	**0.000**	**0.21**	**0.000**
cubic	0.00	0.596	0.00	0.444	0.00	0.439	0.02	**0.023**	0.03	**0.000**	0.07	**0.000**	0.01	0.166	0.04	**0.000**	0.10	**0.000**	**0.22**	**0.000**
n_sp_Repro_LITH																				
linear	0.00	0.975	0.00	0.530	0.00	0.273	0.00	0.741	0.00	0.765	0.00	0.307	0.00	0.973	0.01	**0.006**	0.00	0.921	0.01	**0.012**
quadratic	0.01	**0.050**	0.02	**0.009**	0.02	**0.004**	0.02	**0.001**	0.04	**0.000**	0.03	**0.000**	0.08	**0.000**	0.02	**0.002**	0.07	**0.000**	0.03	**0.000**
cubic	0.01	0.084	0.02	**0.017**	0.02	**0.011**	0.02	**0.003**	0.04	**0.000**	0.04	**0.000**	0.09	**0.000**	0.02	**0.006**	0.09	**0.000**	0.03	**0.000**
perc_sp_Repro_LITH																				
linear	0.00	0.704	0.00	0.729	0.00	0.980	0.00	0.645	0.00	0.125	0.03	**0.000**	0.00	0.752	0.00	0.404	0.09	**0.000**	**0.13**	**0.000**
quadratic	0.00	0.869	0.00	0.894	0.00	0.855	0.00	0.879	0.00	0.260	0.06	**0.000**	0.00	0.951	0.01	0.217	0.09	**0.000**	**0.21**	**0.000**
cubic	0.00	0.586	0.00	0.577	0.00	0.877	0.00	0.916	0.01	0.074	0.07	**0.000**	0.00	0.819	0.03	**0.003**	0.10	**0.000**	**0.21**	**0.000**
kg_ha_Atroph_OMNI																				
linear	0.01	**0.017**	0.01	0.061	0.01	0.080	0.01	**0.028**	0.00	0.075	0.01	**0.034**	0.00	0.331	0.01	0.082	0.01	**0.011**	0.00	0.120
quadratic	0.01	**0.046**	0.01	0.154	0.01	0.193	0.01	0.085	0.01	0.161	0.01	0.093	0.00	0.430	0.01	0.201	0.01	**0.009**	0.00	0.282
cubic	0.01	0.076	0.01	**0.046**	0.01	0.072	0.01	**0.027**	0.01	0.074	0.01	0.191	0.00	0.622	0.01	0.213	0.01	**0.018**	0.00	0.272
perc_kgha_Atroph_OMNI																				
linear	0.00	0.295	0.00	0.519	0.00	0.557	0.01	**0.016**	0.01	0.060	0.03	**0.000**	0.00	0.461	0.01	**0.029**	0.08	**0.000**	**0.12**	**0.000**
quadratic	0.00	0.479	0.00	0.603	0.00	0.620	0.01	0.056	0.01	0.087	0.03	**0.000**	0.00	0.701	0.02	**0.022**	**0.10**	**0.000**	**0.15**	**0.000**
cubic	0.00	0.644	0.00	0.666	0.00	0.634	0.01	0.116	0.01	0.180	0.03	**0.000**	0.02	**0.020**	0.02	**0.030**	**0.12**	**0.000**	**0.15**	**0.000**
n_ha_Atroph_OMNI																				
linear	0.01	**0.014**	0.01	**0.016**	0.01	**0.012**	0.01	**0.004**	0.01	**0.021**	0.02	**0.000**	0.01	0.058	0.00	0.676	0.02	**0.000**	0.04	**0.000**
quadratic	0.02	**0.005**	0.01	**0.023**	0.01	**0.018**	0.01	**0.009**	0.01	0.070	0.02	**0.000**	0.01	0.072	0.00	0.413	0.02	**0.000**	0.05	**0.000**
cubic	0.02	**0.014**	0.01	**0.048**	0.01	**0.038**	0.02	**0.022**	0.01	0.145	0.02	**0.001**	0.02	**0.002**	0.00	0.596	0.03	**0.000**	0.05	**0.000**
perc_nha_Atroph_OMNI																				
linear	0.00	0.822	0.00	0.899	0.00	0.656	0.00	0.270	0.00	0.490	0.03	**0.000**	0.00	0.379	0.00	0.207	0.07	**0.000**	0.08	**0.000**
quadratic	0.00	0.809	0.00	0.904	0.00	0.842	0.00	0.323	0.01	0.152	0.03	**0.000**	0.00	0.293	0.01	**0.049**	0.09	**0.000**	0.10	**0.000**
cubic	0.00	0.842	0.00	0.887	0.00	0.792	0.01	0.302	0.01	0.279	0.03	**0.000**	0.02	**0.002**	0.01	0.077	**0.11**	**0.000**	**0.10**	**0.000**
n_sp_Atroph_OMNI																				
linear	0.00	0.452	0.00	0.580	0.00	0.949	0.00	0.462	0.00	0.264	0.03	**0.000**	0.00	0.765	0.00	0.169	0.08	**0.000**	**0.10**	**0.000**
quadratic	0.00	0.663	0.00	0.643	0.00	0.709	0.01	0.187	0.01	**0.029**	0.03	**0.000**	0.01	0.130	0.01	0.150	0.10	**0.000**	**0.12**	**0.000**
cubic	0.00	0.770	0.00	0.731	0.00	0.751	0.01	0.336	0.01	**0.026**	0.04	**0.000**	0.02	**0.001**	0.04	**0.000**	0.10	**0.000**	**0.12**	**0.000**
perc_sp_Atroph_OMNI																				
linear	0.00	0.123	0.00	0.195	0.00	0.253	0.01	**0.020**	0.01	**0.005**	0.05	**0.000**	0.00	0.298	0.01	**0.029**	**0.12**	**0.000**	**0.13**	**0.000**
quadratic	0.00	0.299	0.00	0.417	0.00	0.497	0.01	0.059	0.01	**0.009**	0.06	**0.000**	0.00	0.433	0.02	**0.020**	**0.12**	**0.000**	**0.15**	**0.000**
cubic	0.00	0.491	0.00	0.619	0.00	0.693	0.01	0.119	0.02	**0.012**	0.07	**0.000**	0.02	**0.002**	0.04	**0.000**	**0.13**	**0.000**	**0.16**	**0.000**
kg_ha_Mig_POTAD																				
linear	0.01	**0.031**	0.01	**0.022**	0.01	**0.028**	0.01	**0.005**	0.00	0.233	0.00	0.525	0.00	0.377	0.01	**0.035**	0.01	**0.020**	0.00	0.543
quadratic	0.01	0.073	0.01	0.060	0.01	0.081	0.01	**0.014**	0.00	0.457	0.00	0.214	0.00	0.384	0.01	0.100	0.01	**0.016**	0.00	0.122
cubic	0.01	**0.025**	0.02	**0.004**	0.03	**0.001**	0.03	**0.001**	0.02	**0.007**	0.00	0.286	0.00	0.409	0.01	0.066	0.01	**0.029**	0.01	0.098
perc_kgha_Mig_POTAD																				
linear	0.01	**0.048**	0.01	0.073	0.00	0.121	0.01	**0.026**	0.01	**0.003**	0.07	**0.000**	0.00	0.115	0.02	**0.001**	0.08	**0.000**	0.10	**0.000**
quadratic	0.01	0.092	0.01	0.171	0.00	0.230	0.01	**0.049**	0.02	**0.002**	**0.20**	**0.000**	0.01	0.069	0.06	**0.000**	**0.10**	**0.000**	**0.23**	**0.000**
cubic	0.01	0.189	0.01	0.256	0.01	0.301	0.01	**0.049**	0.03	**0.000**	**0.21**	**0.000**	0.01	0.124	**0.10**	**0.000**	**0.10**	**0.000**	**0.24**	**0.000**

Table E.2: Curve fitting for morphological index with high reliability (part 2)

	Morphological Index (high relyability)																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
n_ha_Mig_POTAD																				
linear	0.00	0.112	0.00	0.110	0.00	0.103	0.01	**0.039**	0.00	0.227	0.00	0.103	0.00	0.117	0.00	0.948	0.01	**0.002**	0.01	**0.017**
quadratic	0.03	**0.000**	0.02	**0.002**	0.02	**0.002**	0.02	**0.002**	0.00	0.238	0.00	0.139	0.05	**0.000**	0.00	0.594	0.05	**0.000**	0.01	**0.041**
cubic	0.03	**0.000**	0.02	**0.004**	0.02	**0.004**	0.02	**0.007**	0.01	0.169	0.01	0.246	0.06	**0.000**	0.00	0.638	0.05	**0.000**	0.01	**0.035**
perc_nha_Mig_POTAD																				
linear	0.00	0.089	0.00	0.099	0.00	0.112	0.01	**0.004**	0.02	**0.001**	0.04	**0.000**	0.01	**0.020**	0.06	**0.000**	0.05	**0.000**	0.05	**0.000**
quadratic	0.00	0.226	0.00	0.256	0.00	0.284	0.01	**0.009**	0.02	**0.003**	0.07	**0.000**	0.01	**0.040**	0.07	**0.000**	0.05	**0.000**	0.10	**0.000**
cubic	0.00	0.394	0.00	0.431	0.00	0.463	0.02	**0.009**	0.02	**0.002**	0.07	**0.000**	0.01	0.066	0.07	**0.000**	0.05	**0.000**	**0.10**	**0.000**
n_sp_Mig_POTAD																				
linear	0.00	0.820	0.00	0.767	0.00	0.288	0.00	0.809	0.00	0.974	0.00	0.114	0.00	0.936	0.01	**0.021**	0.01	**0.048**	0.00	0.805
quadratic	0.01	0.067	0.01	**0.017**	0.02	**0.007**	0.02	**0.001**	0.04	**0.000**	0.04	**0.000**	0.10	**0.000**	0.02	**0.003**	**0.10**	**0.000**	0.01	0.074
cubic	0.01	0.115	0.01	**0.029**	0.02	**0.017**	0.02	**0.001**	0.04	**0.000**	0.05	**0.000**	**0.12**	**0.000**	0.02	**0.007**	**0.12**	**0.000**	0.01	0.074
perc_sp_Mig_POTAD																				
linear	0.00	0.950	0.00	0.772	0.00	0.679	0.00	0.777	0.00	0.637	0.02	**0.000**	0.00	0.700	0.00	0.272	0.05	**0.000**	0.08	**0.000**
quadratic	0.00	0.399	0.00	0.393	0.00	0.329	0.00	0.884	0.00	0.856	0.05	**0.000**	0.00	0.927	0.01	0.167	0.05	**0.000**	**0.11**	**0.000**
cubic	0.00	0.539	0.00	0.507	0.00	0.496	0.00	0.607	0.01	0.192	0.05	**0.000**	0.00	0.571	0.02	**0.013**	0.05	**0.000**	**0.11**	**0.000**
kg_ha_Hab_RH																				
linear	0.01	**0.016**	0.01	**0.012**	0.01	**0.015**	0.02	**0.002**	0.00	0.132	0.00	0.851	0.00	0.202	0.01	**0.014**	0.01	**0.016**	0.00	0.417
quadratic	0.01	**0.038**	0.01	**0.032**	0.01	**0.043**	0.02	**0.005**	0.00	0.268	0.00	0.642	0.01	0.172	0.01	**0.047**	0.01	**0.003**	0.00	0.127
cubic	0.02	**0.013**	0.02	**0.002**	0.03	**0.001**	0.03	**0.000**	0.02	**0.006**	0.00	0.613	0.01	0.223	0.02	**0.042**	0.02	**0.003**	0.01	0.111
perc_kgha_Hab_RH																				
linear	0.00	0.207	0.00	0.284	0.00	0.136	0.00	0.078	0.01	0.060	0.00	0.206	0.01	**0.031**	0.01	**0.022**	0.04	**0.000**	**0.11**	**0.000**
quadratic	0.00	0.449	0.00	0.513	0.00	0.251	0.01	0.051	0.01	**0.042**	0.00	0.283	0.01	**0.017**	0.02	**0.010**	0.05	**0.000**	**0.15**	**0.000**
cubic	0.00	0.403	0.00	0.517	0.01	0.309	0.01	0.079	0.02	**0.005**	0.00	0.409	0.03	**0.001**	0.03	**0.001**	0.07	**0.000**	**0.15**	**0.000**
n_ha_Hab_RH																				
linear	0.01	**0.003**	0.02	**0.002**	0.02	**0.001**	0.03	**0.000**	0.02	**0.000**	0.04	**0.000**	0.03	**0.000**	0.02	**0.002**	0.03	**0.000**	0.03	**0.000**
quadratic	0.04	**0.000**	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.03	**0.000**	0.09	**0.000**	0.08	**0.000**	0.03	**0.001**	**0.14**	**0.000**	0.04	**0.000**
cubic	0.04	**0.000**	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.03	**0.000**	0.09	**0.000**	0.10	**0.000**	0.03	**0.001**	**0.15**	**0.000**	0.05	**0.000**
perc_nha_Hab_RH																				
linear	0.00	0.081	0.00	0.093	0.01	**0.046**	0.01	0.057	0.01	**0.042**	0.00	0.371	0.01	**0.023**	0.01	**0.007**	0.06	**0.000**	**0.14**	**0.000**
quadratic	0.00	0.217	0.00	0.244	0.01	0.137	0.01	0.058	0.01	**0.046**	0.00	0.590	0.01	**0.027**	0.02	**0.004**	0.07	**0.000**	**0.19**	**0.000**
cubic	0.01	0.164	0.01	0.261	0.01	0.118	0.01	0.068	0.02	**0.004**	0.00	0.718	0.03	**0.001**	0.03	**0.001**	0.10	**0.000**	**0.19**	**0.000**
n_sp_Hab_RH																				
linear	0.00	0.631	0.00	0.840	0.00	0.449	0.00	0.911	0.00	0.847	0.00	0.147	0.00	0.905	0.03	**0.000**	0.00	0.580	0.00	0.052
quadratic	0.01	**0.038**	0.02	**0.008**	0.02	**0.003**	0.02	**0.003**	0.03	**0.000**	0.02	**0.000**	0.07	**0.000**	0.03	**0.000**	0.07	**0.000**	0.02	**0.001**
cubic	0.01	0.085	0.02	**0.020**	0.02	**0.009**	0.02	**0.007**	0.03	**0.000**	0.03	**0.000**	0.07	**0.000**	0.03	**0.001**	0.09	**0.000**	0.02	**0.001**
perc_sp_Hab_RH																				
linear	0.00	0.650	0.00	0.884	0.00	0.721	0.00	0.998	0.00	0.660	0.02	**0.000**	0.00	0.793	0.00	0.505	0.08	**0.000**	**0.16**	**0.000**
quadratic	0.00	0.899	0.00	0.989	0.00	0.938	0.00	0.656	0.00	0.521	0.03	**0.000**	0.00	0.408	0.01	**0.043**	0.09	**0.000**	**0.20**	**0.000**
cubic	0.00	0.816	0.00	0.756	0.00	0.811	0.00	0.494	0.01	**0.024**	0.03	**0.000**	0.03	**0.000**	0.06	**0.000**	**0.10**	**0.000**	**0.20**	**0.000**
P-INSE (EFI)																				
linear	0.01	0.055	0.01	**0.025**	0.01	**0.026**	0.02	**0.002**	0.01	**0.025**	0.03	**0.000**	0.00	0.157	0.00	0.150	0.05	**0.000**	0.07	**0.000**
quadratic	0.01	0.153	0.01	**0.044**	0.01	**0.045**	0.02	**0.007**	0.01	**0.021**	0.06	**0.000**	0.01	0.218	0.02	**0.003**	0.05	**0.000**	0.10	**0.000**
cubic	0.01	0.236	0.01	0.056	0.01	**0.046**	0.02	**0.008**	0.01	**0.023**	0.06	**0.000**	0.01	0.166	0.05	**0.000**	0.07	**0.000**	0.10	**0.000**
exponential	0.00	0.245	0.00	0.148	0.00	0.144	0.01	**0.013**	0.01	**0.028**	0.06	**0.000**	0.01	0.086	0.00	0.424	0.09	**0.000**	**0.15**	**0.000**
logistic	0.00	0.245	0.00	0.148	0.00	0.144	0.01	**0.013**	0.01	**0.028**	0.06	**0.000**	0.01	0.086	0.00	0.424	0.09	**0.000**	**0.15**	**0.000**
P-OMNI (EFI)																				
linear	0.00	0.386	0.00	0.345	0.00	0.290	0.00	0.348	0.00	0.242	0.01	**0.011**	0.01	0.086	0.00	0.959	0.02	**0.000**	0.08	**0.000**
quadratic	0.00	0.373	0.01	0.209	0.00	0.304	0.00	0.615	0.00	0.372	0.01	**0.028**	0.01	0.141	0.01	**0.045**	0.02	**0.000**	0.09	**0.000**
cubic	0.00	0.578	0.01	0.357	0.01	0.357	0.00	0.607	0.00	0.378	0.01	0.065	0.03	**0.001**	0.01	0.102	0.04	**0.000**	0.09	**0.000**
exponential	0.00	0.253	0.00	0.383	0.00	0.372	0.00	0.127	0.00	0.217	0.02	**0.000**	0.00	0.369	0.00	0.943	0.03	**0.000**	0.06	**0.000**
logistic	0.00	0.253	0.00	0.383	0.00	0.372	0.00	0.127	0.00	0.217	0.02	**0.000**	0.00	0.369	0.00	0.943	0.03	**0.000**	0.06	**0.000**
P-PHYT (EFI)																				
linear	0.00	0.438	0.00	0.546	0.00	0.394	0.00	0.084	0.00	0.139	0.00	0.080	0.01	**0.035**	0.00	0.317	0.02	**0.000**	0.05	**0.000**
quadratic	0.01	**0.047**	0.01	0.093	0.01	0.084	0.00	0.225	0.00	0.237	0.03	**0.000**	0.01	**0.014**	0.02	**0.004**	0.03	**0.000**	0.06	**0.000**
cubic	0.01	0.087	0.01	0.114	0.01	0.108	0.01	0.352	0.01	0.146	0.04	**0.000**	0.02	**0.007**	0.04	**0.001**	0.04	**0.000**	0.06	**0.000**
exponential	0.01	0.068	0.01	0.073	0.00	0.155	0.01	0.079	0.01	**0.024**	0.05	**0.000**	0.00	0.228	0.01	0.053	0.06	**0.000**	0.05	**0.000**
logistic	0.01	0.068	0.01	0.073	0.00	0.155	0.01	0.079	0.01	**0.024**	0.05	**0.000**	0.00	0.228	0.01	0.053	0.06	**0.000**	0.05	**0.000**
P-BENT (EFI)																				
linear	0.01	**0.022**	0.01	**0.008**	0.02	**0.002**	0.02	**0.000**	0.02	**0.000**	0.00	0.464	0.02	**0.001**	0.01	0.123	0.00	0.241	0.03	**0.000**
quadratic	0.01	0.050	0.02	**0.013**	0.02	**0.002**	0.02	**0.001**	0.02	**0.001**	0.01	0.126	0.02	**0.003**	0.01	0.234	0.00	0.233	0.04	**0.000**
cubic	0.01	0.104	0.02	**0.032**	0.02	**0.004**	0.02	**0.002**	0.02	**0.002**	0.01	0.247	0.04	**0.000**	0.01	0.351	0.01	0.245	0.04	**0.000**
exponential	0.01	**0.018**	0.01	**0.004**	0.02	**0.001**	0.05	**0.000**	0.03	**0.000**	0.01	**0.040**	0.03	**0.000**	0.02	**0.002**	0.00	0.867	0.01	**0.013**
logistic	0.01	**0.018**	0.01	**0.004**	0.02	**0.001**	0.05	**0.000**	0.03	**0.000**	0.01	**0.040**	0.03	**0.000**	0.02	**0.002**	0.00	0.867	0.01	**0.013**
P-RHEO (EFI)																				
linear	0.01	0.085	0.01	**0.016**	0.01	**0.008**	0.02	**0.002**	0.01	**0.002**	0.00	0.159	0.01	**0.021**	0.00	0.777	0.01	**0.006**	0.01	**0.012**
quadratic	0.01	0.055	0.02	**0.005**	0.02	**0.001**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.001**	0.01	0.130	0.02	**0.001**	0.02	**0.001**
cubic	0.01	0.104	0.02	**0.011**	0.03	**0.002**	0.04	**0.000**	0.04	**0.000**	0.03	**0.000**	0.03	**0.001**	0.03	**0.004**	0.02	**0.000**	0.02	**0.001**
exponential	0.01	0.083	0.01	**0.020**	0.01	**0.005**	0.02	**0.001**	0.01	**0.006**	0.01	**0.031**	0.01	**0.048**	0.01	0.128	0.03	**0.000**	0.04	**0.000**
logistic	0.01	0.083	0.01	**0.020**	0.01	**0.005**	0.02	**0.001**	0.01	**0.006**	0.01	**0.031**	0.01	**0.048**	0.01	0.128	0.03	**0.000**	0.04	**0.000**
P-LONG (EFI)																				
linear	0.01	**0.003**	0.02	**0.003**	0.02	**0.002**	0.02	**0.001**	0.02	**0.002**	0.00	0.644	0.02	**0.000**	0.07	**0.000**	0.00	0.075	0.00	0.243
quadratic	0.02	**0.011**	0.02	**0.011**	0.02	**0.008**	0.02	**0.001**	0.02	**0.007**	0.01	0.062	0.02	**0.001**	0.10	**0.000**	0.02	**0.004**	0.01	**0.005**
cubic	0.02	**0.024**	0.02	**0.025**	0.02	**0.018**	0.02	**0.002**	0.02	**0.018**	0.01	**0.034**	0.03	**0.001**	0.10	**0.000**	0.03	**0.000**	0.01	**0.007**
exponential	0.02	**0.002**	0.02	**0.002**	0.02	**0.002**	0.02	**0.000**	0.02	**0.001**	0.00	0.498	0.02	**0.001**	0.08	**0.000**	0.01	0.057	0.00	0.593
logistic	0.02	**0.002**	0.02	**0.002**	0.02	**0.002**	0.02	**0.000**	0.02	**0.001**	0.00	0.498	0.02	**0.001**	0.08	**0.000**	0.01	0.057	0.00	0.593

Table E.2: Curve fitting for morphological index with high reliability (part 3)

	Morphological Index (high relyability)																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
P-POTA (EFI)																				
linear	0.00	0.618	0.00	0.252	0.00	0.116	0.01	0.060	0.01	0.055	0.01	**0.031**	0.00	0.419	0.00	0.912	0.00	0.073	0.01	**0.036**
quadratic	0.00	0.324	0.01	**0.038**	0.02	**0.007**	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.03	**0.002**	0.03	**0.000**	0.02	**0.003**
cubic	0.00	0.519	0.01	0.086	0.02	**0.018**	0.04	**0.000**	0.04	**0.000**	0.06	**0.000**	0.07	**0.000**	0.04	**0.001**	0.04	**0.000**	0.01	**0.004**
exponential	0.00	0.641	0.00	0.262	0.00	0.152	0.00	0.128	0.01	**0.049**	0.01	**0.008**	0.00	0.346	0.00	0.783	0.01	**0.025**	0.01	**0.022**
logistic	0.00	0.641	0.00	0.262	0.00	0.152	0.00	0.128	0.01	**0.049**	0.01	**0.008**	0.00	0.346	0.00	0.783	0.01	**0.025**	0.01	**0.022**
P-LITH (EFI)																				
linear	0.00	0.770	0.00	0.359	0.00	0.421	0.00	0.906	0.00	0.937	0.01	**0.003**	0.00	0.888	0.01	0.092	0.06	**0.000**	**0.17**	**0.000**
quadratic	0.02	**0.001**	0.03	**0.000**	0.03	**0.000**	0.02	**0.007**	0.02	**0.002**	0.06	**0.000**	0.06	**0.000**	0.03	**0.002**	**0.11**	**0.000**	**0.24**	**0.000**
cubic	0.02	**0.003**	0.03	**0.000**	0.03	**0.000**	0.02	**0.004**	0.02	**0.002**	0.06	**0.000**	0.07	**0.000**	0.03	**0.002**	**0.16**	**0.000**	**0.25**	**0.000**
exponential	0.00	0.431	0.00	0.250	0.00	0.173	0.00	0.101	0.00	0.111	0.04	**0.000**	0.00	0.140	0.00	0.149	**0.12**	**0.000**	**0.15**	**0.000**
logistic	0.00	0.431	0.00	0.250	0.00	0.173	0.00	0.101	0.00	0.111	0.04	**0.000**	0.00	0.140	0.00	0.149	**0.12**	**0.000**	**0.15**	**0.000**
P-INTO (EFI)																				
linear	0.00	0.564	0.00	0.306	0.00	0.222	0.00	0.478	0.00	0.571	0.02	**0.000**	0.00	0.581	0.00	0.818	0.07	**0.000**	**0.16**	**0.000**
quadratic	0.01	0.089	0.01	**0.025**	0.01	**0.039**	0.00	0.770	0.00	0.805	0.03	**0.000**	0.01	0.062	0.00	0.519	0.08	**0.000**	**0.17**	**0.000**
cubic	0.01	0.127	0.01	**0.043**	0.01	0.089	0.00	0.908	0.00	0.702	0.03	**0.000**	0.04	**0.000**	0.01	0.179	0.10	**0.000**	**0.17**	**0.000**
exponential	0.00	0.242	0.00	0.125	0.01	0.076	0.01	0.077	0.00	0.156	0.04	**0.000**	0.01	0.077	0.00	0.164	**0.11**	**0.000**	**0.19**	**0.000**
logistic	0.00	0.242	0.00	0.125	0.01	0.076	0.01	0.077	0.00	0.156	0.04	**0.000**	0.01	0.077	0.00	0.164	**0.11**	**0.000**	**0.19**	**0.000**
P-TOLE (EFI)																				
linear	0.00	0.825	0.00	0.769	0.00	0.937	0.00	0.694	0.00	0.936	0.02	**0.001**	0.00	0.729	0.01	**0.023**	0.06	**0.000**	**0.14**	**0.000**
quadratic	0.00	0.774	0.00	0.477	0.00	0.483	0.00	0.922	0.00	0.996	0.02	**0.000**	0.00	0.567	0.02	**0.015**	0.06	**0.000**	**0.19**	**0.000**
cubic	0.00	0.911	0.00	0.682	0.00	0.672	0.00	0.980	0.00	0.958	0.02	**0.000**	0.01	0.200	0.04	**0.001**	0.08	**0.000**	**0.20**	**0.000**
exponential	0.00	0.223	0.00	0.244	0.00	0.402	0.00	0.233	0.00	0.216	0.01	**0.020**	0.00	0.755	0.01	0.113	0.08	**0.000**	**0.19**	**0.000**
logistic	0.00	0.223	0.00	0.244	0.00	0.402	0.00	0.233	0.00	0.216	0.01	**0.020**	0.00	0.755	0.01	0.113	0.08	**0.000**	**0.19**	**0.000**
FAME Index																				
linear	0.01	0.066	0.01	**0.009**	0.01	**0.005**	0.01	**0.005**	0.01	**0.010**	0.04	**0.000**	0.00	0.123	0.00	0.670	0.09	**0.000**	**0.17**	**0.000**
quadratic	0.02	**0.001**	0.04	**0.000**	0.05	**0.000**	0.03	**0.000**	0.03	**0.000**	0.08	**0.000**	0.05	**0.000**	0.03	**0.001**	**0.11**	**0.000**	**0.21**	**0.000**
cubic	0.02	**0.002**	0.04	**0.000**	0.05	**0.000**	0.03	**0.000**	0.03	**0.000**	0.09	**0.000**	0.05	**0.000**	0.06	**0.000**	**0.15**	**0.000**	**0.21**	**0.000**
exponential	0.00	0.089	0.01	**0.020**	0.01	**0.011**	0.01	**0.007**	0.01	**0.010**	0.04	**0.000**	0.00	0.105	0.00	0.609	**0.10**	**0.000**	**0.18**	**0.000**
logistic	0.00	0.089	0.01	**0.020**	0.01	**0.011**	0.01	**0.007**	0.01	**0.010**	0.04	**0.000**	0.00	0.105	0.00	0.609	**0.10**	**0.000**	**0.18**	**0.000**
MetHINTOL150 (EFIplus)																				
linear	0.01	0.093	0.01	0.072	0.01	**0.043**	0.01	**0.028**	0.01	0.143	0.01	**0.035**	0.00	0.282	0.00	0.529	0.02	**0.004**	0.00	0.851
quadratic	0.01	0.217	0.01	0.191	0.01	0.128	0.01	0.075	0.01	0.295	0.02	**0.021**	0.01	0.340	0.00	0.544	0.02	**0.008**	0.01	**0.034**
cubic	0.01	0.227	0.01	0.326	0.01	0.250	0.02	0.076	0.01	0.478	0.02	**0.024**	0.01	0.431	0.00	0.686	0.03	**0.003**	0.01	**0.026**
MetO2INTOL (EFIplus)																				
linear	0.00	0.362	0.00	0.535	0.00	0.662	0.00	0.664	0.00	0.908	0.04	**0.000**	0.00	0.781	0.00	0.689	0.04	**0.000**	0.02	**0.001**
quadratic	0.00	0.628	0.00	0.823	0.00	0.908	0.00	0.617	0.00	0.612	0.05	**0.000**	0.00	0.792	0.01	0.154	0.04	**0.000**	0.02	**0.003**
cubic	0.00	0.704	0.00	0.942	0.00	0.956	0.00	0.765	0.00	0.805	0.05	**0.000**	0.01	0.133	0.02	0.168	0.07	**0.000**	0.02	**0.003**
MetRHPAR (EFIplus)																				
linear	0.00	0.881	0.00	0.836	0.00	0.794	0.00	0.827	0.01	0.459	0.00	0.666	0.00	0.828	0.01	0.649	**0.15**	**0.000**	**0.46**	**0.000**
quadratic	0.01	0.792	0.03	0.562	0.07	0.323	0.00	0.929	0.02	0.681	0.02	0.460	0.00	0.903	0.06	0.440	**0.30**	**0.000**	**0.47**	**0.000**
cubic	0.02	0.827	0.04	0.696	0.07	0.528	0.02	0.830	0.03	0.747	0.02	0.460	0.01	0.960	0.07	0.403	**0.30**	**0.000**	**0.47**	**0.000**
exponential	0.00	0.884	0.00	0.857	0.00	0.824	0.00	0.745	0.02	0.380	0.01	0.311	0.02	0.399	0.01	0.643	0.08	**0.011**	**0.34**	**0.000**
logistic	0.00	0.884	0.00	0.857	0.00	0.824	0.00	0.745	0.02	0.380	0.01	0.311	0.02	0.399	0.01	0.643	0.08	**0.011**	**0.34**	**0.000**
MetLITH (EFIplus)																				
linear	0.00	0.959	0.00	0.927	0.00	0.697	0.00	0.782	0.00	0.958	0.03	0.142	0.00	0.728	0.02	0.468	**0.41**	**0.000**	**0.38**	**0.000**
quadratic	0.01	0.763	0.06	0.368	0.07	0.338	0.09	0.152	**0.25**	**0.002**	0.05	0.123	0.02	0.672	**0.34**	**0.006**	**0.46**	**0.000**	**0.41**	**0.000**
cubic	0.02	0.906	0.06	0.557	**0.11**	0.330	0.10	0.287	**0.26**	**0.006**	0.05	0.127	0.04	0.606	**0.36**	**0.004**	**0.46**	**0.000**	**0.40**	**0.000**
EFIplus Index																				
linear	0.00	0.151	0.01	0.144	0.01	0.114	0.01	0.107	0.00	0.421	0.03	**0.000**	0.00	0.560	0.00	0.611	0.07	**0.000**	0.05	**0.000**
quadratic	0.00	0.355	0.01	0.343	0.01	0.278	0.01	0.270	0.00	0.676	0.03	**0.000**	0.00	0.736	0.02	**0.049**	0.07	**0.000**	0.06	**0.000**
cubic	0.01	0.323	0.01	0.529	0.01	0.445	0.01	0.296	0.00	0.737	0.04	**0.000**	0.00	0.796	0.02	0.109	**0.10**	**0.000**	0.06	**0.000**
EFIplus Class																				
linear	0.01	0.097	0.01	0.092	0.01	0.087	0.01	**0.046**	0.00	0.265	0.02	**0.000**	0.00	0.589	0.00	0.930	0.05	**0.000**	0.04	**0.000**
quadratic	0.01	0.251	0.01	0.242	0.01	0.230	0.01	0.136	0.00	0.504	0.03	**0.000**	0.00	0.851	0.01	0.085	0.05	**0.000**	0.04	**0.000**
cubic	0.01	0.287	0.01	0.415	0.01	0.363	0.01	0.169	0.00	0.644	0.04	**0.000**	0.00	0.952	0.01	0.168	0.08	**0.000**	0.04	**0.000**
exponential	0.01	0.131	0.01	0.136	0.01	0.154	0.00	0.181	0.00	0.676	0.01	**0.006**	0.00	0.976	0.00	0.950	0.04	**0.000**	0.03	**0.000**
logistic	0.01	0.131	0.01	0.136	0.01	0.154	0.00	0.181	0.00	0.676	0.01	**0.006**	0.00	0.976	0.00	0.950	0.04	**0.000**	0.03	**0.000**

Table E.3: Curve fitting for hydro peaking (part 1)

	Percentage Hydro Peaking																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
N_sp_all																				
linear	0.00	0.578	0.00	0.451	0.00	0.374	0.00	0.421	0.00	0.369	0.01	**0.009**	0.00	0.301	0.00	0.170	0.00	0.727	0.00	0.406
quadratic	0.00	0.578	0.00	0.563	0.00	0.640	0.00	0.560	0.00	0.668	0.01	**0.034**	0.00	0.558	0.01	0.102	0.01	**0.044**	0.01	0.130
cubic	0.00	0.578	0.01	0.169	0.00	0.644	0.00	0.635	0.00	0.800	0.01	0.064	0.00	0.455	0.01	0.204	0.02	**0.001**	0.01	0.099
exponential	0.00	0.480	0.00	0.551	0.00	0.633	0.00	0.743	0.00	0.889	0.00	0.053	0.00	0.731	0.00	0.862	0.01	**0.017**	0.00	0.702
logistic	0.00	0.480	0.00	0.551	0.00	0.633	0.00	0.743	0.00	0.889	0.00	0.053	0.00	0.731	0.00	0.862	0.01	**0.017**	0.00	0.702
Density_sp_all																				
linear	0.01	**0.016**	0.01	**0.014**	0.01	**0.010**	0.01	**0.009**	0.01	**0.005**	0.01	**0.001**	0.01	**0.005**	0.01	**0.002**	0.02	**0.000**	0.02	**0.000**
quadratic	0.01	**0.016**	0.01	**0.039**	0.01	**0.037**	0.01	**0.031**	0.01	**0.020**	0.02	**0.001**	0.01	**0.010**	0.02	**0.003**	0.02	**0.000**	0.02	**0.001**
cubic	0.01	**0.016**	0.01	0.090	0.01	0.076	0.01	0.066	0.01	**0.046**	0.02	**0.002**	0.01	**0.027**	0.02	**0.003**	0.02	**0.000**	0.02	**0.003**
exponential	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.06	**0.000**	0.04	**0.000**	0.07	**0.000**	0.09	**0.000**	0.07	**0.000**
logistic	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.06	**0.000**	0.04	**0.000**	0.07	**0.000**	0.09	**0.000**	0.07	**0.000**
Biom_sp_all																				
linear	0.01	**0.040**	0.01	**0.031**	0.01	**0.023**	0.01	**0.021**	0.01	**0.017**	0.01	**0.009**	0.01	**0.040**	0.01	**0.023**	0.01	**0.041**	0.01	**0.014**
quadratic	0.01	**0.040**	0.01	0.070	0.01	0.073	0.01	0.069	0.01	0.057	0.01	**0.030**	0.01	0.116	0.01	**0.039**	0.01	0.070	0.01	**0.048**
cubic	0.01	**0.040**	0.01	0.143	0.01	0.149	0.01	0.122	0.01	0.095	0.01	0.071	0.01	0.093	0.01	**0.048**	0.01	0.128	0.01	**0.047**
exponential	0.03	**0.000**	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.03	**0.000**	0.04	**0.000**	0.03	**0.000**	0.06	**0.000**
logistic	0.03	**0.000**	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.03	**0.000**	0.04	**0.000**	0.03	**0.000**	0.06	**0.000**
kg_ha_Repro_LITH																				
linear	0.00	0.055	0.01	**0.042**	0.01	**0.032**	0.01	**0.030**	0.01	**0.025**	0.01	**0.016**	0.01	**0.046**	0.01	**0.039**	0.00	0.072	0.01	**0.013**
quadratic	0.00	0.055	0.01	0.084	0.01	0.096	0.01	0.094	0.01	0.081	0.01	0.052	0.01	0.135	0.01	0.074	0.01	0.121	0.01	**0.044**
cubic	0.00	0.055	0.01	0.168	0.01	0.189	0.01	0.155	0.01	0.118	0.01	0.115	0.01	0.086	0.01	0.093	0.01	0.208	0.01	**0.015**
perc_kgha_Repro_LITH																				
linear	0.00	0.126	0.00	0.182	0.00	0.174	0.00	0.150	0.00	0.133	0.01	**0.029**	0.00	0.246	0.01	**0.016**	0.01	**0.018**	0.00	0.637
quadratic	0.00	0.126	0.00	0.306	0.00	0.395	0.00	0.188	0.01	0.112	0.01	**0.029**	0.00	0.257	0.01	**0.038**	0.01	0.052	0.00	0.627
cubic	0.00	0.126	0.00	0.385	0.00	0.603	0.00	0.339	0.01	0.177	0.01	**0.013**	0.00	0.318	0.01	0.063	0.01	0.108	0.02	**0.001**
n_ha_Repro_LITH																				
linear	0.01	**0.030**	0.01	**0.026**	0.01	**0.020**	0.01	**0.020**	0.01	**0.013**	0.01	**0.004**	0.01	**0.008**	0.01	**0.006**	0.02	**0.000**	0.01	**0.000**
quadratic	0.01	**0.030**	0.01	0.064	0.01	0.066	0.01	**0.048**	0.01	**0.040**	0.01	**0.013**	0.01	**0.026**	0.01	**0.013**	0.02	**0.001**	0.02	**0.002**
cubic	0.01	**0.030**	0.01	0.139	0.01	0.127	0.01	0.081	0.01	0.061	0.01	**0.024**	0.01	0.050	0.01	**0.013**	0.02	**0.002**	0.02	**0.001**
perc_nha_Repro_LITH																				
linear	0.00	0.486	0.00	0.525	0.00	0.503	0.00	0.556	0.00	0.529	0.01	**0.026**	0.00	0.365	0.01	**0.010**	0.01	**0.001**	0.00	0.145
quadratic	0.00	0.486	0.00	0.812	0.00	0.514	0.00	0.216	0.01	**0.019**	0.01	**0.006**	0.00	0.513	0.01	**0.015**	0.01	**0.004**	0.00	0.342
cubic	0.00	0.486	0.00	0.897	0.00	0.682	0.00	0.382	0.01	**0.045**	0.01	**0.012**	0.00	0.306	0.01	**0.030**	0.01	**0.010**	0.02	**0.000**
n_sp_Repro_LITH																				
linear	0.00	0.776	0.00	0.909	0.00	0.986	0.00	0.945	0.00	0.985	0.00	0.253	0.00	0.914	0.00	0.400	0.01	**0.010**	0.00	0.960
quadratic	0.00	0.776	0.00	0.811	0.00	0.925	0.00	0.556	0.00	0.644	0.00	0.253	0.00	0.189	0.02	**0.003**	0.03	**0.000**	0.01	0.060
cubic	0.00	0.776	0.00	0.338	0.00	0.920	0.00	0.707	0.00	0.830	0.00	0.412	0.01	0.086	0.02	**0.004**	0.05	**0.000**	0.01	0.119
perc_sp_Repro_LITH																				
linear	0.00	0.497	0.00	0.470	0.00	0.400	0.00	0.286	0.00	0.186	0.01	**0.004**	0.00	0.053	0.01	**0.001**	0.01	**0.014**	0.00	0.119
quadratic	0.00	0.497	0.00	0.708	0.00	0.682	0.00	0.394	0.01	**0.035**	0.02	**0.001**	0.01	**0.012**	0.02	**0.003**	0.01	**0.021**	0.01	0.069
cubic	0.00	0.497	0.00	0.735	0.00	0.756	0.00	0.596	0.01	**0.045**	0.02	**0.002**	0.01	**0.032**	0.02	**0.003**	0.01	0.052	0.03	**0.000**
kg_ha_Atroph_OMNI																				
linear	0.00	0.221	0.00	0.208	0.00	0.187	0.00	0.225	0.00	0.190	0.00	0.160	0.00	0.300	0.00	0.124	0.00	0.062	0.00	0.279
quadratic	0.00	0.221	0.00	0.438	0.00	0.395	0.00	0.479	0.00	0.420	0.00	0.368	0.00	0.540	0.00	0.192	0.00	0.142	0.00	0.431
cubic	0.00	0.221	0.00	0.645	0.00	0.598	0.00	0.628	0.00	0.619	0.00	0.407	0.00	0.620	0.01	0.268	0.01	0.266	0.00	0.401
perc_kgha_Atroph_OMNI																				
linear	0.01	**0.002**	0.01	**0.003**	0.01	**0.002**	0.01	**0.004**	0.01	**0.001**	0.02	**0.000**	0.01	**0.001**	0.02	**0.000**	0.02	**0.000**	0.01	**0.006**
quadratic	0.01	**0.002**	0.01	**0.011**	0.01	**0.007**	0.01	**0.016**	0.01	**0.006**	0.02	**0.000**	0.02	**0.000**	0.03	**0.000**	0.02	**0.000**	0.01	**0.011**
cubic	0.01	**0.002**	0.01	**0.029**	0.01	**0.019**	0.01	**0.015**	0.01	**0.016**	0.02	**0.000**	0.02	**0.001**	0.03	**0.000**	0.02	**0.000**	0.02	**0.002**
n_ha_Atroph_OMNI																				
linear	0.00	0.090	0.00	0.094	0.00	0.086	0.00	0.112	0.00	0.099	0.01	**0.034**	0.00	0.150	0.01	**0.033**	0.01	**0.030**	0.00	0.161
quadratic	0.00	0.090	0.00	0.246	0.00	0.228	0.00	0.278	0.00	0.256	0.01	0.089	0.00	0.220	0.01	**0.044**	0.01	0.070	0.00	0.321
cubic	0.00	0.090	0.00	0.423	0.00	0.398	0.00	0.352	0.00	0.422	0.01	0.176	0.00	0.387	0.01	0.057	0.01	0.139	0.01	0.176
perc_nha_Atroph_OMNI																				
linear	0.01	**0.006**	0.01	**0.010**	0.01	**0.009**	0.01	**0.015**	0.01	**0.010**	0.01	**0.001**	0.01	**0.002**	0.02	**0.000**	0.02	**0.000**	0.00	0.066
quadratic	0.01	**0.006**	0.01	**0.020**	0.01	**0.024**	0.01	**0.048**	0.01	**0.037**	0.01	**0.002**	0.01	**0.004**	0.03	**0.000**	0.02	**0.001**	0.00	0.157
cubic	0.01	**0.006**	0.01	**0.049**	0.01	0.058	0.01	**0.040**	0.01	0.084	0.02	**0.006**	0.01	**0.010**	0.03	**0.000**	0.02	**0.003**	0.01	0.143
n_sp_Atroph_OMNI																				
linear	0.01	**0.009**	0.01	**0.011**	0.01	**0.008**	0.01	**0.009**	0.01	**0.006**	0.02	**0.000**	0.01	**0.006**	0.02	**0.001**	0.01	**0.002**	0.00	0.120
quadratic	0.01	**0.009**	0.01	**0.024**	0.01	**0.025**	0.01	**0.029**	0.01	**0.023**	0.02	**0.000**	0.01	**0.016**	0.02	**0.002**	0.01	**0.007**	0.01	0.077
cubic	0.01	**0.009**	0.01	**0.044**	0.01	0.060	0.01	**0.027**	0.01	0.056	0.02	**0.000**	0.01	**0.032**	0.02	**0.004**	0.01	**0.010**	0.01	**0.036**
perc_sp_Atroph_OMNI																				
linear	0.01	**0.009**	0.01	**0.013**	0.01	**0.009**	0.01	**0.006**	0.01	**0.003**	0.02	**0.000**	0.01	**0.001**	0.02	**0.000**	0.02	**0.000**	0.01	**0.040**
quadratic	0.01	**0.009**	0.01	**0.019**	0.01	**0.028**	0.01	**0.025**	0.01	**0.012**	0.02	**0.000**	0.01	**0.005**	0.02	**0.001**	0.02	**0.002**	0.01	**0.025**
cubic	0.01	**0.009**	0.01	**0.040**	0.01	0.067	0.01	**0.036**	0.01	**0.026**	0.02	**0.000**	0.01	**0.008**	0.02	**0.001**	0.02	**0.003**	0.01	**0.015**
kg_ha_Mig_POTAD																				
linear	0.01	**0.048**	0.01	**0.037**	0.01	**0.028**	0.01	**0.025**	0.01	**0.020**	0.01	**0.013**	0.01	**0.038**	0.01	**0.031**	0.00	0.060	0.01	**0.012**
quadratic	0.01	**0.048**	0.01	0.081	0.01	0.086	0.01	0.081	0.01	0.068	0.01	**0.042**	0.01	0.115	0.01	0.056	0.01	0.099	0.01	**0.043**
cubic	0.01	**0.048**	0.01	0.163	0.01	0.171	0.01	0.141	0.01	0.106	0.01	0.095	0.01	0.076	0.01	0.071	0.01	0.170	0.01	**0.019**

Table E.3: Curve fitting for hydro peaking (part 2)

	Percentage Hydro Peaking																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
perc_kgha_Mig_POTAD																				
linear	0.00	0.662	0.00	0.729	0.00	0.787	0.00	0.796	0.00	0.790	0.00	0.261	0.00	0.837	0.00	0.328	0.01	**0.037**	0.00	0.477
quadratic	0.00	0.662	0.00	0.885	0.00	0.740	0.00	0.512	0.00	0.474	0.00	0.294	0.01	0.140	0.00	0.618	0.01	0.111	0.00	0.631
cubic	0.00	0.662	0.00	0.741	0.00	0.819	0.00	0.671	0.00	0.605	0.01	0.068	0.01	0.059	0.01	0.144	0.01	0.219	0.02	**0.000**
n_ha_Mig_POTAD																				
linear	0.01	**0.034**	0.01	**0.027**	0.01	**0.019**	0.01	**0.017**	0.01	**0.010**	0.01	**0.003**	0.01	**0.009**	0.01	**0.004**	0.02	**0.000**	0.02	**0.000**
quadratic	0.01	**0.034**	0.01	0.052	0.01	0.065	0.01	**0.041**	0.01	**0.030**	0.01	**0.012**	0.01	**0.028**	0.01	**0.010**	0.02	**0.000**	0.02	**0.000**
cubic	0.01	**0.034**	0.01	0.114	0.01	0.113	0.01	0.080	0.01	**0.045**	0.01	**0.024**	0.01	**0.048**	0.02	**0.010**	0.02	**0.001**	0.03	**0.000**
perc_nha_Mig_POTAD																				
linear	0.00	0.598	0.00	0.777	0.00	0.841	0.00	0.927	0.00	0.953	0.00	0.076	0.00	0.482	0.01	**0.024**	0.01	**0.004**	0.00	0.815
quadratic	0.00	0.598	0.00	0.476	0.00	0.971	0.00	0.858	0.00	0.167	0.01	**0.023**	0.00	0.546	0.01	0.057	0.01	**0.017**	0.00	0.168
cubic	0.00	0.598	0.00	0.581	0.00	0.981	0.00	0.959	0.00	0.280	0.01	**0.018**	0.01	0.220	0.01	**0.035**	0.01	**0.043**	0.01	**0.014**
n_sp_Mig_POTAD																				
linear	0.00	0.623	0.00	0.798	0.00	0.944	0.00	0.845	0.00	0.815	0.00	0.291	0.00	0.855	0.00	0.338	0.01	**0.002**	0.00	0.806
quadratic	0.00	0.623	0.00	0.522	0.00	0.925	0.00	0.335	0.00	0.478	0.00	0.143	0.01	**0.016**	0.02	**0.000**	0.04	**0.000**	0.02	**0.001**
cubic	0.00	0.623	0.01	0.057	0.00	0.567	0.00	0.386	0.00	0.682	0.01	0.187	0.02	**0.002**	0.03	**0.000**	0.07	**0.000**	0.02	**0.003**
perc_sp_Mig_POTAD																				
linear	0.00	0.572	0.00	0.606	0.00	0.632	0.00	0.454	0.00	0.233	0.01	**0.006**	0.00	0.139	0.01	**0.005**	0.01	**0.025**	0.00	0.531
quadratic	0.00	0.572	0.00	0.874	0.00	0.891	0.00	0.470	0.01	**0.029**	0.02	**0.001**	0.02	**0.001**	0.01	**0.010**	0.01	**0.049**	0.01	**0.011**
cubic	0.00	0.572	0.00	0.937	0.00	0.948	0.00	0.571	0.01	**0.037**	0.02	**0.000**	0.02	**0.003**	0.02	**0.001**	0.01	0.108	0.02	**0.000**
kg_ha_Hab_RH																				
linear	0.00	0.051	0.01	**0.039**	0.01	**0.030**	0.01	**0.026**	0.01	**0.020**	0.01	**0.011**	0.01	**0.032**	0.01	**0.029**	0.00	**0.050**	0.01	**0.006**
quadratic	0.00	0.051	0.01	0.079	0.01	0.090	0.01	0.083	0.01	0.066	0.01	**0.034**	0.01	0.094	0.01	**0.045**	0.01	0.078	0.01	**0.022**
cubic	0.00	0.051	0.01	0.159	0.01	0.178	0.01	0.151	0.01	0.109	0.01	0.080	0.01	0.078	0.01	0.053	0.01	0.135	0.01	**0.012**
perc_kgha_Hab_RH																				
linear	0.00	0.066	0.00	0.078	0.00	0.065	0.00	0.058	0.00	0.056	0.01	**0.031**	0.00	0.212	0.01	**0.016**	0.00	0.140	0.00	0.715
quadratic	0.00	0.066	0.00	0.190	0.00	0.180	0.00	0.151	0.01	0.122	0.01	0.076	0.00	0.456	0.01	**0.049**	0.00	0.325	0.00	0.337
cubic	0.00	0.066	0.00	0.343	0.00	0.323	0.00	0.280	0.01	0.208	0.01	0.135	0.00	0.656	0.01	0.111	0.00	0.438	0.01	0.054
n_ha_Hab_RH																				
linear	0.01	**0.026**	0.01	**0.023**	0.01	**0.017**	0.01	**0.015**	0.01	**0.009**	0.01	**0.001**	0.01	**0.007**	0.01	**0.005**	0.02	**0.000**	0.02	**0.000**
quadratic	0.01	**0.026**	0.01	0.061	0.01	0.059	0.01	0.050	0.01	**0.034**	0.01	**0.003**	0.01	**0.016**	0.01	**0.008**	0.02	**0.000**	0.02	**0.001**
cubic	0.01	**0.026**	0.01	0.133	0.01	0.116	0.01	0.102	0.01	0.072	0.01	**0.006**	0.01	**0.041**	0.02	**0.008**	0.02	**0.001**	0.02	**0.002**
perc_nha_Hab_RH																				
linear	0.00	0.060	0.00	0.051	0.01	**0.038**	0.01	**0.041**	0.01	**0.035**	0.01	**0.003**	0.01	**0.026**	0.01	**0.007**	0.01	**0.019**	0.00	0.222
quadratic	0.00	0.060	0.01	0.138	0.01	0.090	0.01	0.111	0.01	0.081	0.01	**0.006**	0.01	0.056	0.01	**0.012**	0.01	0.052	0.00	0.198
cubic	0.00	0.060	0.01	0.256	0.01	0.171	0.01	0.159	0.01	0.168	0.01	**0.009**	0.01	0.113	0.01	**0.027**	0.01	0.114	0.02	**0.005**
n_sp_Hab_RH																				
linear	0.00	0.755	0.00	0.860	0.00	0.940	0.00	0.991	0.00	0.848	0.00	0.052	0.00	0.765	0.00	0.957	0.00	0.052	0.00	0.460
quadratic	0.00	0.755	0.00	0.936	0.00	0.997	0.00	0.847	0.00	0.970	0.00	0.152	0.00	0.859	0.01	0.085	0.02	**0.002**	0.00	0.413
cubic	0.00	0.755	0.00	0.582	0.00	0.987	0.00	0.952	0.00	0.954	0.01	0.264	0.00	0.641	0.01	0.166	0.03	**0.000**	0.00	0.617
perc_sp_Hab_RH																				
linear	0.00	0.216	0.00	0.165	0.00	0.133	0.00	0.158	0.00	0.161	0.01	**0.030**	0.00	0.098	0.01	**0.014**	0.00	0.097	0.00	0.433
quadratic	0.00	0.216	0.00	0.208	0.00	0.274	0.00	0.359	0.00	0.338	0.01	0.094	0.00	0.236	0.01	**0.041**	0.00	0.148	0.01	**0.041**
cubic	0.00	0.216	0.01	0.095	0.00	0.292	0.00	0.486	0.00	0.491	0.01	0.189	0.00	0.287	0.01	0.095	0.01	0.054	0.02	**0.003**
P-INSE (EFI)																				
linear	0.00	0.061	0.00	0.071	0.00	0.121	0.00	0.125	0.00	0.134	0.00	0.542	0.00	0.313	0.00	0.297	0.01	**0.021**	0.01	**0.001**
quadratic	0.00	0.061	0.00	0.195	0.00	0.296	0.00	0.215	0.00	0.223	0.00	0.713	0.01	**0.032**	0.01	**0.030**	0.01	0.052	0.02	**0.003**
cubic	0.00	0.061	0.01	0.226	0.01	0.199	0.00	0.371	0.00	0.363	0.01	0.211	0.03	**0.000**	0.02	**0.006**	0.01	**0.034**	0.04	**0.000**
exponential	0.00	0.108	0.00	0.110	0.00	0.128	0.00	0.103	0.00	0.091	0.00	0.217	0.00	0.352	0.00	0.085	0.01	**0.039**	0.00	0.371
logistic	0.00	0.108	0.00	0.110	0.00	0.128	0.00	0.103	0.00	0.091	0.00	0.217	0.00	0.352	0.00	0.085	0.01	**0.039**	0.00	0.371
P-OMNI (EFI)																				
linear	0.06	**0.000**	0.06	**0.000**	0.06	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.06	**0.000**	0.08	**0.000**	0.06	**0.000**	0.02	**0.000**
quadratic	0.06	**0.000**	0.06	**0.000**	0.06	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.06	**0.000**	0.09	**0.000**	0.07	**0.000**	0.02	**0.001**
cubic	0.06	**0.000**	0.06	**0.000**	0.06	**0.000**	0.06	**0.000**	0.05	**0.000**	0.05	**0.000**	0.06	**0.000**	0.10	**0.000**	0.07	**0.000**	0.02	**0.000**
exponential	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.03	**0.000**	0.02	**0.000**	0.01	**0.035**
logistic	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.03	**0.000**	0.02	**0.000**	0.01	**0.035**
P-PHYT (EFI)																				
linear	0.04	**0.000**	0.03	**0.000**	0.03	**0.000**	0.02	**0.000**	0.02	**0.000**	0.01	**0.007**	0.01	**0.001**	0.03	**0.000**	0.02	**0.000**	0.00	0.987
quadratic	0.04	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.02	**0.000**	0.01	**0.025**	0.01	**0.004**	0.03	**0.000**	0.03	**0.000**	0.00	0.725
cubic	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.03	**0.000**	0.03	**0.000**	0.01	**0.040**	0.01	**0.009**	0.04	**0.000**	0.03	**0.000**	0.01	0.261
exponential	0.01	**0.009**	0.01	**0.009**	0.01	**0.010**	0.01	**0.032**	0.01	**0.029**	0.00	0.063	0.00	0.436	0.01	**0.031**	0.00	0.102	0.00	0.808
logistic	0.01	**0.009**	0.01	**0.009**	0.01	**0.010**	0.01	**0.032**	0.01	**0.029**	0.00	0.063	0.00	0.436	0.01	**0.031**	0.00	0.102	0.00	0.808
P-BENT (EFI)																				
linear	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.04	**0.000**	0.02	**0.000**	0.02	**0.000**
quadratic	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.04	**0.000**	0.03	**0.000**	0.02	**0.000**
cubic	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.05	**0.000**	0.03	**0.000**	0.04	**0.000**
exponential	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.04	**0.000**	0.04	**0.000**	0.03	**0.000**	0.05	**0.000**	0.08	**0.000**	0.03	**0.000**	0.03	**0.000**
logistic	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.04	**0.000**	0.04	**0.000**	0.03	**0.000**	0.05	**0.000**	0.08	**0.000**	0.03	**0.000**	0.03	**0.000**
P-RHEO (EFI)																				
linear	0.02	**0.000**	0.02	**0.000**	0.02	**0.001**	0.01	**0.001**	0.01	**0.001**	0.01	**0.002**	0.01	**0.012**	0.02	**0.000**	0.00	0.085	0.02	**0.000**
quadratic	0.02	**0.000**	0.02	**0.001**	0.02	**0.001**	0.02	**0.001**	0.01	**0.004**	0.01	**0.008**	0.01	**0.019**	0.02	**0.001**	0.01	0.079	0.02	**0.000**
cubic	0.02	**0.000**	0.02	**0.003**	0.02	**0.003**	0.02	**0.002**	0.01	**0.011**	0.01	**0.021**	0.02	**0.000**	0.03	**0.001**	0.01	0.162	0.02	**0.000**
exponential	0.00	0.128	0.00	0.152	0.00	0.184	0.00	0.211	0.00	0.212	0.00	0.252	0.00	0.425	0.01	0.052	0.00	0.884	0.01	**0.006**
logistic	0.00	0.128	0.00	0.152	0.00	0.184	0.00	0.211	0.00	0.212	0.00	0.252	0.00	0.425	0.01	0.052	0.00	0.884	0.01	**0.006**

Table E.3: Curve fitting for hydro peaking (part 3)

	Percentage Hydro Peaking																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
P-LONG (EFI)																				
linear	0.00	0.405	0.00	0.493	0.00	0.384	0.00	0.287	0.00	0.138	0.01	**0.032**	0.00	0.302	0.00	0.304	0.00	0.732	0.00	0.174
quadratic	0.00	0.405	0.00	0.266	0.00	0.206	0.00	0.410	0.00	0.326	0.01	0.058	0.01	0.138	0.00	0.266	0.01	0.154	0.00	0.189
cubic	0.00	0.405	0.01	0.273	0.01	0.297	0.00	0.363	0.00	0.324	0.01	0.126	0.01	0.096	0.01	0.306	0.01	0.285	0.01	0.166
exponential	0.00	0.377	0.00	0.479	0.00	0.389	0.00	0.470	0.00	0.288	0.01	**0.041**	0.00	0.405	0.00	0.481	0.00	0.506	0.01	**0.010**
logistic	0.00	0.377	0.00	0.479	0.00	0.389	0.00	0.470	0.00	0.288	0.01	**0.041**	0.00	0.405	0.00	0.481	0.00	0.506	0.01	**0.010**
P-POTA (EFI)																				
linear	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.01	**0.003**	0.03	**0.000**	0.01	**0.014**	0.02	**0.000**
quadratic	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.03	**0.000**	0.01	**0.043**	0.03	**0.000**
cubic	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.02	**0.000**	0.02	**0.001**	0.04	**0.000**	0.03	**0.000**	0.01	0.069	0.03	**0.000**
exponential	0.01	**0.001**	0.01	**0.001**	0.01	**0.002**	0.01	**0.003**	0.01	**0.006**	0.01	**0.001**	0.00	0.067	0.01	**0.003**	0.00	0.462	0.03	**0.000**
logistic	0.01	**0.001**	0.01	**0.001**	0.01	**0.002**	0.01	**0.003**	0.01	**0.006**	0.01	**0.001**	0.00	0.067	0.01	**0.003**	0.00	0.462	0.03	**0.000**
P-LITH (EFI)																				
linear	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.04	**0.000**	0.04	**0.000**	0.07	**0.000**	0.07	**0.000**	0.01	**0.003**
quadratic	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.09	**0.000**	**0.11**	**0.000**	0.01	**0.012**
cubic	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	**0.11**	**0.000**	**0.13**	**0.000**	0.03	**0.000**
exponential	0.01	**0.006**	0.01	**0.005**	0.01	**0.004**	0.01	**0.002**	0.01	**0.002**	0.02	**0.000**	0.01	**0.002**	0.02	**0.001**	0.02	**0.001**	0.01	0.052
logistic	0.01	**0.006**	0.01	**0.005**	0.01	**0.004**	0.01	**0.002**	0.01	**0.002**	0.02	**0.000**	0.01	**0.002**	0.02	**0.001**	0.02	**0.001**	0.01	0.052
P-INTO (EFI)																				
linear	0.06	**0.000**	0.06	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.08	**0.000**	0.06	**0.000**	0.02	**0.000**
quadratic	0.06	**0.000**	0.06	**0.000**	0.06	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.06	**0.000**	0.09	**0.000**	0.08	**0.000**	0.02	**0.000**
cubic	0.06	**0.000**	0.06	**0.000**	0.06	**0.000**	0.05	**0.000**	0.05	**0.000**	0.06	**0.000**	0.06	**0.000**	**0.11**	**0.000**	0.08	**0.000**	0.03	**0.000**
exponential	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.04	**0.000**	0.04	**0.000**	0.01	**0.016**
logistic	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.04	**0.000**	0.04	**0.000**	0.01	**0.016**
P-TOLE (EFI)																				
linear	0.00	0.132	0.00	0.081	0.00	0.081	0.00	0.116	0.00	0.155	0.00	0.085	0.01	0.050	0.02	**0.000**	0.01	0.051	0.00	0.954
quadratic	0.00	0.132	0.01	0.113	0.01	0.088	0.01	0.136	0.00	0.364	0.00	0.203	0.01	0.142	0.02	**0.002**	0.01	0.087	0.00	0.623
cubic	0.00	0.132	0.01	**0.032**	0.01	0.102	0.01	0.198	0.00	0.565	0.01	0.224	0.01	0.194	0.02	**0.003**	0.01	0.175	0.02	**0.009**
exponential	0.00	0.211	0.00	0.159	0.00	0.138	0.00	0.122	0.00	0.113	0.01	**0.020**	0.01	**0.040**	0.01	**0.007**	0.01	**0.037**	0.00	0.621
logistic	0.00	0.211	0.00	0.159	0.00	0.138	0.00	0.122	0.00	0.113	0.01	**0.020**	0.01	**0.040**	0.01	**0.007**	0.01	**0.037**	0.00	0.621
FAME Index																				
linear	0.01	**0.001**	0.01	**0.002**	0.01	**0.002**	0.01	**0.003**	0.01	**0.002**	0.01	**0.013**	0.01	**0.002**	0.02	**0.001**	0.02	**0.000**	0.00	0.123
quadratic	0.01	**0.001**	0.01	**0.008**	0.01	**0.009**	0.01	**0.012**	0.01	**0.009**	0.01	**0.016**	0.02	**0.000**	0.03	**0.000**	0.03	**0.000**	0.00	0.177
cubic	0.01	**0.001**	0.01	**0.019**	0.01	**0.017**	0.01	**0.015**	0.01	**0.018**	0.01	**0.014**	0.03	**0.000**	0.04	**0.000**	0.04	**0.000**	0.02	**0.003**
exponential	0.01	**0.004**	0.01	**0.004**	0.01	**0.004**	0.01	**0.005**	0.01	**0.003**	0.01	**0.009**	0.01	**0.004**	0.01	**0.002**	0.02	**0.000**	0.00	0.420
logistic	0.01	**0.004**	0.01	**0.004**	0.01	**0.004**	0.01	**0.005**	0.01	**0.003**	0.01	**0.009**	0.01	**0.004**	0.01	**0.002**	0.02	**0.000**	0.00	0.420
MetHINTOL150 (EFIplus)																				
linear	0.00	0.785	0.00	0.650	0.00	0.654	0.00	0.620	0.00	0.712	0.00	0.882	0.00	0.615	0.00	0.176	0.00	0.273	0.00	0.626
quadratic	0.00	0.785	0.00	0.886	0.00	0.844	0.00	0.847	0.00	0.658	0.00	0.933	0.00	0.879	0.03	**0.001**	0.01	0.212	0.01	0.204
cubic	0.00	0.785	0.00	0.623	0.00	0.920	0.00	0.886	0.00	0.795	0.00	0.983	0.01	0.441	0.04	**0.000**	0.02	0.055	0.03	**0.001**
MetO2INTOL (EFIplus)																				
linear	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.05	**0.000**	0.04	**0.000**	0.04	**0.000**	0.02	**0.002**
quadratic	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.03	**0.000**	0.04	**0.000**	0.03	**0.000**	0.06	**0.000**	0.06	**0.000**	0.06	**0.000**	0.03	**0.001**
cubic	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.03	**0.001**	0.04	**0.000**	0.03	**0.001**	0.06	**0.000**	0.07	**0.000**	0.07	**0.000**	0.03	**0.001**
MetRHPAR (EFIplus)																				
linear	0.02	0.220	0.02	0.250	0.02	0.263	0.01	0.319	0.01	0.346	0.01	0.321	0.01	0.532	0.02	0.201	0.00	0.655	0.00	0.609
quadratic	0.02	0.220	0.02	0.474	0.02	0.474	0.02	0.461	0.02	0.463	0.02	0.467	0.01	0.766	0.02	0.418	0.01	0.682	0.02	0.390
cubic	0.02	0.220	0.02	0.474	0.02	0.474	0.02	0.671	0.02	0.464	0.02	0.466	0.01	0.766	0.02	0.418	0.01	0.682	**0.49**	**0.000**
exponential	0.01	0.385	0.01	0.381	0.01	0.387	0.01	0.408	0.01	0.422	0.01	0.411	0.01	0.523	0.01	0.360	0.00	0.571	0.00	0.764
logistic	0.01	0.385	0.01	0.381	0.01	0.387	0.01	0.408	0.01	0.422	0.01	0.411	0.01	0.523	0.01	0.360	0.00	0.571	0.00	0.764
MetLITH (EFIplus)																				
linear	0.00	0.548	0.01	0.374	0.01	0.350	0.01	0.288	0.01	0.278	0.01	0.307	0.02	0.185	0.01	0.488	0.03	0.129	0.01	0.364
quadratic	0.00	0.548	0.02	0.537	0.02	0.537	0.02	0.468	0.02	0.478	0.02	0.486	0.03	0.325	0.02	0.527	0.04	0.239	0.03	0.271
cubic	0.00	0.548	0.02	0.537	0.02	0.537	0.02	0.676	0.02	0.476	0.02	0.486	0.03	0.325	0.02	0.527	0.04	0.239	**0.43**	**0.000**
EFIplus Index																				
linear	0.01	**0.006**	0.01	**0.004**	0.01	**0.004**	0.01	**0.005**	0.01	**0.005**	0.01	**0.010**	0.01	**0.009**	0.01	0.068	0.01	**0.038**	0.01	**0.045**
quadratic	0.01	**0.006**	0.01	**0.013**	0.01	**0.016**	0.01	**0.017**	0.01	**0.020**	0.01	**0.027**	0.02	**0.012**	0.03	**0.000**	0.02	**0.003**	0.01	0.110
cubic	0.01	**0.006**	0.02	**0.026**	0.01	**0.035**	0.01	**0.035**	0.01	**0.046**	0.01	0.057	0.02	**0.019**	0.03	**0.001**	0.03	**0.001**	0.01	0.221
EFIplus Class																				
linear	0.01	**0.009**	0.01	**0.006**	0.01	**0.006**	0.01	**0.007**	0.01	**0.005**	0.01	**0.011**	0.01	**0.009**	0.00	0.208	0.00	0.118	0.01	**0.019**
quadratic	0.01	**0.009**	0.01	**0.023**	0.01	**0.021**	0.01	**0.024**	0.01	**0.021**	0.01	**0.020**	0.02	**0.008**	0.05	**0.000**	0.02	**0.004**	0.01	0.065
cubic	0.01	**0.009**	0.01	**0.039**	0.01	**0.049**	0.01	**0.046**	0.01	0.050	0.01	**0.041**	0.02	**0.007**	0.05	**0.000**	0.04	**0.000**	0.01	0.086
exponential	0.02	**0.001**	0.02	**0.001**	0.02	**0.000**	0.02	**0.001**	0.02	**0.000**	0.02	**0.002**	0.02	**0.002**	0.01	0.106	0.01	**0.043**	0.01	**0.004**
logistic	0.02	**0.001**	0.02	**0.001**	0.02	**0.000**	0.02	**0.001**	0.02	**0.000**	0.02	**0.002**	0.02	**0.002**	0.01	0.106	0.01	**0.043**	0.01	**0.004**

Table E.4: Curve fitting for impoundment (part 1)

	Percentage Impoundment																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
N_sp_all																				
linear	0.02	**0.000**	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.07	**0.000**	0.04	**0.000**	**0.12**	**0.000**	0.08	**0.000**	0.01	**0.017**
quadratic	0.02	**0.000**	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.06	**0.000**	0.09	**0.000**	0.08	**0.000**	**0.12**	**0.000**	0.08	**0.000**	0.01	**0.015**
cubic	0.02	**0.000**	0.03	**0.000**	0.04	**0.000**	0.06	**0.000**	0.06	**0.000**	0.09	**0.000**	**0.10**	**0.000**	**0.12**	**0.000**	0.09	**0.000**	0.01	**0.023**
exponential	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.07	**0.000**	0.07	**0.000**	0.06	**0.000**	0.06	**0.000**	**0.15**	**0.000**	0.09	**0.000**	0.02	**0.000**
logistic	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.07	**0.000**	0.07	**0.000**	0.06	**0.000**	0.06	**0.000**	**0.15**	**0.000**	0.09	**0.000**	0.02	**0.000**
Density_sp_all																				
linear	0.00	0.057	0.00	0.069	0.00	0.068	0.00	0.138	0.00	0.150	0.00	0.168	0.01	**0.023**	0.01	0.051	0.01	**0.002**	0.00	0.491
quadratic	0.00	0.057	0.00	0.148	0.01	0.102	0.00	0.332	0.00	0.310	0.00	0.371	0.01	**0.047**	0.01	**0.009**	0.10	**0.000**	0.01	0.093
cubic	0.00	0.057	0.01	0.156	0.01	0.202	0.00	0.525	0.00	0.373	0.00	0.526	0.01	0.069	0.03	**0.000**	**0.12**	**0.000**	0.01	**0.018**
exponential	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.01	**0.001**	0.01	**0.005**	0.00	0.062	0.02	**0.000**	0.01	**0.002**	0.01	**0.015**	0.00	0.995
logistic	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.01	**0.001**	0.01	**0.005**	0.00	0.062	0.02	**0.000**	0.01	**0.002**	0.01	**0.015**	0.00	0.995
Biom_sp_all																				
linear	0.00	0.096	0.00	0.131	0.00	0.086	0.00	0.235	0.00	0.199	0.00	0.098	0.00	0.983	0.01	**0.008**	0.00	0.090	0.01	**0.012**
quadratic	0.00	0.096	0.00	0.219	0.01	0.103	0.00	0.482	0.00	0.437	0.00	0.225	0.01	0.125	0.01	**0.014**	0.01	0.112	0.01	**0.036**
cubic	0.00	0.096	0.00	0.360	0.01	0.191	0.00	0.677	0.00	0.577	0.00	0.283	0.01	0.067	0.01	**0.015**	0.01	0.197	0.01	**0.048**
exponential	0.01	**0.001**	0.01	**0.000**	0.02	**0.000**	0.01	**0.006**	0.01	**0.017**	0.01	**0.019**	0.00	0.063	0.02	**0.000**	0.00	0.446	0.00	0.199
logistic	0.01	**0.001**	0.01	**0.000**	0.02	**0.000**	0.01	**0.006**	0.01	**0.017**	0.01	**0.019**	0.00	0.063	0.02	**0.000**	0.00	0.446	0.00	0.199
kg_ha_Repro_LITH																				
linear	0.01	**0.034**	0.00	0.050	0.01	**0.024**	0.00	0.060	0.00	0.055	0.01	**0.034**	0.00	0.624	0.02	**0.001**	0.01	**0.001**	0.01	**0.003**
quadratic	0.01	**0.034**	0.01	0.098	0.01	**0.036**	0.00	0.170	0.00	0.159	0.01	0.095	0.01	0.053	0.02	**0.002**	0.01	**0.004**	0.01	**0.011**
cubic	0.01	**0.034**	0.01	0.175	0.01	0.076	0.00	0.315	0.00	0.294	0.01	0.089	0.01	**0.033**	0.02	**0.006**	0.01	**0.011**	0.01	**0.014**
perc_kgha_Repro_LITH																				
linear	0.06	**0.000**	0.06	**0.000**	0.06	**0.000**	0.08	**0.000**	0.07	**0.000**	0.06	**0.000**	0.05	**0.000**	**0.14**	**0.000**	**0.24**	**0.000**	0.01	**0.001**
quadratic	0.06	**0.000**	0.06	**0.000**	0.07	**0.000**	0.09	**0.000**	0.08	**0.000**	0.07	**0.000**	0.05	**0.000**	**0.15**	**0.000**	**0.26**	**0.000**	0.03	**0.000**
cubic	0.06	**0.000**	0.07	**0.000**	0.08	**0.000**	0.09	**0.000**	0.08	**0.000**	0.08	**0.000**	0.05	**0.000**	**0.22**	**0.000**	**0.27**	**0.000**	0.06	**0.000**
n_ha_Repro_LITH																				
linear	0.01	**0.003**	0.01	**0.003**	0.01	**0.001**	0.01	**0.002**	0.01	**0.004**	0.00	0.070	0.02	**0.000**	0.02	**0.001**	0.01	**0.037**	0.00	0.396
quadratic	0.01	**0.003**	0.01	**0.008**	0.01	**0.002**	0.01	**0.005**	0.01	**0.016**	0.00	0.182	0.02	**0.001**	0.02	**0.000**	0.01	**0.008**	0.00	0.255
cubic	0.01	**0.003**	0.01	**0.016**	0.01	**0.007**	0.01	**0.012**	0.01	**0.038**	0.00	0.329	0.02	**0.003**	0.03	**0.000**	0.03	**0.000**	0.00	0.330
perc_nha_Repro_LITH																				
linear	0.03	**0.000**	0.04	**0.000**	0.04	**0.000**	0.06	**0.000**	0.05	**0.000**	0.04	**0.000**	0.04	**0.000**	**0.13**	**0.000**	**0.21**	**0.000**	0.04	**0.000**
quadratic	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.06	**0.000**	0.06	**0.000**	0.05	**0.000**	0.04	**0.000**	**0.13**	**0.000**	**0.21**	**0.000**	0.05	**0.000**
cubic	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.06	**0.000**	0.06	**0.000**	0.06	**0.000**	0.04	**0.000**	**0.18**	**0.000**	**0.22**	**0.000**	0.09	**0.000**
n_sp_Repro_LITH																				
linear	0.00	0.688	0.00	0.161	0.01	**0.047**	0.01	**0.016**	0.01	**0.007**	0.02	**0.000**	0.01	**0.002**	0.02	**0.000**	0.00	0.864	0.00	0.412
quadratic	0.00	0.688	0.00	0.373	0.01	0.130	0.01	**0.043**	0.01	**0.021**	0.04	**0.000**	0.07	**0.000**	0.02	**0.000**	0.03	**0.000**	0.02	**0.001**
cubic	0.00	0.688	0.01	0.261	0.02	**0.003**	0.02	**0.000**	0.03	**0.000**	0.06	**0.000**	0.10	**0.000**	0.06	**0.000**	0.05	**0.000**	0.03	**0.000**
perc_sp_Repro_LITH																				
linear	0.03	**0.000**	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.03	**0.000**	**0.11**	**0.000**	**0.17**	**0.000**	0.01	**0.017**
quadratic	0.03	**0.000**	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.03	**0.000**	**0.11**	**0.000**	**0.17**	**0.000**	0.01	**0.005**
cubic	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.07	**0.000**	0.03	**0.000**	**0.18**	**0.000**	**0.18**	**0.000**	0.03	**0.000**
kg_ha_Atroph_OMNI																				
linear	0.00	0.833	0.00	0.914	0.00	0.750	0.00	0.462	0.00	0.483	0.00	0.252	0.00	0.069	0.00	0.804	0.02	**0.000**	0.00	0.903
quadratic	0.00	0.833	0.00	0.917	0.00	0.734	0.00	0.738	0.00	0.627	0.01	0.138	0.01	**0.037**	0.00	0.343	0.02	**0.002**	0.00	0.977
cubic	0.00	0.833	0.00	0.955	0.00	0.828	0.00	0.893	0.00	0.817	0.01	0.265	0.02	**0.003**	0.02	**0.012**	0.02	**0.005**	0.00	0.633
perc_kgha_Atroph_OMNI																				
linear	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.06	**0.000**	0.07	**0.000**	**0.11**	**0.000**	0.08	**0.000**	**0.12**	**0.000**	**0.24**	**0.000**	0.02	**0.000**
quadratic	0.03	**0.000**	0.04	**0.000**	0.06	**0.000**	0.07	**0.000**	0.09	**0.000**	**0.13**	**0.000**	**0.10**	**0.000**	**0.12**	**0.000**	**0.24**	**0.000**	0.04	**0.000**
cubic	0.03	**0.000**	0.04	**0.000**	0.06	**0.000**	0.07	**0.000**	0.09	**0.000**	**0.14**	**0.000**	**0.11**	**0.000**	**0.18**	**0.000**	**0.27**	**0.000**	0.05	**0.000**
n_ha_Atroph_OMNI																				
linear	0.01	**0.046**	0.01	**0.022**	0.01	**0.004**	0.01	**0.001**	0.01	**0.009**	0.01	**0.006**	0.01	**0.016**	0.01	**0.005**	0.06	**0.000**	0.01	**0.006**
quadratic	0.01	**0.046**	0.01	0.067	0.01	**0.015**	0.01	**0.002**	0.02	**0.001**	0.02	**0.000**	0.01	**0.043**	0.01	**0.020**	0.07	**0.000**	0.01	**0.002**
cubic	0.01	**0.046**	0.01	0.082	0.01	**0.039**	0.01	**0.006**	0.02	**0.002**	0.02	**0.001**	0.01	**0.044**	0.03	**0.000**	0.08	**0.000**	0.02	**0.001**
perc_nha_Atroph_OMNI																				
linear	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.07	**0.000**	0.06	**0.000**	0.10	**0.000**	0.08	**0.000**	**0.10**	**0.000**	**0.21**	**0.000**	0.01	**0.014**
quadratic	0.04	**0.000**	0.05	**0.000**	0.06	**0.000**	0.07	**0.000**	0.08	**0.000**	**0.12**	**0.000**	0.09	**0.000**	**0.10**	**0.000**	**0.21**	**0.000**	0.02	**0.000**
cubic	0.04	**0.000**	0.05	**0.000**	0.06	**0.000**	0.07	**0.000**	0.08	**0.000**	**0.13**	**0.000**	**0.11**	**0.000**	**0.14**	**0.000**	**0.23**	**0.000**	0.02	**0.000**
n_sp_Atroph_OMNI																				
linear	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.07	**0.000**	0.07	**0.000**	0.10	**0.000**	0.05	**0.000**	**0.16**	**0.000**	**0.21**	**0.000**	0.01	**0.004**
quadratic	0.05	**0.000**	0.06	**0.000**	0.07	**0.000**	0.08	**0.000**	0.08	**0.000**	**0.11**	**0.000**	0.07	**0.000**	**0.16**	**0.000**	**0.21**	**0.000**	0.01	**0.004**
cubic	0.05	**0.000**	0.06	**0.000**	0.07	**0.000**	0.08	**0.000**	0.08	**0.000**	**0.12**	**0.000**	0.08	**0.000**	**0.19**	**0.000**	**0.21**	**0.000**	0.02	**0.004**
perc_sp_Atroph_OMNI																				
linear	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.06	**0.000**	0.07	**0.000**	0.08	**0.000**	0.06	**0.000**	**0.12**	**0.000**	**0.21**	**0.000**	0.01	**0.001**
quadratic	0.04	**0.000**	0.05	**0.000**	0.06	**0.000**	0.07	**0.000**	0.07	**0.000**	0.09	**0.000**	0.07	**0.000**	**0.12**	**0.000**	**0.21**	**0.000**	0.02	**0.000**
cubic	0.04	**0.000**	0.06	**0.000**	0.06	**0.000**	0.07	**0.000**	0.07	**0.000**	0.10	**0.000**	0.08	**0.000**	**0.15**	**0.000**	**0.21**	**0.000**	0.03	**0.000**
kg_ha_Mig_POTAD																				
linear	0.00	0.078	0.00	0.116	0.00	0.073	0.00	0.209	0.00	0.176	0.00	0.079	0.00	0.955	0.01	**0.006**	0.01	**0.016**	0.01	**0.005**
quadratic	0.00	0.078	0.00	0.193	0.01	0.088	0.00	0.449	0.00	0.395	0.00	0.181	0.01	0.093	0.01	**0.016**	0.01	**0.046**	0.01	**0.018**
cubic	0.00	0.078	0.00	0.308	0.01	0.160	0.00	0.656	0.00	0.543	0.01	0.204	0.01	**0.043**	0.01	**0.028**	0.01	0.105	0.01	**0.028**
perc_kgha_Mig_POTAD																				
linear	0.01	**0.001**	0.01	**0.004**	0.01	**0.002**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.01	**0.045**	0.04	**0.000**	0.10	**0.000**	0.01	**0.001**
quadratic	0.01	**0.001**	0.01	**0.005**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.01	**0.019**	0.04	**0.000**	**0.11**	**0.000**	0.02	**0.000**
cubic	0.01	**0.001**	0.02	**0.001**	0.03	**0.000**	0.02	**0.001**	0.02	**0.000**	0.03	**0.000**	0.01	**0.045**	0.07	**0.000**	**0.11**	**0.000**	0.04	**0.000**

Table E.4: Curve fitting for impoundment (part 2)

	Percentage Impoundment																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
n_ha_Mig_POTAD																				
linear	0.01	**0.048**	0.00	0.067	0.00	0.068	0.00	0.090	0.01	**0.041**	0.01	**0.003**	0.01	**0.005**	0.02	**0.001**	0.00	0.241	0.01	**0.001**
quadratic	0.01	**0.048**	0.01	0.060	0.01	**0.030**	0.01	0.071	0.01	0.092	0.01	**0.009**	0.02	**0.001**	0.02	**0.000**	0.02	**0.001**	0.02	**0.000**
cubic	0.01	**0.048**	0.01	0.065	0.01	0.068	0.01	0.057	0.01	0.066	0.01	**0.019**	0.02	**0.000**	0.04	**0.000**	0.04	**0.000**	0.02	**0.000**
perc_nha_Mig_POTAD																				
linear	0.00	0.625	0.00	0.464	0.00	0.206	0.00	0.074	0.01	**0.020**	0.03	**0.000**	0.00	0.132	0.05	**0.000**	0.06	**0.000**	0.04	**0.000**
quadratic	0.00	0.625	0.00	0.317	0.01	**0.012**	0.01	**0.004**	0.01	**0.032**	0.05	**0.000**	0.03	**0.000**	0.05	**0.000**	0.06	**0.000**	0.05	**0.000**
cubic	0.00	0.625	0.00	0.503	0.01	**0.030**	0.02	**0.002**	0.03	**0.000**	0.05	**0.000**	0.04	**0.000**	0.06	**0.000**	0.06	**0.000**	0.05	**0.000**
n_sp_Mig_POTAD																				
linear	0.02	**0.000**	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.04	**0.000**	0.09	**0.000**	0.02	**0.000**	0.00	0.100
quadratic	0.02	**0.000**	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.06	**0.000**	0.08	**0.000**	0.10	**0.000**	0.04	**0.000**	0.02	**0.000**
cubic	0.02	**0.000**	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.07	**0.000**	**0.11**	**0.000**	**0.10**	**0.000**	0.04	**0.000**	0.02	**0.000**
perc_sp_Mig_POTAD																				
linear	0.00	0.150	0.00	0.073	0.00	**0.048**	0.01	**0.011**	0.01	**0.002**	0.02	**0.000**	0.01	**0.004**	0.04	**0.000**	0.07	**0.000**	0.00	0.111
quadratic	0.00	0.150	0.01	0.116	0.01	**0.020**	0.01	**0.028**	0.01	**0.004**	0.03	**0.000**	0.01	**0.003**	0.04	**0.000**	0.07	**0.000**	0.01	**0.005**
cubic	0.00	0.150	0.01	0.054	0.01	**0.039**	0.01	0.067	0.01	**0.007**	0.04	**0.000**	0.02	**0.004**	0.06	**0.000**	0.07	**0.000**	0.01	**0.007**
kg_ha_Hab_RH																				
linear	0.01	**0.020**	0.01	**0.028**	0.01	**0.012**	0.01	**0.035**	0.01	**0.033**	0.01	**0.021**	0.00	0.569	0.02	**0.000**	0.01	**0.002**	0.01	**0.005**
quadratic	0.01	**0.020**	0.01	0.065	0.01	**0.023**	0.01	0.107	0.01	0.103	0.01	0.058	0.01	0.060	0.02	**0.001**	0.01	**0.007**	0.01	**0.015**
cubic	0.01	**0.020**	0.01	0.127	0.01	0.053	0.01	0.215	0.01	0.209	0.01	0.060	0.01	**0.042**	0.02	**0.003**	0.01	**0.012**	0.01	**0.019**
perc_kgha_Hab_RH																				
linear	0.09	**0.000**	0.09	**0.000**	**0.10**	**0.000**	**0.13**	**0.000**	**0.12**	**0.000**	0.10	**0.000**	0.07	**0.000**	**0.20**	**0.000**	**0.24**	**0.000**	0.01	**0.000**
quadratic	0.09	**0.000**	0.09	**0.000**	**0.11**	**0.000**	**0.13**	**0.000**	**0.12**	**0.000**	0.10	**0.000**	0.07	**0.000**	**0.20**	**0.000**	**0.25**	**0.000**	0.03	**0.000**
cubic	0.09	**0.000**	**0.10**	**0.000**	**0.11**	**0.000**	**0.14**	**0.000**	**0.12**	**0.000**	**0.11**	**0.000**	0.07	**0.000**	**0.24**	**0.000**	**0.30**	**0.000**	0.07	**0.000**
n_ha_Hab_RH																				
linear	0.01	**0.001**	0.01	**0.001**	0.01	**0.001**	0.01	**0.002**	0.01	**0.005**	0.01	**0.016**	0.02	**0.000**	0.02	**0.000**	0.00	0.397	0.00	0.683
quadratic	0.01	**0.001**	0.01	**0.005**	0.02	**0.002**	0.01	**0.008**	0.01	**0.019**	0.01	0.056	0.02	**0.001**	0.03	**0.000**	0.08	**0.000**	0.00	0.320
cubic	0.01	**0.001**	0.01	**0.008**	0.02	**0.005**	0.01	**0.022**	0.01	**0.027**	0.01	0.123	0.02	**0.001**	0.04	**0.000**	**0.11**	**0.000**	0.01	0.208
perc_nha_Hab_RH																				
linear	0.10	**0.000**	**0.10**	**0.000**	**0.12**	**0.000**	**0.15**	**0.000**	**0.14**	**0.000**	**0.10**	**0.000**	**0.10**	**0.000**	**0.22**	**0.000**	**0.30**	**0.000**	0.01	**0.001**
quadratic	0.10	**0.000**	**0.11**	**0.000**	**0.13**	**0.000**	**0.16**	**0.000**	**0.14**	**0.000**	**0.10**	**0.000**	**0.10**	**0.000**	**0.22**	**0.000**	**0.30**	**0.000**	0.03	**0.000**
cubic	0.10	**0.000**	**0.11**	**0.000**	**0.13**	**0.000**	**0.16**	**0.000**	**0.15**	**0.000**	**0.13**	**0.000**	**0.10**	**0.000**	**0.29**	**0.000**	**0.36**	**0.000**	0.07	**0.000**
n_sp_Hab_RH																				
linear	0.00	0.790	0.00	0.398	0.00	0.170	0.00	0.097	0.01	**0.045**	0.01	**0.001**	0.01	**0.004**	0.02	**0.001**	0.00	0.518	0.00	0.150
quadratic	0.00	0.790	0.00	0.677	0.00	0.382	0.01	0.084	0.01	**0.031**	0.05	**0.000**	0.07	**0.000**	0.03	**0.000**	0.03	**0.000**	0.02	**0.000**
cubic	0.00	0.790	0.00	0.507	0.01	**0.023**	0.02	**0.001**	0.02	**0.000**	0.06	**0.000**	0.10	**0.000**	0.05	**0.000**	0.05	**0.000**	0.04	**0.000**
perc_sp_Hab_RH																				
linear	0.08	**0.000**	0.09	**0.000**	0.10	**0.000**	**0.12**	**0.000**	**0.12**	**0.000**	**0.11**	**0.000**	0.08	**0.000**	**0.21**	**0.000**	**0.23**	**0.000**	0.01	**0.001**
quadratic	0.08	**0.000**	0.09	**0.000**	**0.10**	**0.000**	**0.12**	**0.000**	**0.12**	**0.000**	**0.11**	**0.000**	0.08	**0.000**	**0.21**	**0.000**	**0.24**	**0.000**	0.03	**0.000**
cubic	0.08	**0.000**	0.09	**0.000**	**0.11**	**0.000**	**0.13**	**0.000**	**0.12**	**0.000**	**0.13**	**0.000**	0.08	**0.000**	**0.28**	**0.000**	**0.26**	**0.000**	0.06	**0.000**
P-INSE (EFI)																				
linear	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.04	**0.000**	0.09	**0.000**	0.01	**0.004**
quadratic	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.10	**0.000**	0.02	**0.000**
cubic	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.05	**0.000**	0.06	**0.000**	0.05	**0.000**	0.10	**0.000**	0.03	**0.000**
exponential	0.05	**0.000**	0.06	**0.000**	0.06	**0.000**	0.08	**0.000**	0.07	**0.000**	0.05	**0.000**	0.06	**0.000**	0.07	**0.000**	**0.14**	**0.000**	0.01	**0.049**
logistic	0.05	**0.000**	0.06	**0.000**	0.06	**0.000**	0.08	**0.000**	0.07	**0.000**	0.05	**0.000**	0.06	**0.000**	0.07	**0.000**	**0.14**	**0.000**	0.01	**0.049**
P-OMNI (EFI)																				
linear	0.00	0.087	0.00	0.076	0.01	**0.018**	0.01	**0.001**	0.02	**0.000**	0.05	**0.000**	0.02	**0.000**	0.04	**0.000**	**0.11**	**0.000**	0.01	**0.013**
quadratic	0.00	0.087	0.01	0.053	0.01	**0.008**	0.02	**0.000**	0.03	**0.000**	0.07	**0.000**	0.03	**0.000**	0.04	**0.000**	**0.11**	**0.000**	0.03	**0.000**
cubic	0.00	0.087	0.01	0.115	0.02	**0.003**	0.02	**0.000**	0.04	**0.000**	0.07	**0.000**	0.04	**0.000**	0.06	**0.000**	**0.13**	**0.000**	0.04	**0.000**
exponential	0.01	**0.029**	0.01	**0.019**	0.01	**0.001**	0.02	**0.000**	0.02	**0.000**	0.04	**0.000**	0.01	**0.003**	0.03	**0.000**	0.08	**0.000**	0.01	**0.003**
logistic	0.01	**0.029**	0.01	**0.019**	0.01	**0.001**	0.02	**0.000**	0.02	**0.000**	0.04	**0.000**	0.01	**0.003**	0.03	**0.000**	0.08	**0.000**	0.01	**0.003**
P-PHYT (EFI)																				
linear	0.02	**0.000**	0.01	**0.001**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.01	**0.021**	0.02	**0.000**	0.05	**0.000**	0.00	0.692
quadratic	0.02	**0.000**	0.02	**0.003**	0.02	**0.001**	0.02	**0.000**	0.03	**0.000**	0.02	**0.000**	0.01	0.059	0.02	**0.000**	0.07	**0.000**	0.00	0.206
cubic	0.02	**0.000**	0.02	**0.004**	0.02	**0.002**	0.04	**0.000**	0.04	**0.000**	0.04	**0.000**	0.01	0.129	0.09	**0.000**	0.08	**0.000**	0.02	**0.006**
exponential	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.03	**0.000**	0.02	**0.000**	0.01	**0.001**	0.01	**0.023**	0.03	**0.000**	0.07	**0.000**	0.00	0.548
logistic	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.03	**0.000**	0.02	**0.000**	0.01	**0.001**	0.01	**0.023**	0.03	**0.000**	0.07	**0.000**	0.00	0.548
P-BENT (EFI)																				
linear	0.01	0.053	0.00	0.111	0.00	0.198	0.00	0.883	0.00	0.669	0.01	**0.047**	0.00	0.721	0.01	**0.031**	0.03	**0.000**	0.00	0.462
quadratic	0.01	0.053	0.01	0.138	0.01	0.120	0.01	0.155	0.00	0.400	0.01	**0.011**	0.00	0.467	0.01	0.097	0.04	**0.000**	0.00	0.170
cubic	0.01	0.053	0.01	0.230	0.01	0.090	0.01	0.287	0.01	0.191	0.01	**0.014**	0.01	0.104	0.02	**0.003**	0.04	**0.000**	0.01	0.109
exponential	0.01	**0.001**	0.01	**0.003**	0.01	**0.009**	0.00	0.064	0.00	0.209	0.00	0.351	0.01	0.056	0.00	0.736	0.01	**0.035**	0.00	0.671
logistic	0.01	**0.001**	0.01	**0.003**	0.01	**0.009**	0.00	0.064	0.00	0.209	0.00	0.351	0.01	0.056	0.00	0.736	0.01	**0.035**	0.00	0.671
P-RHEO (EFI)																				
linear	0.05	**0.000**	0.04	**0.000**	0.03	**0.000**	0.03	**0.000**	0.02	**0.000**	0.01	**0.037**	0.01	**0.006**	0.01	**0.013**	0.01	**0.019**	0.00	0.616
quadratic	0.05	**0.000**	0.04	**0.000**	0.03	**0.000**	0.03	**0.000**	0.02	**0.000**	0.04	**0.000**	0.02	**0.000**	0.02	**0.001**	0.01	**0.014**	0.00	0.527
cubic	0.05	**0.000**	0.04	**0.000**	0.05	**0.000**	0.04	**0.000**	0.03	**0.000**	0.05	**0.000**	0.04	**0.000**	0.03	**0.000**	0.01	**0.029**	0.01	0.289
exponential	0.07	**0.000**	0.05	**0.000**	0.05	**0.000**	0.06	**0.000**	0.05	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.00	0.115
logistic	0.07	**0.000**	0.05	**0.000**	0.05	**0.000**	0.06	**0.000**	0.05	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.00	0.115

Table E.4: Curve fitting for impoundment (part 3)

	Percentage Impoundment																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
P-LONG (EFI)																				
linear	0.02	**0.000**	0.03	**0.000**	0.03	**0.000**	0.02	**0.000**	0.02	**0.000**	0.05	**0.000**	0.03	**0.000**	0.00	0.081	0.00	0.489	0.00	0.172
quadratic	0.02	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.04	**0.000**	0.06	**0.000**	0.06	**0.000**	0.01	0.065	0.02	**0.000**	0.01	**0.005**
cubic	0.02	**0.000**	0.04	**0.000**	0.03	**0.000**	0.03	**0.000**	0.04	**0.000**	0.08	**0.000**	0.06	**0.000**	0.03	**0.000**	0.06	**0.000**	0.03	**0.000**
exponential	0.05	**0.000**	0.08	**0.000**	0.08	**0.000**	0.07	**0.000**	0.08	**0.000**	0.09	**0.000**	0.05	**0.000**	0.04	**0.000**	0.01	0.056	0.01	**0.031**
logistic	0.05	**0.000**	0.08	**0.000**	0.08	**0.000**	0.07	**0.000**	0.08	**0.000**	0.09	**0.000**	0.05	**0.000**	0.04	**0.000**	0.01	0.056	0.01	**0.031**
P-POTA (EFI)																				
linear	0.00	0.068	0.00	0.107	0.00	0.184	0.00	0.371	0.00	0.362	0.00	0.634	0.00	0.520	0.00	0.958	0.00	0.493	0.01	**0.012**
quadratic	0.00	0.068	0.01	0.142	0.00	0.413	0.01	**0.041**	0.01	0.068	0.03	**0.000**	0.02	**0.001**	0.01	0.064	0.01	0.142	0.02	**0.001**
cubic	0.00	0.068	0.01	0.117	0.01	**0.012**	0.01	**0.015**	0.01	**0.033**	0.04	**0.000**	0.05	**0.000**	0.01	**0.026**	0.01	0.192	0.02	**0.002**
exponential	0.00	0.351	0.00	0.636	0.00	0.985	0.00	0.694	0.00	0.977	0.00	0.593	0.00	0.156	0.00	0.162	0.00	0.633	0.02	**0.001**
logistic	0.00	0.351	0.00	0.636	0.00	0.985	0.00	0.694	0.00	0.977	0.00	0.593	0.00	0.156	0.00	0.162	0.00	0.633	0.02	**0.001**
P-LITH (EFI)																				
linear	0.00	0.068	0.00	0.106	0.00	0.063	0.02	**0.000**	0.02	**0.000**	0.03	**0.000**	0.01	**0.041**	0.04	**0.000**	**0.17**	**0.000**	0.01	**0.001**
quadratic	0.00	0.068	0.01	0.064	0.02	**0.002**	0.03	**0.000**	0.02	**0.000**	0.03	**0.000**	0.01	**0.007**	0.05	**0.000**	**0.20**	**0.000**	0.05	**0.000**
cubic	0.00	0.068	0.01	0.069	0.02	**0.004**	0.03	**0.000**	0.03	**0.000**	0.06	**0.000**	0.02	**0.005**	**0.14**	**0.000**	**0.26**	**0.000**	0.09	**0.000**
exponential	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.06	**0.000**	0.05	**0.000**	0.03	**0.000**	0.04	**0.000**	0.08	**0.000**	**0.20**	**0.000**	0.00	0.183
logistic	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.06	**0.000**	0.05	**0.000**	0.03	**0.000**	0.04	**0.000**	0.08	**0.000**	**0.20**	**0.000**	0.00	0.183
P-INTO (EFI)																				
linear	0.01	**0.013**	0.01	**0.031**	0.01	**0.019**	0.02	**0.000**	0.02	**0.000**	0.05	**0.000**	0.02	**0.000**	0.04	**0.000**	**0.15**	**0.000**	0.03	**0.000**
quadratic	0.01	**0.013**	0.02	**0.000**	0.03	**0.000**	0.04	**0.000**	0.04	**0.000**	0.08	**0.000**	0.02	**0.000**	0.04	**0.000**	**0.16**	**0.000**	0.05	**0.000**
cubic	0.01	**0.013**	0.02	**0.000**	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.08	**0.000**	0.03	**0.000**	0.07	**0.000**	**0.18**	**0.000**	0.06	**0.000**
exponential	0.02	**0.000**	0.02	**0.001**	0.02	**0.000**	0.03	**0.000**	0.03	**0.000**	0.06	**0.000**	0.03	**0.000**	0.07	**0.000**	**0.19**	**0.000**	0.02	**0.000**
logistic	0.02	**0.000**	0.02	**0.001**	0.02	**0.000**	0.03	**0.000**	0.03	**0.000**	0.06	**0.000**	0.03	**0.000**	0.07	**0.000**	**0.19**	**0.000**	0.02	**0.000**
P-TOLE (EFI)																				
linear	0.03	**0.000**	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.06	**0.000**	0.06	**0.000**	0.03	**0.000**	**0.14**	**0.000**	**0.17**	**0.000**	0.00	0.117
quadratic	0.03	**0.000**	0.03	**0.000**	0.05	**0.000**	0.06	**0.000**	0.06	**0.000**	0.06	**0.000**	0.03	**0.000**	**0.14**	**0.000**	**0.18**	**0.000**	0.01	**0.007**
cubic	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**	0.07	**0.000**	0.07	**0.000**	**0.11**	**0.000**	0.03	**0.000**	**0.23**	**0.000**	**0.22**	**0.000**	0.05	**0.000**
exponential	0.09	**0.000**	0.07	**0.000**	0.08	**0.000**	**0.11**	**0.000**	**0.11**	**0.000**	0.10	**0.000**	0.07	**0.000**	**0.18**	**0.000**	**0.22**	**0.000**	0.01	**0.001**
logistic	0.09	**0.000**	0.07	**0.000**	0.08	**0.000**	**0.11**	**0.000**	**0.11**	**0.000**	0.10	**0.000**	0.07	**0.000**	**0.18**	**0.000**	**0.22**	**0.000**	0.01	**0.001**
FAME Index																				
linear	0.06	**0.000**	0.06	**0.000**	0.06	**0.000**	0.07	**0.000**	0.07	**0.000**	0.08	**0.000**	0.05	**0.000**	0.08	**0.000**	**0.18**	**0.000**	0.01	**0.009**
quadratic	0.06	**0.000**	0.06	**0.000**	0.07	**0.000**	0.08	**0.000**	0.08	**0.000**	0.08	**0.000**	0.05	**0.000**	0.09	**0.000**	**0.19**	**0.000**	0.04	**0.000**
cubic	0.06	**0.000**	0.06	**0.000**	0.08	**0.000**	0.08	**0.000**	0.08	**0.000**	**0.10**	**0.000**	0.05	**0.000**	**0.16**	**0.000**	**0.21**	**0.000**	0.06	**0.000**
exponential	0.08	**0.000**	0.08	**0.000**	0.08	**0.000**	0.09	**0.000**	0.09	**0.000**	0.09	**0.000**	0.06	**0.000**	0.09	**0.000**	**0.20**	**0.000**	0.01	**0.005**
logistic	0.08	**0.000**	0.08	**0.000**	0.08	**0.000**	0.09	**0.000**	0.09	**0.000**	0.09	**0.000**	0.06	**0.000**	0.09	**0.000**	**0.20**	**0.000**	0.01	**0.005**
MetHINTOL150 (EFIplus)																				
linear	0.01	0.086	0.01	**0.034**	0.01	**0.027**	0.01	**0.022**	0.01	**0.047**	0.00	0.359	0.00	0.160	0.00	0.835	0.00	0.821	0.01	**0.030**
quadratic	0.01	0.086	0.01	**0.036**	0.01	0.087	0.01	0.069	0.01	0.068	0.00	0.518	0.00	0.365	0.00	0.501	0.00	0.366	0.01	0.090
cubic	0.01	0.086	0.01	0.079	0.01	0.141	0.02	**0.012**	0.03	**0.000**	0.01	0.223	0.00	0.561	0.00	0.698	0.00	0.500	0.02	**0.029**
MetO2INTOL (EFIplus)																				
linear	0.00	0.151	0.01	0.120	0.00	0.298	0.00	0.249	0.00	0.358	0.00	0.130	0.00	0.980	0.00	0.577	0.02	**0.002**	0.02	**0.001**
quadratic	0.00	0.151	0.01	0.298	0.00	0.441	0.01	0.263	0.00	0.478	0.02	**0.023**	0.01	0.173	0.00	0.799	0.02	**0.003**	0.03	**0.001**
cubic	0.00	0.151	0.01	0.487	0.00	0.637	0.01	0.267	0.00	0.604	0.02	0.057	0.01	0.067	0.01	0.107	0.03	**0.003**	0.04	**0.000**
MetRHPAR (EFIplus)																				
linear	**0.37**	**0.000**	**0.28**	**0.000**	**0.28**	**0.000**	**0.34**	**0.000**	**0.22**	**0.000**	**0.31**	**0.000**	**0.15**	**0.000**	**0.39**	**0.000**	**0.21**	**0.000**	0.08	**0.010**
quadratic	**0.37**	**0.000**	**0.34**	**0.000**	**0.32**	**0.000**	**0.35**	**0.000**	**0.30**	**0.000**	**0.33**	**0.000**	**0.17**	**0.000**	**0.42**	**0.000**	**0.22**	**0.000**	**0.33**	**0.000**
cubic	**0.37**	**0.000**	**0.35**	**0.000**	**0.36**	**0.000**	**0.40**	**0.000**	**0.43**	**0.000**	**0.48**	**0.000**	**0.18**	**0.001**	**0.55**	**0.000**	**0.38**	**0.000**	**0.45**	**0.000**
exponential	**0.33**	**0.000**	**0.21**	**0.000**	**0.21**	**0.000**	**0.29**	**0.000**	**0.18**	**0.000**	**0.25**	**0.000**	0.08	**0.008**	**0.32**	**0.000**	**0.18**	**0.000**	0.08	**0.010**
logistic	**0.33**	**0.000**	**0.21**	**0.000**	**0.21**	**0.000**	**0.29**	**0.000**	**0.18**	**0.000**	**0.25**	**0.000**	0.08	**0.008**	**0.32**	**0.000**	**0.18**	**0.000**	0.08	**0.010**
MetLITH (EFIplus)																				
linear	**0.26**	**0.000**	**0.25**	**0.000**	**0.26**	**0.000**	**0.26**	**0.000**	**0.17**	**0.000**	**0.12**	**0.001**	**0.16**	**0.000**	**0.22**	**0.000**	**0.25**	**0.000**	0.02	0.261
quadratic	**0.26**	**0.000**	**0.26**	**0.000**	**0.26**	**0.000**	**0.26**	**0.000**	**0.21**	**0.000**	**0.13**	**0.003**	**0.16**	**0.001**	**0.23**	**0.000**	**0.31**	**0.000**	**0.45**	**0.000**
cubic	**0.26**	**0.000**	**0.26**	**0.000**	**0.27**	**0.000**	**0.31**	**0.000**	**0.39**	**0.000**	**0.26**	**0.000**	**0.17**	**0.002**	**0.34**	**0.000**	**0.39**	**0.000**	**0.48**	**0.000**
EFIplus Index																				
linear	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.01	**0.003**	0.03	**0.000**	0.03	**0.000**	0.05	**0.000**	0.01	0.093
quadratic	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.02	**0.010**	0.03	**0.000**	0.03	**0.001**	0.07	**0.000**	0.02	**0.002**
cubic	0.03	**0.000**	0.03	**0.000**	0.04	**0.000**	0.06	**0.000**	0.06	**0.000**	0.02	**0.008**	0.03	**0.001**	0.07	**0.000**	0.08	**0.000**	0.02	**0.004**
EFIplus Class																				
linear	0.01	**0.004**	0.01	**0.005**	0.02	**0.003**	0.02	**0.001**	0.01	**0.004**	0.01	**0.046**	0.01	**0.008**	0.01	**0.016**	0.02	**0.000**	0.00	0.256
quadratic	0.01	**0.004**	0.01	**0.020**	0.02	**0.007**	0.02	**0.004**	0.02	**0.009**	0.01	0.111	0.01	**0.027**	0.01	0.054	0.04	**0.000**	0.01	0.056
cubic	0.01	**0.004**	0.02	**0.028**	0.02	**0.012**	0.04	**0.000**	0.04	**0.000**	0.01	0.219	0.01	0.066	0.03	**0.001**	0.05	**0.000**	0.02	**0.015**
exponential	0.01	**0.007**	0.01	**0.005**	0.02	**0.003**	0.02	**0.003**	0.01	**0.007**	0.01	0.051	0.01	**0.010**	0.01	0.071	0.02	**0.003**	0.00	0.383
logistic	0.01	**0.007**	0.01	**0.005**	0.02	**0.003**	0.02	**0.003**	0.01	**0.007**	0.01	0.051	0.01	**0.010**	0.01	0.071	0.02	**0.003**	0.00	0.383

Table E.5: Curve fitting for water abstraction (part 1)

	Percentage Water Abstraction																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
N_sp_all																				
linear	0.00	0.855	0.00	0.517	0.00	0.278	0.01	**0.001**	0.02	**0.000**	0.07	**0.000**	0.00	0.462	0.01	**0.040**	0.00	0.361	0.05	**0.000**
quadratic	0.00	0.855	0.00	0.479	0.00	0.389	0.01	**0.006**	0.03	**0.000**	0.08	**0.000**	0.04	**0.000**	0.01	**0.012**	0.01	**0.021**	0.05	**0.000**
cubic	0.00	0.855	0.00	0.689	0.00	0.491	0.02	**0.001**	0.04	**0.000**	0.08	**0.000**	0.05	**0.000**	0.04	**0.000**	0.02	**0.002**	0.07	**0.000**
exponential	0.00	0.875	0.00	0.996	0.00	0.671	0.01	**0.014**	0.02	**0.000**	0.05	**0.000**	0.00	0.586	0.00	0.134	0.00	0.802	0.04	**0.000**
logistic	0.00	0.875	0.00	0.996	0.00	0.671	0.01	**0.014**	0.02	**0.000**	0.05	**0.000**	0.00	0.586	0.00	0.134	0.00	0.802	0.04	**0.000**
Density_sp_all																				
linear	0.00	0.264	0.01	**0.025**	0.01	**0.006**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.01	**0.012**	0.02	**0.000**	0.04	**0.000**	0.02	**0.000**
quadratic	0.00	0.264	0.01	0.065	0.01	**0.019**	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.04	**0.000**	0.03	**0.000**	0.05	**0.000**	0.02	**0.000**
cubic	0.00	0.264	0.01	0.081	0.01	**0.023**	0.02	**0.001**	0.02	**0.000**	0.02	**0.000**	0.04	**0.000**	0.04	**0.000**	0.05	**0.000**	0.03	**0.000**
exponential	0.00	0.635	0.01	**0.047**	0.01	**0.009**	0.02	**0.000**	0.03	**0.000**	0.04	**0.000**	0.00	0.165	0.03	**0.000**	**0.11**	**0.000**	0.02	**0.000**
logistic	0.00	0.635	0.01	**0.047**	0.01	**0.009**	0.02	**0.000**	0.03	**0.000**	0.04	**0.000**	0.00	0.165	0.03	**0.000**	**0.11**	**0.000**	0.02	**0.000**
Biom_sp_all																				
linear	0.00	0.628	0.00	0.879	0.00	0.974	0.00	0.211	0.00	0.284	0.00	0.391	0.00	0.434	0.00	0.867	0.00	0.093	0.00	0.802
quadratic	0.00	0.628	0.00	0.322	0.00	0.207	0.00	0.452	0.00	0.342	0.00	0.436	0.00	0.659	0.00	0.607	0.00	0.189	0.00	0.423
cubic	0.00	0.628	0.00	0.500	0.00	0.328	0.00	0.375	0.00	0.358	0.00	0.454	0.00	0.751	0.01	0.077	0.01	0.057	0.00	0.632
exponential	0.00	0.685	0.00	0.573	0.00	0.329	0.01	**0.004**	0.01	**0.003**	0.01	**0.013**	0.00	0.444	0.00	0.481	0.03	**0.000**	0.00	0.334
logistic	0.00	0.685	0.00	0.573	0.00	0.329	0.01	**0.004**	0.01	**0.003**	0.01	**0.013**	0.00	0.444	0.00	0.481	0.03	**0.000**	0.00	0.334
kg_ha_Repro_LITH																				
linear	0.00	0.514	0.00	0.591	0.00	0.648	0.00	0.505	0.00	0.683	0.00	0.866	0.00	0.604	0.00	0.515	0.00	0.278	0.00	0.211
quadratic	0.00	0.514	0.00	0.185	0.00	0.153	0.00	0.694	0.00	0.319	0.00	0.199	0.00	0.754	0.00	0.785	0.00	0.294	0.01	0.062
cubic	0.00	0.514	0.00	0.302	0.01	0.242	0.00	0.568	0.00	0.281	0.01	0.090	0.00	0.700	0.01	0.283	0.01	**0.047**	0.01	0.114
perc_kgha_Repro_LITH																				
linear	0.00	0.099	0.01	**0.005**	0.01	**0.004**	0.02	**0.000**	0.03	**0.000**	0.07	**0.000**	0.00	0.505	0.04	**0.000**	0.05	**0.000**	0.10	**0.000**
quadratic	0.00	0.099	0.02	**0.001**	0.01	**0.007**	0.03	**0.000**	0.05	**0.000**	**0.11**	**0.000**	0.00	0.192	0.08	**0.000**	0.07	**0.000**	**0.16**	**0.000**
cubic	0.00	0.099	0.02	**0.000**	0.02	**0.003**	0.03	**0.000**	0.06	**0.000**	**0.15**	**0.000**	0.01	0.212	0.10	**0.000**	0.08	**0.000**	**0.24**	**0.000**
n_ha_Repro_LITH																				
linear	0.00	0.202	0.00	0.057	0.01	**0.017**	0.01	**0.003**	0.01	**0.006**	0.01	**0.022**	0.00	0.382	0.01	**0.002**	0.02	**0.000**	0.00	0.167
quadratic	0.00	0.202	0.01	**0.045**	0.01	**0.030**	0.01	**0.010**	0.01	**0.023**	0.01	0.072	0.02	**0.000**	0.01	**0.007**	0.02	**0.000**	0.00	0.385
cubic	0.00	0.202	0.01	**0.033**	0.01	**0.017**	0.01	**0.026**	0.01	**0.038**	0.01	0.154	0.02	**0.001**	0.01	**0.016**	0.02	**0.002**	0.00	0.460
perc_nha_Repro_LITH																				
linear	0.00	0.294	0.01	**0.026**	0.01	**0.014**	0.02	**0.000**	0.03	**0.000**	0.07	**0.000**	0.00	0.947	0.02	**0.000**	0.06	**0.000**	0.07	**0.000**
quadratic	0.00	0.294	0.02	**0.001**	0.01	**0.004**	0.02	**0.000**	0.04	**0.000**	0.09	**0.000**	0.01	**0.024**	0.04	**0.000**	0.08	**0.000**	0.09	**0.000**
cubic	0.00	0.294	0.02	**0.001**	0.02	**0.004**	0.02	**0.000**	0.05	**0.000**	**0.12**	**0.000**	0.01	0.055	0.07	**0.000**	0.09	**0.000**	**0.16**	**0.000**
n_sp_Repro_LITH																				
linear	0.00	0.278	0.00	0.191	0.00	0.389	0.00	0.760	0.00	0.351	0.01	**0.014**	0.00	0.576	0.01	0.052	0.02	**0.000**	0.00	0.179
quadratic	0.00	0.278	0.00	0.351	0.00	0.681	0.00	0.252	0.00	0.143	0.01	**0.017**	0.08	**0.000**	0.01	0.097	0.06	**0.000**	0.01	**0.021**
cubic	0.00	0.278	0.01	0.145	0.01	0.088	0.01	0.082	0.01	0.065	0.01	**0.025**	0.09	**0.000**	0.02	**0.004**	0.08	**0.000**	0.01	**0.019**
perc_sp_Repro_LITH																				
linear	0.00	0.370	0.01	**0.032**	0.01	**0.019**	0.03	**0.000**	0.05	**0.000**	0.10	**0.000**	0.00	0.314	0.04	**0.000**	0.06	**0.000**	0.09	**0.000**
quadratic	0.00	0.370	0.01	**0.010**	0.01	**0.013**	0.03	**0.000**	0.06	**0.000**	**0.12**	**0.000**	0.00	0.305	0.07	**0.000**	0.08	**0.000**	**0.12**	**0.000**
cubic	0.00	0.370	0.01	**0.012**	0.01	**0.010**	0.03	**0.000**	0.07	**0.000**	**0.14**	**0.000**	0.00	0.472	0.08	**0.000**	0.08	**0.000**	**0.17**	**0.000**
kg_ha_Atroph_OMNI																				
linear	0.00	0.977	0.00	0.722	0.00	0.656	0.00	0.107	0.01	**0.031**	0.01	**0.002**	0.00	0.488	0.00	0.174	0.00	0.103	0.01	**0.003**
quadratic	0.00	0.977	0.00	0.910	0.00	0.592	0.00	0.204	0.01	0.065	0.02	**0.002**	0.00	0.333	0.01	**0.013**	0.00	0.263	0.01	**0.004**
cubic	0.00	0.977	0.00	0.881	0.00	0.782	0.01	0.213	0.01	0.124	0.02	**0.003**	0.00	0.504	0.03	**0.000**	0.01	0.254	0.01	**0.008**
perc_kgha_Atroph_OMNI																				
linear	0.00	0.993	0.00	0.469	0.00	0.278	0.02	**0.000**	0.03	**0.000**	0.10	**0.000**	0.00	0.895	0.02	**0.001**	0.05	**0.000**	**0.10**	**0.000**
quadratic	0.00	0.993	0.01	0.053	0.00	0.332	0.02	**0.001**	0.04	**0.000**	**0.14**	**0.000**	0.00	0.965	0.04	**0.000**	0.05	**0.000**	**0.15**	**0.000**
cubic	0.00	0.993	0.02	**0.003**	0.01	0.120	0.02	**0.002**	0.04	**0.000**	**0.16**	**0.000**	0.00	0.376	0.09	**0.000**	0.05	**0.000**	**0.20**	**0.000**
n_ha_Atroph_OMNI																				
linear	0.00	0.491	0.00	0.056	0.01	**0.026**	0.02	**0.000**	0.02	**0.000**	0.04	**0.000**	0.00	0.358	0.02	**0.000**	0.02	**0.000**	0.04	**0.000**
quadratic	0.00	0.491	0.00	0.159	0.01	0.072	0.02	**0.000**	0.03	**0.000**	0.06	**0.000**	0.00	0.215	0.04	**0.000**	0.03	**0.000**	0.05	**0.000**
cubic	0.00	0.491	0.00	0.296	0.01	0.153	0.02	**0.001**	0.03	**0.000**	0.07	**0.000**	0.01	0.124	0.06	**0.000**	0.03	**0.000**	0.06	**0.000**
perc_nha_Atroph_OMNI																				
linear	0.00	0.920	0.00	0.202	0.00	0.157	0.02	**0.000**	0.04	**0.000**	**0.12**	**0.000**	0.00	0.319	0.02	**0.000**	0.03	**0.000**	0.10	**0.000**
quadratic	0.00	0.920	0.01	**0.014**	0.00	0.320	0.02	**0.000**	0.05	**0.000**	**0.15**	**0.000**	0.00	0.472	0.05	**0.000**	0.04	**0.000**	**0.14**	**0.000**
cubic	0.00	0.920	0.02	**0.000**	0.01	0.055	0.02	**0.000**	0.05	**0.000**	**0.18**	**0.000**	0.01	0.137	0.09	**0.000**	0.04	**0.000**	**0.18**	**0.000**
n_sp_Atroph_OMNI																				
linear	0.00	0.483	0.00	0.100	0.00	0.059	0.02	**0.000**	0.04	**0.000**	**0.12**	**0.000**	0.00	0.139	0.02	**0.000**	0.02	**0.000**	0.10	**0.000**
quadratic	0.00	0.483	0.01	**0.010**	0.01	0.077	0.02	**0.000**	0.05	**0.000**	**0.17**	**0.000**	0.01	**0.049**	0.04	**0.000**	0.02	**0.000**	**0.14**	**0.000**
cubic	0.00	0.483	0.02	**0.002**	0.01	**0.043**	0.03	**0.000**	0.06	**0.000**	**0.20**	**0.000**	0.02	**0.002**	0.08	**0.000**	0.02	**0.000**	**0.19**	**0.000**
perc_sp_Atroph_OMNI																				
linear	0.00	0.860	0.00	0.381	0.00	0.294	0.01	**0.001**	0.03	**0.000**	**0.11**	**0.000**	0.00	0.831	0.02	**0.001**	0.02	**0.000**	**0.10**	**0.000**
quadratic	0.00	0.860	0.01	**0.027**	0.00	0.394	0.01	**0.003**	0.03	**0.000**	**0.14**	**0.000**	0.00	0.573	0.03	**0.000**	0.02	**0.000**	**0.15**	**0.000**
cubic	0.00	0.860	0.02	**0.002**	0.01	0.093	0.02	**0.005**	0.04	**0.000**	**0.17**	**0.000**	0.01	**0.017**	0.07	**0.000**	0.02	**0.000**	**0.20**	**0.000**
kg_ha_Mig_POTAD																				
linear	0.00	0.451	0.00	0.670	0.00	0.738	0.00	0.396	0.00	0.543	0.00	0.888	0.00	0.679	0.00	0.660	0.00	0.177	0.00	0.382
quadratic	0.00	0.451	0.00	0.251	0.00	0.172	0.00	0.632	0.00	0.345	0.00	0.295	0.00	0.829	0.00	0.836	0.00	0.261	0.00	0.174
cubic	0.00	0.451	0.00	0.413	0.00	0.283	0.00	0.530	0.00	0.317	0.01	0.176	0.00	0.725	0.01	0.253	0.01	0.059	0.00	0.317
perc_kgha_Mig_POTAD																				
linear	0.00	0.096	0.00	0.107	0.00	0.085	0.01	**0.004**	0.02	**0.000**	0.03	**0.000**	0.00	0.681	0.02	**0.000**	0.03	**0.000**	0.05	**0.000**
quadratic	0.00	0.096	0.01	**0.021**	0.01	0.055	0.02	**0.002**	0.02	**0.000**	0.05	**0.000**	0.00	0.422	0.04	**0.000**	0.05	**0.000**	0.08	**0.000**
cubic	0.00	0.096	0.01	**0.040**	0.01	**0.039**	0.02	**0.005**	0.03	**0.000**	0.07	**0.000**	0.00	0.604	0.06	**0.000**	0.06	**0.000**	**0.12**	**0.000**

Table E.5: Curve fitting for water abstraction (part 2)

	Percentage Water Abstraction																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
n_ha_Mig_POTAD																				
linear	0.00	0.267	0.01	**0.015**	0.01	**0.003**	0.02	**0.000**	0.01	**0.006**	0.01	**0.031**	0.00	0.779	0.02	**0.000**	0.02	**0.000**	0.00	0.124
quadratic	0.00	0.267	0.01	**0.033**	0.01	**0.009**	0.02	**0.001**	0.01	**0.024**	0.01	0.094	0.04	**0.000**	0.02	**0.001**	0.03	**0.000**	0.00	0.297
cubic	0.00	0.267	0.01	**0.048**	0.01	**0.006**	0.02	**0.004**	0.01	**0.036**	0.01	0.185	0.04	**0.000**	0.02	**0.002**	0.03	**0.000**	0.00	0.321
perc_nha_Mig_POTAD																				
linear	0.00	0.928	0.00	0.857	0.00	0.755	0.01	**0.036**	0.02	**0.000**	0.04	**0.000**	0.00	0.453	0.00	0.307	0.03	**0.000**	0.03	**0.000**
quadratic	0.00	0.928	0.00	0.501	0.00	0.297	0.01	0.089	0.02	**0.000**	0.05	**0.000**	0.00	0.683	0.01	**0.025**	0.03	**0.000**	0.04	**0.000**
cubic	0.00	0.928	0.00	0.646	0.00	0.487	0.01	0.064	0.02	**0.000**	0.06	**0.000**	0.00	0.735	0.03	**0.000**	0.03	**0.000**	0.07	**0.000**
n_sp_Mig_POTAD																				
linear	0.00	0.728	0.00	0.891	0.00	0.827	0.00	0.101	0.01	**0.015**	0.02	**0.000**	0.00	0.458	0.00	0.922	0.01	**0.003**	0.01	**0.001**
quadratic	0.00	0.728	0.00	0.832	0.00	0.870	0.00	0.222	0.01	0.051	0.02	**0.001**	0.08	**0.000**	0.00	0.947	0.04	**0.000**	0.01	**0.003**
cubic	0.00	0.728	0.00	0.895	0.00	0.395	0.01	**0.021**	0.02	**0.002**	0.02	**0.002**	0.09	**0.000**	0.01	**0.031**	0.06	**0.000**	0.01	**0.007**
perc_sp_Mig_POTAD																				
linear	0.00	0.647	0.00	0.312	0.00	0.177	0.01	**0.001**	0.03	**0.000**	0.08	**0.000**	0.00	0.082	0.01	**0.004**	0.04	**0.000**	0.06	**0.000**
quadratic	0.00	0.647	0.00	0.467	0.00	0.260	0.01	**0.003**	0.03	**0.000**	0.08	**0.000**	0.00	0.219	0.02	**0.000**	0.04	**0.000**	0.07	**0.000**
cubic	0.00	0.647	0.00	0.674	0.00	0.435	0.02	**0.005**	0.03	**0.000**	0.09	**0.000**	0.01	0.160	0.04	**0.000**	0.04	**0.000**	0.09	**0.000**
kg_ha_Hab_RH																				
linear	0.00	0.552	0.00	0.657	0.00	0.717	0.00	0.445	0.00	0.586	0.00	0.923	0.00	0.491	0.00	0.540	0.00	0.189	0.00	0.314
quadratic	0.00	0.552	0.00	0.217	0.00	0.171	0.00	0.656	0.00	0.300	0.00	0.213	0.00	0.748	0.00	0.793	0.00	0.265	0.01	0.094
cubic	0.00	0.552	0.00	0.333	0.01	0.269	0.00	0.565	0.01	0.251	0.01	0.102	0.00	0.705	0.01	0.252	0.01	0.050	0.01	0.161
perc_kgha_Hab_RH																				
linear	0.00	0.080	0.01	**0.006**	0.01	**0.003**	0.03	**0.000**	0.04	**0.000**	0.09	**0.000**	0.01	**0.033**	0.05	**0.000**	0.03	**0.000**	0.09	**0.000**
quadratic	0.00	0.080	0.02	**0.001**	0.01	**0.008**	0.03	**0.000**	0.06	**0.000**	**0.14**	**0.000**	0.01	0.101	0.08	**0.000**	0.05	**0.000**	**0.14**	**0.000**
cubic	0.00	0.080	0.03	**0.000**	0.02	**0.004**	0.03	**0.000**	0.07	**0.000**	**0.17**	**0.000**	0.01	**0.021**	**0.11**	**0.000**	0.06	**0.000**	**0.20**	**0.000**
n_ha_Hab_RH																				
linear	0.00	0.215	0.01	**0.045**	0.01	**0.014**	0.01	**0.001**	0.01	**0.001**	0.01	**0.004**	0.01	**0.005**	0.02	**0.001**	0.03	**0.000**	0.01	**0.014**
quadratic	0.00	0.215	0.01	0.082	0.01	**0.035**	0.01	**0.002**	0.01	**0.002**	0.01	**0.013**	0.04	**0.000**	0.02	**0.001**	0.04	**0.000**	0.01	**0.035**
cubic	0.00	0.215	0.01	0.062	0.01	**0.025**	0.02	**0.005**	0.01	**0.007**	0.01	**0.028**	0.04	**0.000**	0.02	**0.001**	0.04	**0.000**	0.01	**0.026**
perc_nha_Hab_RH																				
linear	0.00	0.187	0.01	**0.008**	0.01	**0.005**	0.03	**0.000**	0.04	**0.000**	0.10	**0.000**	0.01	**0.007**	0.05	**0.000**	0.04	**0.000**	**0.10**	**0.000**
quadratic	0.00	0.187	0.02	**0.001**	0.01	**0.007**	0.03	**0.000**	0.06	**0.000**	**0.15**	**0.000**	0.01	**0.019**	0.08	**0.000**	0.06	**0.000**	**0.16**	**0.000**
cubic	0.00	0.187	0.03	**0.000**	0.02	**0.001**	0.03	**0.000**	0.07	**0.000**	**0.20**	**0.000**	0.02	**0.002**	0.10	**0.000**	0.07	**0.000**	**0.23**	**0.000**
n_sp_Hab_RH																				
linear	0.00	0.147	0.00	0.110	0.00	0.249	0.00	0.867	0.00	0.287	0.01	**0.002**	0.00	0.617	0.01	**0.029**	0.01	**0.016**	0.00	0.051
quadratic	0.00	0.147	0.00	0.256	0.00	0.495	0.00	0.180	0.01	0.101	0.01	**0.003**	0.07	**0.000**	0.01	0.068	0.04	**0.000**	0.01	**0.009**
cubic	0.00	0.147	0.01	**0.041**	0.01	0.064	0.01	**0.026**	0.01	**0.029**	0.02	**0.005**	0.08	**0.000**	0.02	**0.003**	0.07	**0.000**	0.01	**0.016**
perc_sp_Hab_RH																				
linear	0.00	**0.048**	0.01	**0.001**	0.01	**0.000**	0.04	**0.000**	0.06	**0.000**	**0.13**	**0.000**	0.00	0.226	0.07	**0.000**	0.03	**0.000**	**0.12**	**0.000**
quadratic	0.00	**0.048**	0.02	**0.000**	0.02	**0.001**	0.04	**0.000**	0.08	**0.000**	**0.18**	**0.000**	0.00	0.481	**0.10**	**0.000**	0.04	**0.000**	**0.17**	**0.000**
cubic	0.00	**0.048**	0.03	**0.000**	0.02	**0.000**	0.05	**0.000**	0.09	**0.000**	**0.22**	**0.000**	0.01	**0.012**	**0.12**	**0.000**	0.04	**0.000**	**0.23**	**0.000**
P-INSE (EFI)																				
linear	0.00	0.111	0.00	0.139	0.00	0.082	0.00	0.480	0.00	0.338	0.02	**0.000**	0.01	**0.049**	0.00	0.690	0.01	0.050	0.01	**0.001**
quadratic	0.00	0.111	0.01	**0.040**	0.01	0.113	0.00	0.434	0.01	0.060	0.04	**0.000**	0.01	0.105	0.01	**0.049**	0.01	**0.010**	0.03	**0.000**
cubic	0.00	0.111	0.02	**0.002**	0.01	**0.022**	0.00	0.601	0.01	**0.021**	0.06	**0.000**	0.01	0.179	0.04	**0.000**	0.02	**0.004**	0.05	**0.000**
exponential	0.00	0.840	0.00	0.504	0.00	0.597	0.01	**0.018**	0.02	**0.000**	0.05	**0.000**	0.00	0.125	0.02	**0.001**	0.02	**0.000**	0.05	**0.000**
logistic	0.00	0.840	0.00	0.504	0.00	0.597	0.01	**0.018**	0.02	**0.000**	0.05	**0.000**	0.00	0.125	0.02	**0.001**	0.02	**0.000**	0.05	**0.000**
P-OMNI (EFI)																				
linear	0.00	0.097	0.00	0.307	0.00	0.440	0.00	0.256	0.02	**0.000**	**0.10**	**0.000**	0.01	**0.006**	0.00	0.103	0.07	**0.000**	0.08	**0.000**
quadratic	0.00	0.097	0.01	0.137	0.00	0.642	0.00	0.472	0.02	**0.000**	**0.13**	**0.000**	0.01	**0.022**	0.02	**0.001**	0.07	**0.000**	**0.11**	**0.000**
cubic	0.00	0.097	0.01	0.095	0.00	0.625	0.00	0.453	0.03	**0.000**	**0.14**	**0.000**	0.01	**0.013**	0.08	**0.000**	0.08	**0.000**	**0.12**	**0.000**
exponential	0.00	0.927	0.00	0.753	0.00	0.572	0.01	**0.010**	0.03	**0.000**	0.08	**0.000**	0.00	0.867	0.02	**0.001**	0.05	**0.000**	0.05	**0.000**
logistic	0.00	0.927	0.00	0.753	0.00	0.572	0.01	**0.010**	0.03	**0.000**	0.08	**0.000**	0.00	0.867	0.02	**0.001**	0.05	**0.000**	0.05	**0.000**
P-PHYT (EFI)																				
linear	0.00	0.858	0.00	0.520	0.00	0.418	0.00	0.063	0.01	**0.011**	0.04	**0.000**	0.01	**0.006**	0.02	**0.000**	0.03	**0.000**	0.02	**0.000**
quadratic	0.00	0.858	0.00	0.490	0.00	0.474	0.01	**0.021**	0.02	**0.000**	0.06	**0.000**	0.02	**0.000**	0.03	**0.000**	0.05	**0.000**	0.05	**0.000**
cubic	0.00	0.858	0.00	0.360	0.00	0.680	0.01	**0.047**	0.03	**0.000**	0.07	**0.000**	0.02	**0.001**	0.03	**0.000**	0.05	**0.000**	0.07	**0.000**
exponential	0.00	0.145	0.00	0.103	0.00	0.073	0.01	**0.001**	0.02	**0.000**	0.05	**0.000**	0.00	0.713	0.03	**0.000**	0.02	**0.000**	0.04	**0.000**
logistic	0.00	0.145	0.00	0.103	0.00	0.073	0.01	**0.001**	0.02	**0.000**	0.05	**0.000**	0.00	0.713	0.03	**0.000**	0.02	**0.000**	0.04	**0.000**
P-BENT (EFI)																				
linear	0.00	0.207	0.00	0.469	0.00	0.738	0.01	0.053	0.02	**0.000**	0.09	**0.000**	0.03	**0.000**	0.00	0.310	0.06	**0.000**	0.07	**0.000**
quadratic	0.00	0.207	0.00	0.715	0.00	0.941	0.01	0.142	0.03	**0.000**	0.10	**0.000**	0.03	**0.000**	0.01	**0.025**	0.06	**0.000**	0.08	**0.000**
cubic	0.00	0.207	0.00	0.853	0.00	0.987	0.01	0.078	0.03	**0.000**	0.10	**0.000**	0.03	**0.000**	0.03	**0.000**	0.06	**0.000**	0.08	**0.000**
exponential	0.00	0.257	0.00	0.940	0.00	0.710	0.01	**0.006**	0.03	**0.000**	0.10	**0.000**	0.03	**0.000**	0.00	0.445	0.07	**0.000**	0.05	**0.000**
logistic	0.00	0.257	0.00	0.940	0.00	0.710	0.01	**0.006**	0.03	**0.000**	0.10	**0.000**	0.03	**0.000**	0.00	0.445	0.07	**0.000**	0.05	**0.000**
P-RHEO (EFI)																				
linear	0.00	0.334	0.00	0.333	0.00	0.668	0.00	0.772	0.00	0.186	0.01	**0.008**	0.01	**0.006**	0.00	0.415	0.00	0.076	0.00	0.363
quadratic	0.00	0.334	0.00	0.266	0.00	0.912	0.01	**0.047**	0.01	0.097	0.02	**0.000**	0.03	**0.000**	0.00	0.550	0.01	0.072	0.01	**0.042**
cubic	0.00	0.334	0.02	**0.003**	0.01	**0.014**	0.01	0.062	0.01	0.190	0.04	**0.000**	0.03	**0.000**	0.01	0.164	0.03	**0.000**	0.01	**0.013**
exponential	0.00	0.653	0.00	0.560	0.00	0.806	0.00	0.669	0.00	0.763	0.00	0.552	0.01	**0.023**	0.01	**0.029**	0.00	0.524	0.01	**0.013**
logistic	0.00	0.653	0.00	0.560	0.00	0.806	0.00	0.669	0.00	0.763	0.00	0.552	0.01	**0.023**	0.01	**0.029**	0.00	0.524	0.01	**0.013**

Table E.5: Curve fitting for water abstraction (part 3)

	Percentage Water Abstraction																			
	local		250		500		2500		5000		25000		SA		fishr		DU		catch	
	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.	R^2	sig.
P-LONG (EFI)																				
linear	0.02	**0.000**	0.02	**0.000**	0.02	**0.000**	0.01	**0.001**	0.02	**0.001**	0.00	0.902	0.01	**0.004**	0.02	**0.000**	0.01	**0.001**	0.00	0.281
quadratic	0.02	**0.000**	0.02	**0.000**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.00	0.687	0.01	**0.007**	0.04	**0.000**	0.04	**0.000**	0.02	**0.000**
cubic	0.02	**0.000**	0.02	**0.001**	0.03	**0.000**	0.03	**0.000**	0.03	**0.000**	0.00	0.831	0.02	**0.002**	0.04	**0.000**	0.05	**0.000**	0.02	**0.001**
exponential	0.01	**0.001**	0.02	**0.001**	0.02	**0.000**	0.01	**0.011**	0.01	**0.019**	0.00	0.186	0.01	**0.011**	0.02	**0.001**	0.01	**0.001**	0.00	0.163
logistic	0.01	**0.001**	0.02	**0.001**	0.02	**0.000**	0.01	**0.011**	0.01	**0.019**	0.00	0.186	0.01	**0.011**	0.02	**0.001**	0.01	**0.001**	0.00	0.163
P-POTA (EFI)																				
linear	0.00	0.662	0.00	0.633	0.00	0.901	0.00	0.449	0.00	0.123	0.01	**0.003**	0.00	0.473	0.00	0.261	0.00	0.498	0.00	0.139
quadratic	0.00	0.662	0.00	0.735	0.00	0.990	0.00	0.175	0.00	0.229	0.02	**0.001**	0.06	**0.000**	0.00	0.501	0.01	**0.044**	0.01	**0.007**
cubic	0.00	0.662	0.00	0.751	0.01	0.224	0.00	0.322	0.00	0.383	0.03	**0.000**	0.07	**0.000**	0.02	**0.005**	0.04	**0.000**	0.01	**0.013**
exponential	0.00	0.975	0.00	0.963	0.00	0.660	0.00	0.158	0.00	0.067	0.00	0.129	0.00	0.639	0.00	0.915	0.00	0.689	0.00	0.594
logistic	0.00	0.975	0.00	0.963	0.00	0.660	0.00	0.158	0.00	0.067	0.00	0.129	0.00	0.639	0.00	0.915	0.00	0.689	0.00	0.594
P-LITH (EFI)																				
linear	0.00	0.485	0.01	**0.042**	0.01	**0.020**	0.02	**0.000**	0.04	**0.000**	**0.11**	**0.000**	0.00	0.078	0.05	**0.000**	**0.14**	**0.000**	0.08	**0.000**
quadratic	0.00	0.485	0.01	**0.033**	0.01	**0.045**	0.02	**0.000**	0.06	**0.000**	**0.15**	**0.000**	0.07	**0.000**	0.08	**0.000**	**0.22**	**0.000**	**0.13**	**0.000**
cubic	0.00	0.485	0.01	**0.030**	0.01	**0.044**	0.02	**0.000**	0.06	**0.000**	**0.18**	**0.000**	0.07	**0.000**	0.09	**0.000**	**0.23**	**0.000**	**0.17**	**0.000**
exponential	0.00	0.342	0.01	**0.036**	0.01	**0.022**	0.02	**0.000**	0.04	**0.000**	0.08	**0.000**	0.00	0.801	0.05	**0.000**	0.07	**0.000**	0.10	**0.000**
logistic	0.00	0.342	0.01	**0.036**	0.01	**0.022**	0.02	**0.000**	0.04	**0.000**	0.08	**0.000**	0.00	0.801	0.05	**0.000**	0.07	**0.000**	0.10	**0.000**
P-INTO (EFI)																				
linear	0.00	0.526	0.00	0.893	0.00	0.660	0.01	**0.039**	0.02	**0.000**	**0.12**	**0.000**	0.00	0.359	0.02	**0.000**	0.06	**0.000**	0.08	**0.000**
quadratic	0.00	0.526	0.00	0.493	0.00	0.761	0.01	0.068	0.03	**0.000**	**0.14**	**0.000**	0.01	**0.028**	0.03	**0.000**	0.06	**0.000**	0.10	**0.000**
cubic	0.00	0.526	0.01	0.304	0.00	0.725	0.01	0.130	0.03	**0.000**	**0.16**	**0.000**	0.02	**0.001**	0.07	**0.000**	0.07	**0.000**	**0.12**	**0.000**
exponential	0.00	0.679	0.00	0.268	0.00	0.165	0.01	**0.001**	0.04	**0.000**	**0.12**	**0.000**	0.00	0.979	0.05	**0.000**	0.07	**0.000**	**0.11**	**0.000**
logistic	0.00	0.679	0.00	0.268	0.00	0.165	0.01	**0.001**	0.04	**0.000**	**0.12**	**0.000**	0.00	0.979	0.05	**0.000**	0.07	**0.000**	**0.11**	**0.000**
P-TOLE (EFI)																				
linear	0.00	0.113	0.01	**0.008**	0.01	**0.004**	0.02	**0.000**	0.04	**0.000**	0.09	**0.000**	0.00	0.144	0.06	**0.000**	0.04	**0.000**	0.10	**0.000**
quadratic	0.00	0.113	0.02	**0.003**	0.01	**0.009**	0.03	**0.000**	0.06	**0.000**	**0.13**	**0.000**	0.01	**0.015**	0.09	**0.000**	0.06	**0.000**	**0.16**	**0.000**
cubic	0.00	0.113	0.02	**0.001**	0.02	**0.003**	0.03	**0.000**	0.07	**0.000**	**0.17**	**0.000**	0.01	**0.026**	0.10	**0.000**	0.07	**0.000**	**0.22**	**0.000**
exponential	0.00	0.134	0.01	**0.037**	0.01	**0.034**	0.02	**0.000**	0.03	**0.000**	0.08	**0.000**	0.00	0.858	0.05	**0.000**	0.04	**0.000**	0.10	**0.000**
logistic	0.00	0.134	0.01	**0.037**	0.01	**0.034**	0.02	**0.000**	0.03	**0.000**	0.08	**0.000**	0.00	0.858	0.05	**0.000**	0.04	**0.000**	0.10	**0.000**
FAME Index																				
linear	0.00	0.810	0.00	0.591	0.00	0.682	0.00	0.162	0.01	**0.007**	0.05	**0.000**	0.00	0.477	0.03	**0.000**	0.04	**0.000**	0.05	**0.000**
quadratic	0.00	0.810	0.01	**0.016**	0.00	0.409	0.01	**0.016**	0.03	**0.000**	**0.11**	**0.000**	0.05	**0.000**	0.04	**0.000**	0.07	**0.000**	0.10	**0.000**
cubic	0.00	0.810	0.02	**0.000**	0.01	**0.014**	0.01	**0.041**	0.03	**0.000**	**0.16**	**0.000**	0.05	**0.000**	0.05	**0.000**	0.08	**0.000**	**0.15**	**0.000**
exponential	0.00	0.877	0.00	0.324	0.00	0.400	0.01	**0.038**	0.01	**0.001**	0.06	**0.000**	0.00	0.355	0.03	**0.000**	0.04	**0.000**	0.06	**0.000**
logistic	0.00	0.877	0.00	0.324	0.00	0.400	0.01	**0.038**	0.01	**0.001**	0.06	**0.000**	0.00	0.355	0.03	**0.000**	0.04	**0.000**	0.06	**0.000**
MetHINTOL150 (EFIplus)																				
linear	0.00	0.292	0.00	0.443	0.00	0.671	0.01	0.100	0.00	0.131	0.00	0.630	0.00	0.332	0.02	**0.005**	0.00	0.919	0.00	0.656
quadratic	0.00	0.292	0.00	0.648	0.00	0.526	0.01	0.114	0.01	0.092	0.03	**0.000**	0.01	0.272	0.02	**0.020**	0.01	0.058	0.00	0.860
cubic	0.00	0.292	0.01	0.103	0.01	0.289	0.01	0.087	0.02	**0.035**	0.03	**0.001**	0.01	0.157	0.02	**0.040**	0.02	**0.042**	0.00	0.781
MetO2INTOL (EFIplus)																				
linear	0.00	0.277	0.00	0.452	0.00	0.303	0.02	**0.002**	0.04	**0.000**	**0.12**	**0.000**	0.00	0.170	0.01	**0.039**	0.06	**0.000**	0.08	**0.000**
quadratic	0.00	0.277	0.00	0.753	0.01	0.276	0.02	**0.002**	0.05	**0.000**	**0.15**	**0.000**	0.01	0.276	0.02	**0.005**	0.07	**0.000**	**0.10**	**0.000**
cubic	0.00	0.277	0.00	0.531	0.01	0.455	0.03	**0.005**	0.06	**0.000**	**0.16**	**0.000**	0.01	0.344	0.06	**0.000**	0.07	**0.000**	**0.10**	**0.000**
MetRHPAR (EFIplus)																				
linear	0.04	0.071	0.07	**0.015**	0.06	**0.023**	**0.15**	**0.000**	**0.19**	**0.000**	**0.24**	**0.000**	0.00	0.952	**0.18**	**0.000**	**0.26**	**0.000**	**0.27**	**0.000**
quadratic	0.04	0.071	**0.14**	**0.002**	**0.11**	**0.010**	**0.16**	**0.001**	**0.20**	**0.000**	**0.30**	**0.000**	0.05	0.154	**0.26**	**0.000**	**0.39**	**0.000**	**0.46**	**0.000**
cubic	0.04	0.071	**0.33**	**0.000**	**0.21**	**0.000**	**0.17**	**0.001**	**0.20**	**0.000**	**0.33**	**0.000**	0.05	0.240	**0.27**	**0.000**	**0.43**	**0.000**	**0.49**	**0.000**
exponential	0.03	0.144	0.02	0.239	0.01	0.316	0.08	**0.011**	**0.10**	**0.003**	**0.15**	**0.000**	0.01	0.448	**0.12**	**0.001**	**0.17**	**0.000**	**0.20**	**0.000**
logistic	0.03	0.144	0.02	0.239	0.01	0.316	0.08	**0.011**	**0.10**	**0.003**	**0.15**	**0.000**	0.01	0.448	**0.12**	**0.001**	**0.17**	**0.000**	**0.20**	**0.000**
MetLITH (EFIplus)																				
linear	0.01	0.376	**0.12**	**0.001**	**0.12**	**0.001**	**0.18**	**0.000**	**0.21**	**0.000**	**0.29**	**0.000**	0.01	0.514	**0.20**	**0.000**	**0.30**	**0.000**	**0.34**	**0.000**
quadratic	0.01	0.376	**0.13**	**0.003**	**0.12**	**0.005**	**0.20**	**0.000**	**0.24**	**0.000**	**0.39**	**0.000**	**0.12**	**0.007**	**0.27**	**0.000**	**0.39**	**0.000**	**0.43**	**0.000**
cubic	0.01	0.376	**0.21**	**0.000**	**0.17**	**0.002**	**0.20**	**0.000**	**0.24**	**0.000**	**0.43**	**0.000**	**0.12**	**0.018**	**0.27**	**0.000**	**0.44**	**0.000**	**0.45**	**0.000**
EFIplus Index																				
linear	0.01	0.093	0.01	**0.048**	0.01	0.054	0.03	**0.000**	0.04	**0.000**	0.07	**0.000**	0.00	0.951	0.04	**0.000**	0.04	**0.000**	0.06	**0.000**
quadratic	0.01	0.093	0.01	0.127	0.01	0.136	0.04	**0.000**	0.06	**0.000**	**0.12**	**0.000**	0.00	0.982	0.05	**0.000**	0.06	**0.000**	0.09	**0.000**
cubic	0.01	0.093	0.03	**0.000**	0.01	**0.048**	0.04	**0.000**	0.06	**0.000**	**0.12**	**0.000**	0.00	0.997	0.06	**0.000**	0.07	**0.000**	0.10	**0.000**
EFIplus Class																				
linear	0.00	0.177	0.00	0.105	0.00	0.115	0.02	**0.000**	0.03	**0.000**	0.05	**0.000**	0.00	0.660	0.04	**0.000**	0.03	**0.000**	0.04	**0.000**
quadratic	0.00	0.177	0.00	0.264	0.00	0.265	0.03	**0.000**	0.05	**0.000**	0.10	**0.000**	0.00	0.905	0.05	**0.000**	0.06	**0.000**	0.06	**0.000**
cubic	0.00	0.177	0.02	**0.002**	0.01	0.150	0.03	**0.001**	0.05	**0.000**	0.10	**0.000**	0.00	0.885	0.05	**0.000**	0.07	**0.000**	0.06	**0.000**
exponential	0.00	0.330	0.00	0.186	0.00	0.210	0.02	**0.001**	0.03	**0.000**	0.05	**0.000**	0.00	0.968	0.04	**0.000**	0.04	**0.000**	0.03	**0.000**
logistic	0.00	0.330	0.00	0.186	0.00	0.210	0.02	**0.001**	0.03	**0.000**	0.05	**0.000**	0.00	0.968	0.04	**0.000**	0.04	**0.000**	0.03	**0.000**

F. Mann-Whitney

Table F.1: Mann-Whitney for morphological index (significance) (part 1)

	group 1: morph. Index = 1 group 2: morph. Index = 2-5										group 1: morph. Index = 1-2 group 2: morph. Index = 3-5									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	**0.01**	0.17	0.17	0.03	0.03	-	0.18	**0.01**	**0.00**	-	0.46	0.53	0.67	0.14	**0.00**	0.01	**0.00**	0.72	0.03	0.08
Density_sp_all	**0.01**	**0.01**	0.02	0.02	0.81	-	**0.00**	0.97	0.25	-	0.86	0.97	0.85	0.17	0.03	0.64	**0.00**	1.00	**0.00**	**0.00**
Biom_sp_all	0.82	0.05	0.09	0.12	0.96	-	0.08	0.17	0.49	-	0.02	0.12	0.05	0.04	0.44	0.68	0.06	0.51	0.03	0.62
kg_ha_Repro_LITH	0.83	0.03	0.07	0.08	0.79	-	0.14	0.28	0.36	-	0.03	0.42	0.12	0.06	0.40	0.30	0.02	0.08	0.16	**0.01**
perc_kgha_Repro_LITH	0.78	0.87	0.81	0.33	0.32	-	0.46	0.07	0.09	-	0.62	0.95	0.45	0.02	0.56	0.05	**0.00**	0.42	**0.00**	**0.00**
n_ha_Repro_LITH	0.01	**0.01**	0.01	0.02	0.62	-	0.01	0.58	0.21	-	0.90	0.85	0.84	0.23	0.03	0.17	**0.00**	0.16	0.81	0.99
perc_nha_Repro_LITH	0.50	0.52	0.73	0.81	0.76	-	0.29	0.03	0.50	-	0.38	0.42	0.83	0.31	0.42	0.22	0.10	0.72	**0.00**	**0.00**
n_sp_Repro_LITH	**0.00**	0.13	0.10	0.03	0.02	-	0.05	0.01	**0.00**	-	0.74	0.66	0.98	0.02	**0.00**	0.07	**0.00**	0.09	**0.00**	**0.00**
perc_sp_Repro_LITH	0.93	0.87	0.56	0.96	0.89	-	0.82	0.02	0.29	-	0.51	0.28	0.60	0.26	0.83	0.14	0.01	0.97	**0.00**	**0.00**
kg_ha_Atroph_OMNI	0.48	0.93	0.83	0.37	0.07	-	0.38	0.15	0.12	-	0.72	0.94	0.41	0.85	0.05	0.01	0.35	0.03	**0.00**	**0.00**
perc_kgha_Atroph_OMNI	0.49	0.73	0.63	0.17	0.06	-	0.43	0.15	0.10	-	0.72	0.93	0.56	0.53	0.01	**0.00**	0.78	0.15	**0.00**	**0.00**
n_ha_Atroph_OMNI	0.55	0.91	0.88	0.43	0.09	-	0.33	0.13	0.10	-	0.77	0.91	0.43	0.96	0.06	**0.00**	0.75	0.13	**0.00**	**0.00**
perc_nha_Atroph_OMNI	0.52	0.71	0.68	0.24	0.09	-	0.45	0.14	0.08	-	0.94	0.91	0.59	0.71	0.03	**0.00**	0.87	0.15	**0.00**	**0.00**
n_sp_Atroph_OMNI	0.30	0.52	0.56	0.29	0.11	-	0.68	0.13	0.06	-	0.84	0.78	0.31	0.79	0.03	**0.00**	0.95	0.05	**0.00**	**0.00**
perc_sp_Atroph_OMNI	0.25	0.51	0.57	0.29	0.10	-	0.70	0.13	0.08	-	0.77	0.84	0.52	0.50	0.01	**0.00**	0.78	0.06	**0.00**	**0.00**
kg_ha_Mig_POTAD	0.67	0.04	0.07	0.10	0.89	-	0.08	0.23	0.42	-	0.04	0.30	0.10	0.06	0.61	0.38	0.08	0.61	0.74	0.26
perc_kgha_Mig_POTAD	0.87	0.62	0.95	0.25	0.26	-	0.47	0.20	0.32	-	0.94	0.68	0.60	**0.01**	0.69	0.04	**0.01**	0.68	**0.00**	**0.00**
n_ha_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.01**	0.61	-	**0.00**	0.55	0.12	-	0.70	0.45	0.48	0.20	**0.00**	0.16	**0.00**	0.65	0.10	0.09
perc_nha_Mig_POTAD	0.39	0.94	0.88	0.36	0.49	-	0.34	0.03	0.45	-	0.34	0.31	0.70	0.05	0.17	0.06	0.67	0.18	**0.00**	**0.00**
n_sp_Mig_POTAD	**0.01**	0.09	0.04	0.03	0.02	-	0.02	**0.01**	**0.00**	-	0.64	0.87	0.88	**0.00**	**0.00**	0.05	**0.00**	0.72	0.28	0.12
perc_sp_Mig_POTAD	0.90	0.95	0.62	0.45	0.65	-	0.33	0.28	0.36	-	0.41	0.81	0.44	**0.00**	0.20	0.38	**0.00**	0.28	**0.00**	**0.00**
kg_ha_Hab_RH	0.95	0.04	0.08	0.19	0.60	-	0.13	0.27	0.38	-	**0.01**	0.18	0.04	0.02	0.17	0.54	**0.01**	0.02	0.59	0.07
perc_kgha_Hab_RH	0.88	0.22	0.74	0.21	0.38	-	0.31	0.27	0.31	-	0.03	0.38	0.06	0.25	0.62	0.03	0.02	**0.00**	**0.00**	**0.00**
n_ha_Hab_RH	0.02	**0.01**	0.02	0.02	0.72	-	**0.00**	0.75	0.16	-	0.44	0.68	0.77	0.38	0.16	0.57	0.02	0.05	0.16	0.23
perc_nha_Hab_RH	0.42	0.07	0.23	0.07	0.31	-	0.60	0.25	0.26	-	0.14	0.69	0.17	0.52	0.99	0.02	0.02	**0.00**	**0.00**	**0.00**
n_sp_Hab_RH	**0.00**	0.40	0.29	0.06	0.04	-	0.07	**0.01**	**0.00**	-	0.35	0.88	0.53	0.03	**0.00**	0.14	**0.00**	**0.00**	**0.00**	**0.00**
perc_sp_Hab_RH	0.72	0.12	0.56	0.26	0.26	-	0.59	0.23	0.19	-	0.23	1.00	0.30	0.70	0.85	**0.00**	0.06	**0.00**	**0.00**	**0.00**
P-INSE (EFI)	0.24	0.03	0.14	0.06	0.79	-	0.46	0.72	0.42	-	0.48	0.13	0.27	0.60	0.99	0.01	0.51	0.70	**0.00**	**0.00**
P-OMNI (EFI)	0.05	0.14	0.10	0.18	0.78	-	**0.01**	0.92	0.54	-	0.30	0.22	0.08	**0.00**	0.01	0.46	**0.00**	0.04	**0.00**	**0.00**
P-PHYT (EFI)	**0.01**	0.59	0.30	0.46	0.13	-	0.01	0.26	0.18	-	0.12	0.24	0.18	**0.00**	**0.00**	0.12	**0.00**	0.03	**0.00**	**0.00**
P-BENT (EFI)	0.18	0.13	0.04	0.64	0.87	-	0.72	0.22	0.36	-	0.04	0.04	0.02	**0.00**	**0.00**	0.03	**0.00**	**0.00**	**0.00**	**0.00**
P-RHEO (EFI)	0.63	0.05	0.04	0.45	0.87	-	0.91	0.31	0.90	-	0.24	0.02	0.18	**0.01**	0.62	0.05	0.58	0.20	**0.00**	**0.00**
P-LONG (EFI)	**0.00**	**0.01**	**0.00**	0.09	0.31	-	0.14	0.02	**0.01**	-	**0.01**	0.19	0.36	**0.00**	**0.00**	0.04	**0.00**	**0.00**	0.59	0.94
P-POTA (EFI)	0.76	0.55	0.98	0.41	0.28	-	0.15	0.02	0.25	-	0.61	0.21	0.28	0.94	0.67	0.07	0.02	0.40	0.05	**0.00**
P-LITH (EFI)	**0.01**	0.09	0.02	0.03	0.25	-	**0.00**	0.14	0.02	-	0.35	0.49	0.47	**0.00**	**0.00**	0.21	**0.00**	0.09	**0.00**	**0.00**
P-INTO (EFI)	0.42	0.89	0.42	0.87	0.52	-	0.41	0.06	0.45	-	0.88	0.64	0.77	0.08	0.21	0.03	**0.00**	0.03	**0.00**	**0.00**
P-TOLE (EFI)	0.11	1.00	0.21	0.28	0.23	-	0.04	0.38	0.13	-	0.36	0.92	0.47	**0.00**	**0.00**	0.72	**0.00**	**0.01**	**0.00**	**0.00**
FAME Index	0.77	0.16	0.65	0.78	0.60	-	0.01	0.24	0.42	-	0.36	0.13	0.64	0.85	0.25	**0.00**	**0.00**	0.39	**0.00**	**0.00**
MetHINTOL150 (EFIplus)	0.09	0.26	0.16	0.63	0.39	-	0.86	0.18	0.48	-	0.03	0.05	0.07	**0.00**	**0.00**	0.16	0.15	0.14	0.03	0.63
MetO2INTOL (EFIplus)	0.13	0.84	0.85	0.97	0.49	-	0.01	0.23	0.18	-	0.90	0.43	0.37	**0.00**	**0.00**	0.32	**0.00**	0.84	**0.00**	**0.00**
MetRHPAR (EFIplus)	0.45	0.18	0.41	0.35	-	-	0.79		-	-	0.83	0.08	0.39	0.88	0.25	0.40	0.14	**0.00**	**0.00**	**0.00**
MetLITH (EFIplus)	0.70	0.09	0.34	0.45	-	-	0.93		-	-	0.48	0.80	0.94	0.73	0.15	0.67	0.08	0.03	**0.00**	**0.00**
EFIplus Index	0.51	0.06	0.08	0.36	0.85	-	0.72	0.82	0.88	-	0.08	0.09	0.18	0.06	0.29	0.09	0.42	0.84	**0.00**	**0.00**
EFIplus Class	0.47	0.08	0.07	0.55	0.47	-	0.69	0.61	0.80	-	0.07	0.09	0.15	0.04	0.28	**0.01**	0.42	0.49	**0.00**	**0.00**

Table F.2: Mann-Whitney for morphological index (significance) (part 2)

	group 1: morph. Index = 1-3 group 2: morph. Index = 4-5									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	0.59	0.85	0.71	0.98	0.03	0.70	0.05	0.04	0.09	-
Density_sp_all	0.05	0.83	0.44	0.31	0.37	**0.00**	0.48	0.06	**0.00**	-
Biom_sp_all	0.37	0.73	0.37	0.28	0.58	0.27	0.72	0.02	0.05	-
kg_ha_Repro_LITH	0.88	0.53	0.79	0.40	0.88	**0.00**	0.78	0.05	0.83	-
perc_kgha_Repro_LITH	0.76	0.93	0.99	0.77	0.55	**0.00**	0.74	0.26	0.94	-
n_ha_Repro_LITH	0.41	0.43	0.97	0.69	0.94	0.05	0.61	0.06	0.09	-
perc_nha_Repro_LITH	0.65	0.76	0.74	0.68	0.96	**0.00**	0.31	0.09	0.78	-
n_sp_Repro_LITH	0.28	0.36	0.28	0.93	0.03	**0.00**	0.02	**0.00**	0.05	-
perc_sp_Repro_LITH	0.57	0.48	0.59	0.65	0.54	**0.00**	0.56	0.32	0.50	-
kg_ha_Atroph_OMNI	0.50	0.37	0.94	0.82	0.76	0.01	0.26	0.15	0.78	-
perc_kgha_Atroph_OMNI	0.27	0.11	0.61	0.73	0.88	0.01	0.63	0.11	0.97	-
n_ha_Atroph_OMNI	0.30	0.30	0.85	0.84	0.69	**0.00**	0.28	0.12	0.48	-
perc_nha_Atroph_OMNI	0.41	0.22	0.68	0.98	0.68	0.03	0.35	0.08	0.96	-
n_sp_Atroph_OMNI	0.41	0.26	0.95	0.97	0.61	**0.00**	0.29	0.16	0.83	-
perc_sp_Atroph_OMNI	0.24	0.16	0.70	0.71	0.79	**0.00**	0.60	0.30	0.41	-
kg_ha_Mig_POTAD	0.81	0.85	0.60	0.53	0.78	**0.00**	0.96	**0.01**	0.99	-
perc_kgha_Mig_POTAD	0.94	0.96	0.86	0.80	0.72	**0.00**	0.66	0.03	0.24	-
n_ha_Mig_POTAD	0.35	0.84	0.63	0.82	0.84	0.08	0.77	**0.00**	0.12	-
perc_nha_Mig_POTAD	0.46	0.99	0.98	0.41	0.78	**0.00**	0.93	**0.00**	0.57	-
n_sp_Mig_POTAD	0.33	0.90	0.71	0.57	**0.00**	**0.00**	**0.01**	0.08	**0.01**	-
perc_sp_Mig_POTAD	0.36	0.19	0.12	0.76	0.52	**0.00**	0.16	0.35	0.81	-
kg_ha_Hab_RH	0.43	0.89	0.48	0.14	0.27	0.30	0.71	0.05	0.04	-
perc_kgha_Hab_RH	0.57	0.42	0.97	0.45	0.42	**0.00**	0.54	0.51	0.91	-
n_ha_Hab_RH	0.05	0.93	0.49	0.18	0.11	**0.00**	0.52	0.27	**0.00**	-
perc_nha_Hab_RH	0.73	0.54	0.79	0.54	0.35	**0.00**	0.57	0.80	0.90	-
n_sp_Hab_RH	0.41	0.23	0.27	0.74	0.06	0.06	0.03	**0.00**	0.07	-
perc_sp_Hab_RH	0.78	0.36	0.85	0.71	0.47	**0.00**	0.58	0.91	0.88	-
P-INSE (EFI)	0.17	**0.01**	0.10	0.44	0.15	**0.00**	0.01	0.06	0.65	-
P-OMNI (EFI)	0.93	0.88	0.21	0.15	0.02	0.07	0.01	0.67	0.25	-
P-PHYT (EFI)	0.42	0.47	0.80	0.54	0.13	**0.00**	0.23	0.05	0.23	-
P-BENT (EFI)	0.05	0.03	**0.01**	0.08	**0.00**	0.45	**0.00**	0.17	0.40	-
P-RHEO (EFI)	0.02	**0.00**	**0.00**	0.04	**0.00**	**0.00**	**0.00**	0.96	0.29	-
P-LONG (EFI)	**0.00**	0.02	0.06	**0.00**	**0.00**	0.36	0.02	**0.00**	1.00	-
P-POTA (EFI)	0.12	0.19	0.06	0.01	**0.00**	**0.00**	**0.00**	0.95	0.34	-
P-LITH (EFI)	0.03	0.06	0.22	0.79	0.80	**0.00**	0.59	**0.00**	**0.01**	-
P-INTO (EFI)	0.14	0.01	0.10	0.52	0.35	**0.00**	0.86	0.74	0.07	-
P-TOLE (EFI)	0.24	0.52	0.31	0.08	0.13	**0.01**	0.10	**0.00**	0.84	-
FAME Index	**0.00**	**0.00**	**0.01**	0.07	**0.00**	**0.00**	**0.00**	0.96	0.06	-
MetHINTOL150 (EFIplus)	0.25	0.10	0.30	0.21	0.36	0.44	0.61	0.08	0.47	-
MetO2INTOL (EFIplus)	0.89	0.28	0.03	**0.01**	**0.00**	0.05	**0.00**	0.87	0.21	-
MetRHPAR (EFIplus)	0.96	0.01	0.08	0.60	0.89	-	0.35	0.13	0.86	-
MetLITH (EFIplus)	0.57	0.25	0.53	0.44	0.88	-	0.24	0.77	0.12	-
EFIplus Index	0.33	0.06	0.42	0.39	0.87	0.02	0.77	0.16	0.79	-
EFIplus Class	0.24	0.04	0.37	0.34	0.93	0.05	0.87	0.28	0.57	-

	group 1: morph. Index = 1-4 group 2: morph. Index = 5									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	0.19	0.42	0.30	0.37	0.08	-	0.40	0.20	-	-
Density_sp_all	0.67	0.41	0.64	0.69	0.53	-	0.59	0.45	-	-
Biom_sp_all	0.49	0.20	0.82	0.58	0.99	-	0.64	0.69	-	-
kg_ha_Repro_LITH	0.58	0.05	0.93	0.63	0.83	-	0.55	0.63	-	-
perc_kgha_Repro_LITH	0.29	0.28	0.99	0.83	0.14	-	0.29	0.63	-	-
n_ha_Repro_LITH	0.50	0.20	0.65	0.43	0.86	-	0.82	0.43	-	-
perc_nha_Repro_LITH	0.21	0.26	0.81	0.57	0.08	-	0.21	0.31	-	-
n_sp_Repro_LITH	0.34	0.02	0.39	0.32	0.24	-	0.87	0.12	-	-
perc_sp_Repro_LITH	0.20	0.31	0.79	1.00	0.07	-	0.19	0.68	-	-
kg_ha_Atroph_OMNI	0.46	0.99	0.19	0.63	0.27	-	0.44	0.29	-	-
perc_kgha_Atroph_OMNI	0.46	0.86	0.19	0.53	0.28	-	0.44	0.36	-	-
n_ha_Atroph_OMNI	0.45	0.84	0.17	0.55	0.26	-	0.42	0.46	-	-
perc_nha_Atroph_OMNI	0.46	0.89	0.18	0.42	0.26	-	0.43	0.34	-	-
n_sp_Atroph_OMNI	0.45	0.86	0.17	0.55	0.25	-	0.42	0.59	-	-
perc_sp_Atroph_OMNI	0.45	0.85	0.17	0.68	0.26	-	0.42	0.84	-	-
kg_ha_Mig_POTAD	0.55	0.08	0.87	0.52	0.90	-	0.60	0.62	-	-
perc_kgha_Mig_POTAD	0.25	0.35	0.47	0.57	0.62	-	0.66	0.25	-	-
n_ha_Mig_POTAD	0.41	0.30	0.59	0.41	0.82	-	0.77	0.50	-	-
perc_nha_Mig_POTAD	0.17	0.46	0.71	0.95	0.24	-	0.75	0.76	-	-
n_sp_Mig_POTAD	0.42	0.19	0.53	0.30	0.09	-	0.37	0.08	-	-
perc_sp_Mig_POTAD	0.16	0.50	0.68	0.94	0.33	-	0.98	0.26	-	-
kg_ha_Hab_RH	0.56	0.05	0.94	0.75	0.89	-	0.58	0.65	-	-
perc_kgha_Hab_RH	0.57	0.54	0.99	0.76	0.40	-	0.55	0.26	-	-
n_ha_Hab_RH	0.64	0.30	0.54	0.88	0.69	-	0.71	0.42	-	-
perc_nha_Hab_RH	0.55	0.62	0.29	0.85	0.38	-	0.53	0.11	-	-
n_sp_Hab_RH	0.21	0.03	0.40	0.20	0.11	-	0.50	0.17	-	-
perc_sp_Hab_RH	0.53	0.63	0.88	0.62	0.36	-	0.51	0.32	-	-
P-INSE (EFI)	0.97	0.10	0.76	0.48	0.31	-	0.46	0.39	-	-
P-OMNI (EFI)	0.70	0.78	0.23	0.72	0.68	-	0.75	0.23	-	-
P-PHYT (EFI)	0.28	0.16	0.20	0.40	0.34	-	0.51	0.10	-	-
P-BENT (EFI)	0.31	0.89	0.46	0.23	0.07	-	0.19	0.32	-	-
P-RHEO (EFI)	0.69	0.07	0.38	0.08	0.28	-	1.00	0.56	-	-
P-LONG (EFI)	0.19	0.09	0.67	0.40	0.83	-	0.41	0.09	-	-
P-POTA (EFI)	0.67	0.17	0.55	0.02	0.23	-	0.84	0.12	-	-
P-LITH (EFI)	0.33	0.02	0.49	0.66	0.58	-	0.72	0.64	-	-
P-INTO (EFI)	0.18	0.05	0.46	0.95	0.38	-	0.81	0.93	-	-
P-TOLE (EFI)	0.47	0.30	0.60	0.57	0.99	-	0.94	0.32	-	-
FAME Index	0.35	0.02	0.50	0.05	0.16	-	0.41	0.54	-	-
MetHINTOL150 (EFIplus)	0.42	0.69	0.28	0.01	-	-	-	0.48	-	-
MetO2INTOL (EFIplus)	0.32	0.08	0.61	0.39	-	-	-	0.48	-	-
MetRHPAR (EFIplus)	-	0.15	-	-	-	-	-	-	-	-
MetLITH (EFIplus)	-	0.28	-	-	-	-	-	-	-	-
EFIplus Index	0.79	0.12	0.20	**0.01**		-		0.66	-	-
EFIplus Class	0.63	0.13	0.27	0.01	-	-	-	0.61	-	-

Table F.3: Mann-Whitney for morphological index with high reliability (significance) (part 1)

	group 1: morph. Index = 1 group 2: morph. Index = 2-5										group 1: morph. Index = 1-2 group 2: morph. Index = 3-5									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	**0.01**	0.06	0.26	**0.01**	**0.01**	-	0.07	**0.01**	**0.00**	-	0.46	0.64	0.47	0.14	**0.03**	0.07	**0.01**	**0.04**	**0.03**	0.12
Density_sp_all	**0.01**	**0.01**	**0.01**	0.27	0.80	-	**0.02**	0.74	0.30	-	0.86	0.37	0.71	0.59	0.25	0.73	**0.05**	0.87	**0.00**	**0.00**
Biom_sp_all	0.82	**0.03**	**0.03**	0.32	0.45	-	0.20	0.10	0.66	-	**0.02**	**0.01**	**0.01**	**0.01**	0.07	0.86	**0.04**	**0.01**	**0.01**	0.52
kg_ha_Repro_LITH	0.83	**0.03**	**0.05**	0.29	0.65	-	0.15	0.17	0.50	-	**0.03**	**0.05**	**0.02**	**0.01**	0.06	0.63	**0.02**	**0.00**	0.26	**0.01**
perc_kgha_Repro_LITH	0.78	0.78	0.85	0.27	0.25	-	0.95	0.08	0.07	-	0.62	0.77	0.61	**0.05**	0.60	0.09	0.06	0.65	**0.00**	**0.00**
n_ha_Repro_LITH	**0.01**	**0.01**	**0.02**	0.33	0.90	-	**0.02**	0.92	0.23	-	0.90	0.41	0.68	0.79	0.21	0.56	0.11	0.57	0.99	0.86
perc_nha_Repro_LITH	0.50	0.78	0.61	0.64	0.41	-	0.81	**0.03**	0.26	-	0.38	0.36	0.49	0.69	0.21	0.20	0.97	**0.04**	**0.00**	**0.00**
n_sp_Repro_LITH	**0.00**	**0.02**	0.12	**0.01**	**0.01**	-	0.07	**0.02**	**0.01**	-	0.74	0.94	0.78	**0.04**	**0.01**	0.23	**0.00**	**0.03**	**0.00**	**0.00**
perc_sp_Repro_LITH	0.93	0.97	0.81	0.66	0.75	-	0.52	**0.02**	0.16	-	0.51	0.53	0.45	0.40	0.49	0.16	0.53	0.38	**0.00**	**0.00**
kg_ha_Atroph_OMNI	0.48	0.75	0.86	0.21	**0.04**	-	0.74	0.20	0.15	-	0.72	0.83	0.76	0.30	0.22	**0.02**	0.57	0.84	**0.00**	**0.00**
perc_kgha_Atroph_OMNI	0.49	0.61	0.97	0.18	**0.04**	-	0.75	0.21	0.13	-	0.72	0.72	0.68	0.23	0.14	**0.00**	0.81	0.52	**0.00**	**0.00**
n_ha_Atroph_OMNI	0.55	0.66	0.92	0.15	**0.03**	-	0.81	0.19	0.14	-	0.77	0.81	0.66	0.34	0.24	**0.00**	0.67	0.86	**0.00**	**0.00**
perc_nha_Atroph_OMNI	0.52	0.54	0.93	0.18	**0.04**	-	0.82	0.20	0.10	-	0.94	0.55	0.53	0.35	0.25	**0.00**	0.95	0.73	**0.00**	**0.00**
n_sp_Atroph_OMNI	0.30	0.32	0.68	0.08	**0.03**	-	0.90	0.19	0.08	-	0.84	0.46	0.49	0.38	0.28	**0.00**	0.78	0.75	**0.00**	**0.00**
perc_sp_Atroph_OMNI	0.25	0.35	0.66	0.09	**0.03**	-	0.91	0.19	0.11	-	0.77	0.70	0.64	0.23	0.16	**0.00**	0.49	0.87	**0.00**	**0.00**
kg_ha_Mig_POTAD	0.67	**0.02**	**0.03**	0.24	0.59	-	0.17	0.15	0.57	-	**0.04**	**0.04**	**0.02**	**0.02**	0.16	0.75	0.07	**0.02**	0.54	0.33
perc_kgha_Mig_POTAD	0.87	0.59	0.95	0.15	0.22	-	0.94	0.27	0.32	-	0.94	0.95	0.74	0.08	0.89	0.08	0.11	0.70	**0.00**	**0.00**
n_ha_Mig_POTAD	**0.00**	**0.00**	**0.00**	0.09	0.79	-	**0.02**	0.88	0.13	-	0.70	0.92	0.70	0.18	**0.00**	0.55	**0.01**	0.25	0.06	0.06
perc_nha_Mig_POTAD	0.39	0.66	0.98	0.21	0.20	-	0.38	**0.04**	0.26	-	0.34	0.35	0.39	0.84	**0.04**	0.09	0.99	**0.00**	**0.00**	**0.00**
n_sp_Mig_POTAD	**0.01**	**0.04**	0.17	**0.03**	**0.01**	-	**0.01**	**0.01**	**0.00**	-	0.64	0.95	0.93	**0.01**	**0.01**	0.15	**0.00**	**0.02**	0.28	0.10
perc_sp_Mig_POTAD	0.90	0.80	0.86	0.21	0.41	-	0.62	0.29	0.31	-	0.41	0.76	0.78	**0.01**	0.19	0.53	**0.02**	0.33	**0.00**	**0.00**
kg_ha_Hab_RH	0.95	**0.03**	0.05	0.33	0.61	-	0.15	0.15	0.52	-	**0.01**	**0.01**	**0.00**	**0.00**	**0.01**	0.94	**0.00**	**0.00**	0.80	0.10
perc_kgha_Hab_RH	0.88	0.34	0.83	0.13	0.11	-	0.95	0.32	0.38	-	**0.03**	0.09	0.09	0.09	0.08	0.06	0.32	**0.00**	**0.00**	**0.00**
n_ha_Hab_RH	**0.02**	**0.01**	**0.03**	0.37	0.99	-	**0.01**	0.88	0.19	-	0.44	0.15	0.33	0.84	0.87	0.77	0.44	0.20	0.09	0.19
perc_nha_Hab_RH	0.42	0.10	0.31	0.08	0.08	-	0.59	0.29	0.32	-	0.14	0.37	0.44	0.28	0.37	**0.04**	0.52	**0.00**	**0.00**	**0.00**
n_sp_Hab_RH	**0.00**	0.08	0.25	**0.02**	**0.02**	-	0.10	**0.01**	**0.00**	-	0.35	0.60	0.35	**0.03**	**0.00**	0.35	**0.00**	**0.00**	**0.00**	**0.00**
perc_sp_Hab_RH	0.72	0.24	0.68	0.05	0.07	-	0.67	0.27	0.24	-	0.23	0.37	0.36	0.49	0.56	**0.01**	0.61	**0.00**	**0.00**	**0.00**
P-INSE (EFI)	0.24	0.09	0.20	0.23	0.79	-	0.48	0.46	0.40	-	0.48	0.51	0.58	0.16	0.83	0.05	0.06	0.92	**0.00**	**0.00**
P-OMNI (EFI)	0.05	0.12	0.05	0.63	0.77	-	**0.03**	0.68	0.33	-	0.30	0.11	0.06	**0.02**	**0.04**	0.25	**0.00**	0.08	**0.00**	**0.00**
P-PHYT (EFI)	**0.01**	0.21	0.30	0.73	0.34	-	0.09	0.27	0.11	-	0.12	0.06	0.09	**0.00**	**0.00**	0.38	**0.00**	**0.00**	**0.00**	**0.00**
P-BENT (EFI)	0.18	0.27	0.06	0.78	0.90	-	0.68	0.21	0.37	-	**0.04**	**0.03**	**0.04**	**0.00**	**0.00**	0.07	**0.00**	**0.02**	**0.00**	**0.00**
P-RHEO (EFI)	0.63	0.21	0.08	0.72	0.75	-	0.92	0.29	0.82	-	0.24	0.10	0.30	0.10	0.68	0.15	0.55	0.25	**0.00**	**0.00**
P-LONG (EFI)	**0.00**	**0.00**	**0.01**	0.07	0.13	-	0.22	**0.02**	**0.01**	-	**0.01**	**0.03**	0.05	**0.00**	**0.00**	0.14	**0.01**	**0.00**	0.62	0.86
P-POTA (EFI)	0.76	0.84	0.56	0.75	0.14	-	0.15	**0.03**	0.30	-	0.61	0.31	0.40	0.98	0.96	0.12	0.42	0.31	**0.03**	**0.00**
P-LITH (EFI)	**0.01**	0.05	**0.02**	0.23	0.63	-	**0.00**	0.13	**0.01**	-	0.35	0.41	0.17	**0.00**	**0.00**	0.65	**0.00**	0.14	**0.00**	**0.00**
P-INTO (EFI)	0.42	0.71	0.45	0.90	0.45	-	0.98	0.07	0.49	-	0.88	0.85	0.80	0.54	0.33	**0.01**	**0.00**	0.24	**0.00**	**0.00**
P-TOLE (EFI)	0.11	0.36	0.14	0.69	0.37	-	0.28	0.26	0.06	-	0.36	0.39	0.29	**0.00**	**0.00**	0.92	**0.00**	**0.00**	**0.00**	**0.00**
FAME Index	0.77	0.56	0.72	0.69	0.95	-	0.07	0.19	0.30	-	0.36	0.35	0.78	0.63	0.56	**0.01**	**0.00**	0.12	**0.00**	**0.00**
MetHINTOL150 (EFIplus)	0.09	0.33	0.28	0.93	0.41	-	0.21	0.14	0.60	-	**0.03**	**0.02**	0.05	**0.01**	0.15	0.17	0.22	0.42	**0.04**	0.56
MetO2INTOL (EFIplus)	0.13	0.90	0.83	0.70	0.54	-	0.08	0.23	0.15	-	0.90	0.68	0.41	**0.01**	**0.01**	0.14	**0.00**	0.40	**0.00**	**0.00**
MetRHPAR (EFIplus)	0.45	0.58	0.47	0.31	-	-	-	-	-	-	0.83	0.75	0.87	0.78	0.21	0.51	0.23	0.20	**0.00**	**0.00**
MetLITH (EFIplus)	0.70	1.00	0.98	0.24	-	-	-	-	-	-	0.48	0.19	0.26	**0.04**	**0.01**	0.74	0.17	0.23	**0.00**	**0.00**
EFIplus Index	0.51	0.26	0.30	0.80	0.91	-	0.52	0.77	0.93	-	0.08	0.12	0.19	0.24	0.92	0.08	0.43	0.44	**0.00**	**0.00**
EFIplus Class	0.47	0.19	0.16	0.87	0.47	-	0.64	0.55	0.97	-	0.07	0.11	0.17	0.12	0.70	**0.01**	0.27	0.23	**0.00**	**0.00**

Table F.4: Mann-Whitney for morphological index with high reliability (significance) (part 2)

	group 1: morph. Index = 1-3 group 2: morph. Index = 4-5										group 1: morph. Index = 1-4 group 2: morph. Index = 5									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	0.59	0.19	0.02	0.81	**0.01**	0.71	0.03	**0.00**	0.09	-	0.19	0.07	0.07	0.48	-	-	-	-	-	-
Density_sp_all	0.05	0.13	0.19	0.09	0.05	**0.00**	0.04	0.66	**0.00**	-	0.67	0.75	0.74	0.34	-	-	-	-	-	-
Biom_sp_all	0.37	0.20	0.15	0.19	0.31	0.27	0.22	**0.01**	0.05	-	0.49	0.15	0.14	0.03	-	-	-	-	-	-
kg_ha_Repro_LITH	0.88	0.48	0.31	0.37	0.79	**0.00**	0.48	**0.00**	0.81	-	0.58	0.18	0.17	0.02	-	-	-	-	-	-
perc_kgha_Repro_LITH	0.76	0.38	0.24	0.71	0.88	**0.00**	0.70	**0.00**	0.91	-	0.29	0.91	0.89	0.12	-	-	-	-	-	-
n_ha_Repro_LITH	0.41	0.49	0.52	0.42	0.70	0.05	0.35	0.24	0.09	-	0.50	0.62	0.60	0.03	-	-	-	-	-	-
perc_nha_Repro_LITH	0.65	1.00	0.82	0.17	0.22	**0.00**	0.29	**0.00**	0.76	-	0.21	0.82	0.81	0.09	-	-	-	-	-	-
n_sp_Repro_LITH	0.28	0.12	0.02	0.35	**0.00**	**0.00**	0.01	**0.00**	0.05	-	0.34	0.09	0.09	0.06	-	-	-	-	-	-
perc_sp_Repro_LITH	0.57	0.26	0.24	0.88	0.84	**0.00**	0.52	0.25	0.49	-	0.20	0.97	0.95	0.09	-	-	-	-	-	-
kg_ha_Atroph_OMNI	0.50	0.75	0.25	0.25	0.40	0.01	0.45	**0.00**	0.82	-	0.46	0.31	0.32	0.93	-	-	-	-	-	-
perc_kgha_Atroph_OMNI	0.27	0.99	0.31	0.19	0.58	0.02	0.61	**0.00**	0.92	-	0.46	0.31	0.32	0.91	-	-	-	-	-	-
n_ha_Atroph_OMNI	0.30	0.95	0.39	0.26	0.50	**0.00**	0.59	**0.00**	0.50	-	0.45	0.29	0.30	1.00	-	-	-	-	-	-
perc_nha_Atroph_OMNI	0.41	0.83	0.25	0.37	0.30	0.03	0.34	**0.00**	0.91	-	0.46	0.30	0.31	0.90	-	-	-	-	-	-
n_sp_Atroph_OMNI	0.41	0.78	0.23	0.57	0.25	**0.00**	0.36	0.02	0.86	-	0.45	0.29	0.30	0.92	-	-	-	-	-	-
perc_sp_Atroph_OMNI	0.24	0.99	0.42	0.33	0.71	**0.00**	0.79	0.03	0.43	-	0.45	0.29	0.30	0.61	-	-	-	-	-	-
kg_ha_Mig_POTAD	0.81	0.43	0.28	0.53	0.99	**0.00**	0.56	**0.00**	0.96	-	0.55	0.17	0.16	0.02	-	-	-	-	-	-
perc_kgha_Mig_POTAD	0.94	0.57	0.36	0.22	0.43	**0.00**	0.77	**0.00**	0.25	-	0.25	0.96	0.98	0.07	-	-	-	-	-	-
n_ha_Mig_POTAD	0.35	0.46	0.45	0.78	0.77	0.08	0.42	**0.00**	0.12	-	0.41	0.69	0.68	0.04	-	-	-	-	-	-
perc_nha_Mig_POTAD	0.46	0.92	0.72	0.04	0.32	**0.00**	0.31	**0.00**	0.59	-	0.17	0.93	0.92	0.07	-	-	-	-	-	-
n_sp_Mig_POTAD	0.33	0.14	0.01	0.14	**0.00**	**0.00**	**0.00**	0.10	**0.01**	-	0.42	0.11	0.11	0.08	-	-	-	-	-	-
perc_sp_Mig_POTAD	0.36	0.17	0.08	0.74	0.82	**0.00**	0.48	**0.00**	0.83	-	0.16	0.77	0.79	0.14	-	-	-	-	-	-
kg_ha_Hab_RH	0.43	0.18	0.12	0.10	0.17	0.31	0.12	0.02	0.04	-	0.56	0.19	0.18	0.04	-	-	-	-	-	-
perc_kgha_Hab_RH	0.57	0.27	0.13	0.29	0.53	**0.00**	0.24	0.60	0.89	-	0.57	0.43	0.44	0.30	-	-	-	-	-	-
n_ha_Hab_RH	0.05	0.10	0.12	0.04	0.02	**0.00**	0.01	0.85	**0.00**	-	0.64	0.84	0.83	0.38	-	-	-	-	-	-
perc_nha_Hab_RH	0.73	0.34	0.23	0.57	0.55	**0.00**	0.50	0.36	0.87	-	0.55	0.40	0.40	0.39	-	-	-	-	-	-
n_sp_Hab_RH	0.41	0.15	0.02	0.81	**0.00**	0.06	0.02	**0.00**	0.07	-	0.21	0.09	0.09	0.09	-	-	-	-	-	-
perc_sp_Hab_RH	0.78	0.33	0.26	0.63	0.72	**0.00**	0.51	0.17	0.89	-	0.53	0.38	0.39	0.19	-	-	-	-	-	-
P-INSE (EFI)	0.17	0.06	0.12	0.07	0.07	**0.00**	**0.01**	0.02	0.69	-	0.97	0.34	0.33	0.03	-	-	-	-	-	-
P-OMNI (EFI)	0.93	0.56	0.10	0.35	0.01	0.08	0.06	0.10	0.26	-	0.70	0.74	0.75	0.79	-	-	-	-	-	-
P-PHYT (EFI)	0.42	0.73	0.86	0.06	0.13	**0.00**	0.35	0.16	0.21	-	0.28	0.56	0.55	0.88	-	-	-	-	-	-
P-BENT (EFI)	0.05	**0.01**	**0.00**	0.09	**0.00**	0.51	**0.00**	0.47	0.39	-	0.31	0.33	0.32	0.66	-	-	-	-	-	-
P-RHEO (EFI)	0.02	0.02	**0.00**	0.02	**0.00**	**0.00**	**0.00**	0.63	0.29	-	0.69	0.24	0.24	0.01	-	-	-	-	-	-
P-LONG (EFI)	**0.00**	0.01	**0.00**	**0.00**	**0.00**	0.33	**0.00**	**0.00**	0.99	-	0.19	0.17	0.18	0.95	-	-	-	-	-	-
P-POTA (EFI)	0.12	0.09	**0.01**	0.01	**0.00**	**0.00**	**0.00**	0.65	0.34	-	0.67	0.41	0.41	**0.00**	-	-	-	-	-	-
P-LITH (EFI)	0.03	0.03	0.07	0.56	0.37	**0.00**	0.17	0.24	**0.01**	-	0.33	0.07	0.06	0.10	-	-	-	-	-	-
P-INTO (EFI)	0.14	0.09	0.18	0.83	0.99	**0.00**	0.51	0.45	0.07	-	0.18	0.17	0.16	0.30	-	-	-	-	-	-
P-TOLE (EFI)	0.24	0.22	0.24	0.01	0.09	**0.01**	0.07	**0.00**	0.81	-	0.47	0.95	0.93	0.53	-	-	-	-	-	-
FAME Index	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	0.38	0.06	-	0.35	0.09	0.08	0.01	-	-	-	-	-	-
MetHINTOL150 (EFIplus)	0.25	0.16	0.20	0.92	0.99	0.49	0.38	0.05	0.49	-	0.42	0.66	0.65	**0.01**	-	-	-	-	-	-
MetO2INTOL (EFIplus)	0.89	0.74	0.38	0.22	**0.01**	0.05	0.07	0.13	0.22	-	0.32	0.08	0.08	0.16	-	-	-	-	-	-
MetRHPAR (EFIplus)	0.96	0.58	0.67	0.96	0.42	-	0.26	0.54	0.86	-	-	-	-	-	-	-	-	-	-	-
MetLITH (EFIplus)	0.57	0.80	0.79	0.66	0.66	-	0.25	0.62	0.12	-	-	-	-	-	-	-	-	-	-	-
EFIplus Index	0.33	0.20	0.40	0.98	0.61	0.02	0.55	0.70	0.79	-	0.79	0.36	0.36	**0.00**	-	-	-	-	-	-
EFIplus Class	0.24	0.23	0.43	0.64	0.95	0.05	0.48	0.93	0.57	-	0.63	0.38	0.38	**0.00**	-	-	-	-	-	-

Table F.5: Mann-Whitney for hydro peaking (significance) (part 1)

	group 1: 0 % hydro peaking group 2: > 0 % hydro peaking										group 1: 0 - 10 % hydro peaking group 2: > 10 % hydro peaking									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	0.45	0.61	0.73	0.80	0.90	0.18	0.10	**0.00**	**0.00**	**0.00**	0.45	0.51	0.57	0.54	0.88	0.13	0.50	0.55	0.67	0.71
Density_sp_all	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Biom_sp_all	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.03	**0.00**
kg_ha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.04	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	0.09	**0.00**
perc_kgha_Repro_LITH	0.48	0.98	0.42	0.25	0.05	**0.01**	0.08	**0.00**	0.01	0.17	0.48	0.89	0.61	0.37	0.09	0.08	0.04	0.01	**0.00**	0.22
n_ha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.12	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
perc_nha_Repro_LITH	0.81	0.94	0.50	0.34	0.04	**0.00**	0.02	**0.00**	**0.00**	0.46	0.81	0.91	0.68	0.53	0.11	0.02	0.04	0.02	**0.00**	0.68
n_sp_Repro_LITH	0.19	0.26	0.30	0.21	0.20	0.32	**0.00**	0.21	**0.00**	**0.00**	0.19	0.25	0.22	0.13	0.28	0.89	0.01	0.01	0.07	0.72
perc_sp_Repro_LITH	0.90	0.79	0.62	0.29	0.04	**0.00**	**0.00**	**0.00**	**0.00**	0.96	0.90	0.95	0.74	0.47	0.08	0.04	**0.01**	**0.01**	0.08	0.20
kg_ha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.05	**0.00**	0.15	0.14	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**
perc_kgha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.03	**0.00**	0.25	0.09	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01
n_ha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	0.09	**0.00**	0.18	0.15	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02
perc_nha_Atroph_OMNI	**0.01**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	0.15	**0.00**	0.41	0.07	**0.01**	0.01	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	0.06
n_sp_Atroph_OMNI	0.01	0.02	**0.01**	0.02	**0.00**	**0.00**	0.23	**0.00**	0.93	0.02	0.01	0.02	0.02	0.04	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	0.08
perc_sp_Atroph_OMNI	0.01	0.02	0.01	0.02	**0.00**	**0.00**	0.27	**0.00**	0.75	0.02	0.01	0.03	0.02	0.02	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	0.05
kg_ha_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	0.08	**0.00**
perc_kgha_Mig_POTAD	0.80	0.57	0.98	0.51	0.17	0.07	0.27	**0.00**	**0.00**	0.44	0.80	0.61	0.76	0.72	0.30	0.16	0.16	0.06	0.02	0.09
n_ha_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
perc_nha_Mig_POTAD	0.72	0.77	0.75	0.47	0.06	**0.00**	0.03	**0.00**	**0.01**	0.48	0.72	0.73	1.00	0.71	0.17	0.01	0.04	0.01	**0.01**	0.27
n_sp_Mig_POTAD	0.26	0.38	0.50	0.29	0.30	0.83	**0.00**	0.01	**0.00**	**0.00**	0.26	0.30	0.41	0.19	0.37	0.76	0.01	0.01	0.20	0.20
perc_sp_Mig_POTAD	0.36	0.41	0.32	0.07	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	0.80	0.36	0.40	0.47	0.14	0.02	**0.01**	**0.00**	**0.00**	0.08	0.11
kg_ha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.06	**0.00**
perc_kgha_Hab_RH	0.07	0.05	0.05	0.15	0.14	0.28	0.63	**0.00**	0.07	**0.00**	0.07	0.06	0.07	0.19	0.14	0.12	0.67	0.43	0.03	0.35
n_ha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.07	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
perc_nha_Hab_RH	0.30	0.20	0.09	0.37	0.27	0.31	0.38	**0.00**	0.36	**0.00**	0.30	0.23	0.13	0.46	0.30	0.12	0.40	0.28	0.07	0.50
n_sp_Hab_RH	0.13	0.23	0.25	0.29	0.49	0.55	0.02	0.12	**0.00**	0.08	0.13	0.19	0.18	0.16	0.48	0.45	0.15	0.09	0.12	1.00
perc_sp_Hab_RH	0.47	0.33	0.27	0.54	0.47	0.61	0.26	**0.00**	0.04	**0.00**	0.47	0.38	0.35	0.66	0.43	0.29	0.82	0.75	0.04	0.45
P-INSE (EFI)	0.03	0.08	0.12	0.06	0.09	0.44	0.03	**0.00**	0.06	**0.00**	0.03	0.06	0.15	0.05	0.07	0.10	**0.00**	**0.00**	0.90	**0.00**
P-OMNI (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.91	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**
P-PHYT (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.07	**0.00**	0.35	**0.00**	0.39	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	0.79
P-BENT (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.43	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02
P-RHEO (EFI)	**0.00**	**0.00**	**0.01**	0.02	**0.01**	0.02	0.32	0.18	0.07	**0.00**	**0.00**	**0.00**	**0.01**	0.03	0.01	**0.00**	0.27	**0.00**	0.03	**0.00**
P-LONG (EFI)	0.76	0.50	0.34	0.51	0.46	**0.01**	0.33	**0.00**	0.02	0.08	0.76	0.41	0.51	0.63	0.57	0.07	0.08	0.56	0.46	0.20
P-POTA (EFI)	**0.00**	**0.00**	**0.00**	0.02	0.01	0.05	0.52	**0.00**	0.35	0.05	**0.00**	**0.00**	**0.00**	0.03	0.02	**0.00**	0.43	**0.00**	**0.00**	**0.00**
P-LITH (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.12	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02
P-INTO (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.35	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
P-TOLE (EFI)	0.02	0.04	0.20	0.39	0.52	0.59	0.46	0.74	**0.00**	**0.00**	0.02	0.04	0.13	0.35	0.43	0.81	0.57	**0.00**	0.29	0.07
FAME Index	**0.00**	**0.01**	0.02	0.03	0.03	0.03	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	0.02	0.02	0.02	0.01	**0.00**	**0.00**	0.11	0.04
MetHINTOL150 (EFIplus)	0.30	0.17	0.31	0.26	0.65	0.53	0.56	**0.01**	1.00	0.77	0.30	0.17	0.29	0.23	0.63	0.37	0.65	0.45	0.13	0.01
MetO2INTOL (EFIplus)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.21
MetRHPAR (EFIplus)	0.11	0.30	0.30	0.60	0.60	0.60	0.85	0.21	0.52	**0.00**	0.11	0.30	0.30	0.60	0.60	0.60	0.85	0.11	0.93	0.62
MetLITH (EFIplus)	0.78	0.30	0.30	0.34	0.34	0.34	0.18	0.07	0.12	**0.01**	0.78	0.30	0.30	0.34	0.34	0.34	0.18	0.76	0.25	0.34
EFIplus Index	**0.00**	**0.00**	**0.00**	**0.00**	0.01	0.07	**0.01**	**0.00**	0.02	0.34	**0.00**	**0.00**	**0.00**	**0.00**	0.01	**0.01**	**0.00**	**0.00**	0.92	0.02
EFIplus Class	**0.01**	**0.00**	0.01	**0.01**	0.01	0.07	**0.01**	**0.00**	0.04	0.77	**0.01**	**0.00**	**0.01**	**0.01**	0.02	**0.01**	**0.00**	**0.00**	0.52	0.02

Table F.6: Mann-Whitney for hydro peaking (significance) (part 2)

	group 1: 0 - 20 % hydro peaking group 2: > 20 % hydro peaking									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	0.45	0.51	0.58	0.64	0.83	0.30	0.43	0.28	0.40	-
Density_sp_all	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.94	-
Biom_sp_all	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.57	-
kg_ha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	0.49	-
perc_kgha_Repro_LITH	0.48	0.89	0.84	0.49	0.17	0.96	0.94	**0.00**	0.29	-
n_ha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.86	-
perc_nha_Repro_LITH	0.81	0.91	0.81	0.60	0.22	0.93	0.92	**0.00**	0.62	-
n_sp_Repro_LITH	0.19	0.25	0.23	0.22	0.38	0.77	0.77	**0.00**	0.35	-
perc_sp_Repro_LITH	0.90	0.95	0.76	0.67	0.18	0.30	0.22	**0.00**	0.48	-
kg_ha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	0.44	-
perc_kgha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	0.45	-
n_ha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	0.01	0.43	-
perc_nha_Atroph_OMNI	**0.01**	0.01	**0.01**	**0.01**	**0.00**	0.01	**0.00**	**0.01**	0.43	-
n_sp_Atroph_OMNI	0.01	0.02	0.03	0.03	**0.00**	0.02	**0.00**	0.09	0.42	-
perc_sp_Atroph_OMNI	0.01	0.03	0.03	0.02	**0.00**	0.02	**0.00**	0.06	0.42	-
kg_ha_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.51	-
perc_kgha_Mig_POTAD	0.80	0.61	0.51	0.93	0.48	0.30	0.54	**0.01**	0.25	-
n_ha_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.84	-
perc_nha_Mig_POTAD	0.72	0.73	0.80	0.91	0.31	0.95	0.97	**0.00**	0.47	-
n_sp_Mig_POTAD	0.26	0.30	0.47	0.34	0.54	0.26	0.82	**0.01**	0.37	-
perc_sp_Mig_POTAD	0.36	0.40	0.60	0.31	0.05	0.75	0.03	**0.01**	0.97	-
kg_ha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	0.50	-
perc_kgha_Hab_RH	0.07	0.06	0.09	0.10	0.08	0.38	0.13	0.25	0.55	-
n_ha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.97	-
perc_nha_Hab_RH	0.30	0.23	0.17	0.27	0.19	0.34	0.22	0.19	0.53	-
n_sp_Hab_RH	0.13	0.19	0.21	0.22	0.54	0.64	0.84	0.02	0.52	-
perc_sp_Hab_RH	0.47	0.38	0.45	0.51	0.32	0.25	0.25	0.55	0.52	-
P-INSE (EFI)	0.03	0.06	0.10	0.07	0.09	0.18	0.31	0.06	0.32	-
P-OMNI (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.54	-
P-PHYT (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.19	0.04	**0.00**	1.00	-
P-BENT (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.06	**0.00**	**0.00**	0.58	-
P-RHEO (EFI)	**0.00**	**0.00**	**0.00**	0.02	**0.01**	0.11	0.07	0.03	0.77	-
P-LONG (EFI)	0.76	0.41	0.48	0.42	0.40	0.12	**0.01**	0.02	0.12	-
P-POTA (EFI)	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	0.07	**0.01**	0.50	-
P-LITH (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	**0.00**	**0.00**	0.92	-
P-INTO (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	1.00	-
P-TOLE (EFI)	0.02	0.04	0.09	0.50	0.27	0.56	0.77	**0.00**	0.55	-
FAME Index	**0.00**	**0.01**	0.02	0.03	0.02	0.67	**0.01**	**0.00**	0.40	-
MetHINTOL150 (EFIplus)	0.30	0.17	0.22	0.23	0.52	0.44	0.79	0.98	0.34	-
MetO2INTOL (EFIplus)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.35	-
MetRHPAR (EFIplus)	0.11	0.30	0.30	0.60	0.60	0.47	0.85	0.11	-	-
MetLITH (EFIplus)	0.78	0.30	0.30	0.34	0.34	0.75	0.18	0.76	-	-
EFIplus Index	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	0.15	0.03	0.03	0.38	-
EFIplus Class	**0.01**	**0.00**	**0.01**	0.01	0.01	0.19	0.03	0.02	0.48	-

	group 1: 0 - 30 % hydro peaking group 2: > 30 % hydro peaking									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	0.45	0.40	0.61	0.95	1.00	0.01	0.19	0.37	0.40	-
Density_sp_all	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.94	-
Biom_sp_all	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.57	-
kg_ha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	**0.00**	0.01	0.49	-
perc_kgha_Repro_LITH	0.48	0.93	0.98	0.49	0.62	0.10	0.87	**0.00**	0.29	-
n_ha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	**0.00**	**0.00**	0.86	-
perc_nha_Repro_LITH	0.81	0.91	0.94	0.57	0.59	0.16	0.47	**0.00**	0.62	-
n_sp_Repro_LITH	0.19	0.22	0.26	0.38	0.39	0.06	0.83	**0.00**	0.35	-
perc_sp_Repro_LITH	0.90	0.90	0.79	0.42	0.46	0.30	0.15	**0.00**	0.48	-
kg_ha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.03	**0.00**	**0.01**	0.44	-
perc_kgha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.03	**0.00**	**0.00**	0.45	-
n_ha_Atroph_OMNI	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	**0.01**	0.43	-
perc_nha_Atroph_OMNI	**0.01**	0.02	**0.01**	**0.00**	**0.00**	0.03	**0.00**	**0.00**	0.43	-
n_sp_Atroph_OMNI	0.01	0.03	0.02	**0.01**	**0.01**	0.02	**0.00**	0.07	0.42	-
perc_sp_Atroph_OMNI	0.01	0.04	0.02	**0.01**	**0.01**	0.02	**0.00**	0.06	0.42	-
kg_ha_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	0.51	-
perc_kgha_Mig_POTAD	0.80	0.83	0.57	0.92	0.94	0.18	0.31	**0.01**	0.25	-
n_ha_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	0.84	-
perc_nha_Mig_POTAD	0.72	0.79	0.77	0.81	0.75	0.10	0.91	**0.00**	0.47	-
n_sp_Mig_POTAD	0.26	0.23	0.38	0.66	0.53	0.05	0.57	0.02	0.37	-
perc_sp_Mig_POTAD	0.36	0.44	0.41	0.29	0.18	0.10	0.04	0.01	0.97	-
kg_ha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	**0.00**	**0.01**	0.50	-
perc_kgha_Hab_RH	0.07	0.09	0.05	0.03	0.06	0.09	0.03	0.19	0.55	-
n_ha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	**0.00**	**0.00**	0.97	-
perc_nha_Hab_RH	0.30	0.30	0.20	0.10	0.11	0.08	0.05	0.12	0.53	-
n_sp_Hab_RH	0.13	0.15	0.23	0.37	0.45	0.04	0.75	0.04	0.52	-
perc_sp_Hab_RH	0.47	0.49	0.33	0.26	0.29	0.06	0.03	0.45	0.52	-
P-INSE (EFI)	0.03	0.02	0.08	0.09	0.07	0.75	0.62	0.04	0.32	-
P-OMNI (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	**0.00**	0.54	-
P-PHYT (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.43	**0.00**	**0.00**	1.00	-
P-BENT (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.58	-
P-RHEO (EFI)	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	0.01	0.01	0.02	0.77	-
P-LONG (EFI)	0.76	0.53	0.50	0.33	0.13	0.95	**0.00**	0.04	0.12	-
P-POTA (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.04	**0.01**	**0.00**	0.50	-
P-LITH (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.18	**0.00**	**0.00**	0.92	-
P-INTO (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.13	**0.00**	**0.00**	1.00	-
P-TOLE (EFI)	0.02	0.03	0.04	0.16	0.17	0.21	0.21	**0.00**	0.55	-
FAME Index	**0.00**	**0.00**	**0.01**	0.02	**0.01**	0.50	**0.00**	**0.00**	0.40	-
MetHINTOL150 (EFIplus)	0.30	0.17	0.17	0.17	0.21	0.89	0.24	0.93	0.34	-
MetO2INTOL (EFIplus)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.19	**0.00**	**0.00**	0.35	-
MetRHPAR (EFIplus)	0.11	0.30	0.30	0.30	0.60	0.11	0.45	0.11		-
MetLITH (EFIplus)	0.78	0.30	0.30	0.30	0.34	0.78	0.37	0.76		-
EFIplus Index	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.42	**0.01**	0.04	0.38	-
EFIplus Class	**0.01**	**0.00**	**0.00**	**0.01**	**0.00**	0.74	**0.01**	0.03	0.48	-

Table F.7: Mann-Whitney for impoundment (significance) (part 1)

	group 1: 0% impoundment group 2: >0 % impoundment										group 1: 0 - 10 % impoundment group 2: >10 % impoundment									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.17	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.79
Density_sp_all	**0.00**	**0.00**	0.06	0.37	0.47	0.20	**0.00**	0.02	**0.00**	0.04	**0.00**	**0.00**	**0.01**	0.05	0.02	0.44	**0.00**	**0.00**	**0.00**	0.13
Biom_sp_all	0.02	0.06	0.56	0.20	0.12	0.03	0.61	0.65	0.78	0.65	0.02	0.03	0.03	0.01	**0.01**	**0.00**	0.64	**0.00**	0.51	0.38
kg_ha_Repro_LITH	**0.00**	**0.00**	0.02	0.87	0.70	0.17	0.15	0.98	0.14	0.67	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	0.25
perc_kgha_Repro_LITH	**0.00**	**0.00**	**0.00**	0.02	0.01	**0.00**	0.01	0.45	**0.00**	0.22	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.42
n_ha_Repro_LITH	**0.00**	**0.00**	**0.00**	0.03	0.65	0.90	**0.00**	**0.00**	**0.00**	0.82	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.03	0.06
perc_nha_Repro_LITH	0.03	**0.01**	**0.00**	**0.01**	0.03	**0.00**	0.01	0.06	**0.00**	0.13	0.03	0.03	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.39
n_sp_Repro_LITH	0.46	0.02	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	0.46	0.04	**0.01**	**0.00**	**0.00**	0.03	**0.00**	**0.00**	0.01	0.59
perc_sp_Repro_LITH	**0.01**	0.01	0.07	0.84	0.73	**0.00**	0.28	0.74	0.02	0.77	**0.01**	0.02	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.05
kg_ha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	0.72	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**
perc_kgha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.55	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01
n_ha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	0.97	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**
perc_nha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.73	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02
n_sp_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.73	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.27
perc_sp_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.49	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.10
kg_ha_Mig_POTAD	**0.01**	0.03	0.37	0.26	0.27	0.08	0.68	0.46	0.47	0.60	**0.01**	0.01	0.01	**0.00**	**0.00**	**0.00**	0.31	**0.00**	0.31	0.30
perc_kgha_Mig_POTAD	0.03	0.03	**0.01**	0.12	0.04	**0.00**	0.06	0.47	0.02	0.14	0.03	0.07	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.95
n_ha_Mig_POTAD	**0.00**	**0.00**	0.01	0.10	0.95	0.97	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.04	**0.00**	**0.00**	0.06	0.10
perc_nha_Mig_POTAD	0.65	0.19	0.02	**0.00**	0.01	**0.00**	**0.00**	0.08	**0.00**	**0.00**	0.65	0.47	0.05	**0.00**	0.02	**0.00**	**0.00**	**0.00**	**0.00**	0.42
n_sp_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	0.16
perc_sp_Mig_POTAD	0.08	0.04	0.04	0.13	0.07	**0.00**	0.33	0.58	0.01	0.62	0.08	0.07	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.32
kg_ha_Hab_RH	**0.00**	**0.00**	**0.01**	0.83	0.74	0.15	0.07	0.69	0.14	0.39	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.27
perc_kgha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	0.01	**0.00**	**0.00**	**0.00**	0.01	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.14
n_ha_Hab_RH	**0.00**	**0.00**	**0.00**	0.01	0.63	0.54	**0.00**	**0.00**	**0.00**	0.96	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.10	0.08
perc_nha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.13
n_sp_Hab_RH	0.89	0.06	0.01	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.89	0.14	0.03	**0.00**	**0.00**	0.02	**0.00**	**0.00**	0.08	0.72
perc_sp_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	0.01	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.11
P-INSE (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.30	0.44	**0.00**	0.83	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.13	**0.00**	0.53
P-OMNI (EFI)	0.25	0.03	0.02	**0.00**	**0.00**	0.05	0.99	0.52	0.18	0.09	0.25	0.11	0.02	**0.00**	**0.00**	**0.00**	**0.00**	0.25	**0.00**	**0.01**
P-PHYT (EFI)	0.16	0.59	0.95	0.40	0.92	1.00	**0.00**	0.07	**0.00**	**0.00**	0.16	0.55	0.73	0.88	0.32	**0.00**	0.68	0.01	**0.00**	0.15
P-BENT (EFI)	0.11	0.69	0.90	0.07	0.07	**0.00**	0.93	0.23	0.04	0.55	0.11	0.39	0.64	0.09	0.17	0.01	**0.00**	0.72	**0.00**	0.76
P-RHEO (EFI)	**0.00**	**0.00**	0.06	0.14	0.27	0.07	**0.00**	**0.00**	0.10	0.29	**0.00**	**0.00**	**0.00**	0.04	**0.01**	0.03	0.89	0.14	0.02	0.58
P-LONG (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.41	0.20
P-POTA (EFI)	0.06	0.49	0.97	**0.01**	0.04	0.10	**0.00**	**0.00**	**0.00**	0.09	0.06	0.40	0.20	0.92	0.30	0.71	**0.00**	0.34	0.55	0.53
P-LITH (EFI)	0.37	0.84	0.96	0.81	0.79	0.43	**0.00**	0.13	**0.00**	**0.00**	0.37	0.33	0.96	0.51	0.19	**0.00**	**0.01**	0.10	**0.00**	0.19
P-INTO (EFI)	0.02	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.91	0.02	**0.00**	0.07	0.02	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.21	**0.00**	0.05
P-TOLE (EFI)	0.08	0.09	0.31	0.13	0.20	0.78	0.02	0.21	0.25	**0.01**	0.08	0.14	0.03	**0.00**	**0.00**	**0.00**	0.92	**0.00**	**0.00**	**0.01**
FAME Index	**0.00**	**0.00**	**0.00**	0.04	**0.00**	0.06	**0.00**	0.13	0.52	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.03	**0.00**	0.07
MetHINTOL150 (EFIplus)	0.16	0.24	0.21	0.90	0.65	0.96	0.05	0.25	0.09	**0.01**	0.16	0.20	0.06	0.50	0.29	0.04	0.54	0.91	0.20	0.36
MetO2INTOL (EFIplus)	0.01	0.13	0.16	0.17	0.54	**0.01**	**0.00**	0.03	**0.01**	0.95	0.01	0.08	0.21	**0.00**	0.07	0.13	0.46	**0.00**	**0.00**	0.07
MetRHPAR (EFIplus)	**0.00**	**0.00**	**0.00**	0.33	0.61	-	0.60	0.89	0.69	0.96	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	
MetLITH (EFIplus)	**0.00**	**0.00**	**0.00**	0.36	0.54	-	0.96	0.96	0.17	0.03	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	
EFIplus Index	**0.00**	**0.00**	0.02	0.91	0.65	0.32	0.40	0.89	0.19	0.02	**0.00**	**0.00**	**0.00**	0.03	0.01	0.02	**0.00**	0.19	**0.00**	0.19
EFIplus Class	0.00	0.04	0.05	0.92	0.61	0.20	1.00	0.65	0.24	0.12	**0.00**	0.01	0.01	0.11	0.04	0.06	0.02	0.26	**0.00**	0.09

Table F.8: Mann-Whitney for impoundment (significance) (part 2)

	group 1: 0 - 20 % impoundment group 2: >20 % impoundment									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.14	**0.00**	**0.00**	0.27	-
Density_sp_all	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	0.75	0.03	0.02	0.08	-
Biom_sp_all	0.02	**0.00**	**0.00**	0.02	0.08	0.14	0.88	**0.00**	0.17	-
kg_ha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	0.03	**0.00**	0.16	-
perc_kgha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.08	-
n_ha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.35	**0.00**	**0.00**	0.93	-
perc_nha_Repro_LITH	0.03	**0.00**	**0.00**	**0.00**	**0.01**	0.03	**0.00**	**0.00**	0.09	-
n_sp_Repro_LITH	0.46	0.07	0.01	0.24	0.05	0.17	**0.00**	**0.00**	0.35	-
perc_sp_Repro_LITH	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	0.11	-
kg_ha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.05	**0.00**	**0.00**	0.13	-
perc_kgha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	**0.00**	0.33	-
n_ha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.05	**0.00**	**0.00**	0.07	-
perc_nha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	**0.00**	0.43	-
n_sp_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.07	-
perc_sp_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	0.06	-
kg_ha_Mig_POTAD	**0.01**	**0.00**	**0.00**	**0.01**	0.03	0.04	0.48	**0.00**	0.19	-
perc_kgha_Mig_POTAD	0.03	0.03	**0.00**	**0.01**	0.02	**0.01**	**0.00**	**0.00**	0.08	-
n_ha_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.39	**0.00**	**0.00**	0.92	-
perc_nha_Mig_POTAD	0.65	0.28	0.06	0.53	0.54	0.06	**0.00**	**0.00**	0.09	-
n_sp_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.77	**0.00**	**0.00**	0.37	-
perc_sp_Mig_POTAD	0.08	0.01	**0.01**	0.10	0.05	0.02	**0.00**	**0.00**	0.09	-
kg_ha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	0.04	**0.00**	0.20	-
perc_kgha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.11	-
n_ha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.22	**0.00**	**0.00**	0.08	-
perc_nha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.16	-
n_sp_Hab_RH	0.89	0.16	0.02	0.44	0.13	0.21	**0.00**	**0.00**	0.91	-
perc_sp_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.07	-
P-INSE (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.15	**0.00**	**0.00**	0.12	-
P-OMNI (EFI)	0.25	0.11	0.02	0.39	0.06	0.01	**0.00**	**0.00**	0.39	-
P-PHYT (EFI)	0.16	0.25	0.43	0.07	0.06	**0.01**	0.99	0.09	0.09	-
P-BENT (EFI)	0.11	0.62	0.80	0.54	0.77	0.58	0.01	0.02	0.44	-
P-RHEO (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.95	**0.01**	0.18	-
P-LONG (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.72	-
P-POTA (EFI)	0.06	0.13	0.19	0.11	0.12	**0.01**	0.05	0.21	0.21	-
P-LITH (EFI)	0.37	0.57	0.47	0.63	0.88	**0.00**	0.53	0.81	0.11	-
P-INTO (EFI)	0.02	**0.00**	**0.00**	0.02	0.01	0.05	**0.00**	**0.00**	0.23	-
P-TOLE (EFI)	0.08	0.02	**0.01**	**0.00**	**0.00**	**0.00**	0.19	**0.00**	0.24	-
FAME Index	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.10	-
MetHINTOL150 (EFIplus)	0.16	0.13	0.18	0.02	**0.01**	0.17	0.74	0.64	0.86	-
MetO2INTOL (EFIplus)	0.01	0.05	0.05	**0.01**	0.01	0.38	0.47	0.37	0.12	-
MetRHPAR (EFIplus)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.06	**0.00**	**0.00**	-	-
MetLITH (EFIplus)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.52	**0.00**	**0.00**	-	-
EFIplus Index	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.52	0.03	**0.00**	0.16	-
EFIplus Class	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.89	0.20	0.02	0.17	-

	group 1: 0 - 30 % impoundment group 2: >30 % impoundment									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.17	**0.00**	**0.00**	0.73	-
Density_sp_all	**0.00**	**0.00**	**0.00**	**0.01**	0.04	0.03	**0.01**	0.68	0.10	-
Biom_sp_all	0.02	0.01	**0.00**	0.05	0.65	0.07	0.01	0.10	0.08	-
kg_ha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.09	**0.00**	**0.00**	0.12	-
perc_kgha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.87	**0.01**	**0.00**	0.14	-
n_ha_Repro_LITH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.05	**0.00**	**0.00**	0.17	-
perc_nha_Repro_LITH	0.03	**0.00**	**0.00**	**0.00**	**0.00**	0.34	0.06	**0.00**	0.08	-
n_sp_Repro_LITH	0.46	0.12	0.08	0.14	0.04	0.09	0.33	0.02	0.58	-
perc_sp_Repro_LITH	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	0.66	**0.00**	**0.00**	0.07	-
kg_ha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.23	0.03	**0.00**	0.27	-
perc_kgha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.06	**0.00**	**0.00**	0.27	-
n_ha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.35	0.03	**0.00**	0.26	-
perc_nha_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.09	**0.00**	**0.00**	0.26	-
n_sp_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.33	**0.00**	**0.00**	0.25	-
perc_sp_Atroph_OMNI	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.44	**0.00**	**0.00**	0.25	-
kg_ha_Mig_POTAD	**0.01**	**0.00**	**0.00**	0.01	0.37	0.08	**0.01**	**0.01**	0.10	-
perc_kgha_Mig_POTAD	0.03	0.01	**0.00**	**0.01**	0.06	0.11	0.11	**0.00**	0.11	-
n_ha_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.01**	0.03	0.05	**0.01**	0.12	0.16	-
perc_nha_Mig_POTAD	0.65	0.22	0.05	0.46	0.68	0.11	0.85	**0.00**	0.11	-
n_sp_Mig_POTAD	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	**0.00**	0.57	-
perc_sp_Mig_POTAD	0.08	0.01	**0.00**	0.03	0.05	0.08	0.03	**0.00**	0.10	-
kg_ha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.09	**0.00**	**0.00**	0.11	-
perc_kgha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.03	**0.00**	**0.00**	0.40	-
n_ha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.04	**0.00**	**0.00**	0.13	-
perc_nha_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.15	**0.00**	**0.00**	0.38	-
n_sp_Hab_RH	0.89	0.25	0.15	0.23	0.09	0.24	0.41	0.03	1.00	-
perc_sp_Hab_RH	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.06	**0.00**	**0.00**	0.36	-
P-INSE (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.44	0.01	**0.00**	0.46	-
P-OMNI (EFI)	0.25	0.17	0.06	0.10	0.08	0.69	1.00	**0.00**	0.04	-
P-PHYT (EFI)	0.16	0.68	0.09	0.15	0.05	0.23	0.90	**0.00**	0.17	-
P-BENT (EFI)	0.11	0.33	0.71	0.70	0.98	0.14	0.15	**0.00**	0.02	-
P-RHEO (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.07	**0.00**	0.01	0.13	-
P-LONG (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	0.01	0.80	-
P-POTA (EFI)	0.06	0.08	0.01	0.14	0.49	0.80	**0.00**	0.90	0.34	-
P-LITH (EFI)	0.37	0.25	0.72	0.66	0.89	0.04	0.73	**0.00**	0.04	-
P-INTO (EFI)	0.02	0.02	**0.01**	0.02	0.03	0.43	0.16	**0.00**	0.13	-
P-TOLE (EFI)	0.08	0.05	**0.00**	**0.00**	**0.00**	0.02	0.08	**0.00**	0.18	-
FAME Index	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.61	**0.00**	**0.00**	0.96	-
MetHINTOL150 (EFIplus)	0.16	0.22	0.06	**0.00**	**0.01**	0.20	0.40	0.16	0.24	-
MetO2INTOL (EFIplus)	0.01	0.03	0.08	0.02	**0.01**	0.36	**0.00**	0.24	0.03	-
MetRHPAR (EFIplus)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	-	**0.00**	**0.00**	-	-
MetLITH (EFIplus)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	-	**0.00**	**0.00**	-	-
EFIplus Index	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.36	0.02	**0.00**	0.68	-
EFIplus Class	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	0.32	0.12	**0.00**	0.89	-

Table F.9: Mann-Whitney for water abstraction (significance) (part 1)

	group 1: 0 % water abstraction group 2: > 0 % water abstraction									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	0.78	0.54	0.91	0.04	**0.00**	0.57	**0.00**	0.27	**0.00**	-
Density_sp_all	0.67	0.03	0.01	0.24	0.79	0.32	**0.00**	**0.00**	**0.00**	-
Biom_sp_all	0.78	0.61	0.43	0.75	0.40	0.53	**0.00**	0.03	0.24	-
kg_ha_Repro_LITH	0.73	0.46	0.37	0.87	0.10	0.16	**0.00**	0.24	0.21	-
perc_kgha_Repro_LITH	0.21	0.25	0.22	**0.01**	**0.00**	0.05	0.85	0.05	0.92	-
n_ha_Repro_LITH	0.74	0.02	0.02	0.74	0.19	0.54	**0.00**	0.01	**0.00**	-
perc_nha_Repro_LITH	0.68	0.85	0.80	0.03	**0.00**	0.04	0.96	0.04	0.74	-
n_sp_Repro_LITH	0.36	0.69	0.58	0.51	0.38	0.01	**0.00**	0.03	**0.00**	-
perc_sp_Repro_LITH	0.51	0.48	0.68	**0.00**	**0.00**	0.05	0.58	0.12	0.85	-
kg_ha_Atroph_OMNI	0.25	0.28	0.83	0.05	**0.00**	0.74	0.04	0.01	**0.00**	-
perc_kgha_Atroph_OMNI	0.63	0.42	0.96	0.02	**0.00**	0.63	0.06	0.03	**0.00**	-
n_ha_Atroph_OMNI	0.49	0.46	0.79	0.01	**0.00**	0.48	0.11	**0.01**	**0.00**	-
perc_nha_Atroph_OMNI	0.65	0.30	0.91	0.02	**0.00**	0.71	0.03	0.03	**0.00**	-
n_sp_Atroph_OMNI	0.63	0.47	0.97	0.01	**0.00**	0.23	0.03	0.26	**0.00**	-
perc_sp_Atroph_OMNI	0.61	0.37	0.89	0.02	**0.00**	0.19	0.17	0.06	**0.00**	-
kg_ha_Mig_POTAD	0.63	0.66	0.49	0.79	0.11	0.14	**0.00**	0.53	0.60	-
perc_kgha_Mig_POTAD	0.30	0.53	0.39	0.02	**0.00**	0.07	0.98	**0.00**	0.26	-
n_ha_Mig_POTAD	0.47	0.02	0.01	0.82	0.27	0.66	**0.00**	0.02	**0.00**	-
perc_nha_Mig_POTAD	0.83	0.98	0.77	0.02	**0.00**	0.11	0.42	0.02	0.63	-
n_sp_Mig_POTAD	0.51	0.14	0.69	0.26	0.06	0.03	**0.00**	**0.00**	**0.00**	-
perc_sp_Mig_POTAD	0.80	0.51	0.67	0.04	**0.00**	0.13	0.40	0.03	0.60	-
kg_ha_Hab_RH	0.66	0.44	0.35	0.87	0.34	0.49	**0.00**	0.01	0.04	-
perc_kgha_Hab_RH	0.07	0.32	0.10	**0.00**	**0.00**	0.11	0.07	0.52	**0.00**	-
n_ha_Hab_RH	0.66	0.01	**0.01**	0.32	0.80	0.33	**0.00**	**0.00**	**0.00**	-
perc_nha_Hab_RH	0.02	0.15	0.06	**0.00**	**0.00**	0.13	0.09	0.94	**0.00**	-
n_sp_Hab_RH	0.21	0.74	0.67	0.27	0.10	0.06	**0.00**	0.20	**0.00**	-
perc_sp_Hab_RH	0.06	0.30	0.12	**0.00**	**0.00**	0.08	0.09	0.80	**0.00**	-
P-INSE (EFI)	0.09	**0.00**	**0.00**	0.08	0.68	0.04	0.81	0.11	0.63	-
P-OMNI (EFI)	0.10	0.11	0.28	0.59	**0.00**	0.58	0.07	**0.00**	0.09	-
P-PHYT (EFI)	0.86	0.83	0.53	0.78	0.16	0.16	**0.00**	0.14	**0.00**	-
P-BENT (EFI)	0.25	0.84	0.84	0.24	**0.00**	0.68	0.47	0.03	0.27	-
P-RHEO (EFI)	0.27	0.44	0.39	0.48	0.21	**0.00**	0.06	0.15	0.58	-
P-LONG (EFI)	**0.00**	**0.00**	**0.00**	0.01	**0.01**	0.60	**0.00**	**0.01**	**0.00**	-
P-POTA (EFI)	0.66	0.98	0.64	0.70	0.34	**0.00**	**0.00**	0.53	**0.00**	-
P-LITH (EFI)	0.74	0.59	0.78	0.90	0.05	0.07	**0.00**	**0.00**	**0.00**	-
P-INTO (EFI)	0.43	0.37	0.43	0.83	0.10	0.87	**0.01**	**0.00**	0.72	-
P-TOLE (EFI)	0.49	0.53	0.68	0.02	**0.00**	0.06	0.16	0.23	0.18	-
FAME Index	0.38	0.04	0.05	0.24	0.54	**0.01**	**0.00**	0.09	0.05	-
MetHINTOL150 (EFIplus)	0.52	0.86	0.82	0.55	0.79	0.41	0.07	0.92	0.39	-
MetO2INTOL (EFIplus)	0.90	0.72	0.31	0.02	**0.00**	0.54	**0.00**	**0.00**	**0.00**	-
MetRHPAR (EFIplus)	0.03	0.71	0.75	0.62	0.35	0.72	0.11	0.67	0.86	-
MetLITH (EFIplus)	0.09	0.25	0.49	0.35	0.14	0.82	0.06	0.11	0.12	-
EFIplus Index	0.08	0.42	0.61	0.05	0.01	0.69	**0.00**	0.31	0.41	-
EFIplus Class	0.18	0.72	0.68	0.05	0.03	0.77	**0.00**	0.28	0.14	-

	group 1: 0 - 10 % water abstraction group 2: > 10 % water abstraction									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	0.78	0.51	0.90	0.06	**0.00**	**0.00**	0.26	**0.00**	0.15	**0.00**
Density_sp_all	0.67	**0.01**	**0.00**	**0.01**	0.03	**0.01**	**0.00**	0.91	**0.00**	0.12
Biom_sp_all	0.78	0.29	0.13	0.33	0.77	0.89	0.12	0.15	**0.00**	**0.00**
kg_ha_Repro_LITH	0.73	0.36	0.24	0.53	0.09	0.08	0.63	**0.00**	**0.00**	**0.00**
perc_kgha_Repro_LITH	0.21	0.29	0.18	**0.00**	**0.00**	**0.00**	0.01	**0.00**	**0.00**	**0.00**
n_ha_Repro_LITH	0.74	0.02	0.02	0.61	0.68	0.79	0.17	**0.01**	**0.00**	**0.00**
perc_nha_Repro_LITH	0.68	0.99	0.77	**0.00**	**0.00**	**0.00**	0.15	0.02	**0.00**	**0.00**
n_sp_Repro_LITH	0.36	0.43	0.95	0.20	0.22	0.75	0.39	0.51	**0.00**	0.31
perc_sp_Repro_LITH	0.51	0.29	0.39	**0.00**	**0.00**	**0.00**	0.14	**0.00**	**0.00**	**0.00**
kg_ha_Atroph_OMNI	0.25	0.23	0.98	0.03	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**
perc_kgha_Atroph_OMNI	0.63	0.35	0.87	**0.01**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**
n_ha_Atroph_OMNI	0.49	0.47	0.64	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
perc_nha_Atroph_OMNI	0.65	0.32	0.89	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
n_sp_Atroph_OMNI	0.63	0.48	0.72	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**
perc_sp_Atroph_OMNI	0.61	0.41	0.83	0.01	**0.00**	**0.00**	0.02	**0.00**	**0.00**	**0.00**
kg_ha_Mig_POTAD	0.63	0.30	0.15	0.78	0.59	0.53	0.35	0.02	**0.00**	**0.00**
perc_kgha_Mig_POTAD	0.30	0.81	0.57	**0.00**	**0.00**	**0.00**	0.02	**0.01**	**0.00**	**0.00**
n_ha_Mig_POTAD	0.47	**0.00**	**0.00**	0.07	0.31	0.12	0.04	0.51	**0.00**	0.01
perc_nha_Mig_POTAD	0.83	0.55	0.70	0.05	**0.00**	**0.00**	0.06	0.54	**0.00**	**0.01**
n_sp_Mig_POTAD	0.51	0.20	0.73	0.58	0.17	0.18	0.81	**0.00**	**0.00**	0.02
perc_sp_Mig_POTAD	0.80	0.72	0.82	0.02	**0.00**	**0.00**	0.01	0.01	**0.00**	**0.00**
kg_ha_Hab_RH	0.66	0.35	0.23	0.58	0.10	0.09	0.53	**0.00**	**0.00**	**0.00**
perc_kgha_Hab_RH	0.07	0.19	0.02	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	**0.00**
n_ha_Hab_RH	0.66	0.02	0.02	0.38	0.95	0.58	0.06	0.01	**0.00**	**0.00**
perc_nha_Hab_RH	0.02	0.11	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
n_sp_Hab_RH	0.21	0.40	0.76	0.27	0.56	0.41	0.22	0.84	**0.00**	0.13
perc_sp_Hab_RH	0.06	0.19	0.02	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	**0.00**
P-INSE (EFI)	0.09	**0.00**	**0.00**	0.82	0.12	**0.00**	0.88	0.70	0.11	0.31
P-OMNI (EFI)	0.10	0.13	0.36	0.15	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**
P-PHYT (EFI)	0.86	0.87	0.92	0.01	**0.00**	**0.00**	0.36	0.28	**0.00**	0.96
P-BENT (EFI)	0.25	0.83	0.69	0.02	**0.00**	**0.00**	0.02	0.02	**0.00**	**0.00**
P-RHEO (EFI)	0.27	0.81	0.79	0.20	0.81	0.38	0.33	0.91	0.33	0.18
P-LONG (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.05	**0.01**	**0.00**	0.10	**0.00**
P-POTA (EFI)	0.66	0.95	0.49	0.65	0.48	0.17	0.22	0.50	0.46	0.59
P-LITH (EFI)	0.74	0.44	0.41	**0.00**	**0.00**	**0.00**	**0.00**	0.02	**0.00**	0.03
P-INTO (EFI)	0.43	0.52	0.94	0.03	**0.00**	**0.00**	0.02	**0.00**	**0.00**	0.01
P-TOLE (EFI)	0.49	0.36	0.28	**0.00**	**0.00**	**0.00**	0.17	**0.00**	**0.00**	**0.00**
FAME Index	0.38	0.07	0.20	0.05	**0.00**	**0.00**	0.86	0.40	**0.00**	0.94
MetHINTOL150 (EFIplus)	0.52	0.73	0.91	0.18	0.08	0.02	0.44	0.05	**0.01**	0.83
MetO2INTOL (EFIplus)	0.90	0.85	0.37	0.01	**0.00**	**0.00**	**0.01**	0.49	**0.00**	**0.00**
MetRHPAR (EFIplus)	0.03	0.19	0.23	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
MetLITH (EFIplus)	0.09	0.02	0.03	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
EFIplus Index	0.08	0.19	0.16	**0.00**	**0.00**	**0.00**	0.02	**0.00**	**0.00**	**0.00**
EFIplus Class	0.18	0.42	0.33	**0.00**	**0.00**	**0.00**	0.11	**0.00**	**0.00**	**0.01**

Table F.10: Mann-Whitney for water abstraction (significance) (part 2)

	III Mann-Whitney: water abstraction group 1: 0 - 20 % water abstraction group 2: > 20 % water abstraction										IV Mann-Whitney: water abstraction group 1: 0 - 30 % water abstraction group 2: > 30 % water abstraction									
	local	250	500	2500	5000	25000	SA	fishr	DU	catch	local	250	500	2500	5000	25000	SA	fishr	DU	catch
N_sp_all	0.78	0.61	0.74	0.18	0.56	**0.00**	0.29	0.97	0.07	**0.00**	0.78	0.47	0.96	0.53	0.20	0.02	0.44	0.25	0.04	**0.00**
Density_sp_all	0.67	0.08	**0.00**	**0.00**	**0.00**	**0.00**	0.03	**0.00**	**0.00**	0.56	0.67	0.22	0.02	**0.00**	**0.00**	**0.00**	0.24	**0.00**	**0.01**	0.56
Biom_sp_all	0.78	0.46	0.27	0.04	**0.00**	**0.00**	0.11	0.13	**0.00**	0.17	0.78	0.97	0.48	**0.00**	**0.00**	**0.01**	0.12	0.63	0.16	0.17
kg_ha_Repro_LITH	0.73	0.57	0.60	0.64	0.07	**0.00**	0.45	0.90	**0.00**	0.30	0.73	0.55	0.88	0.05	0.01	0.04	0.32	0.60	0.37	0.30
perc_kgha_Repro_LITH	0.21	0.21	0.02	**0.00**	0.03	**0.00**	**0.00**	0.04	**0.00**	0.04	0.21	0.10	0.09	**0.00**	0.16	**0.00**	0.08	0.02	**0.00**	0.04
n_ha_Repro_LITH	0.74	0.21	0.05	0.07	**0.00**	**0.00**	0.36	0.06	**0.00**	0.97	0.74	0.78	0.17	**0.00**	**0.00**	0.03	0.72	**0.00**	0.06	0.97
perc_nha_Repro_LITH	0.68	0.62	0.22	**0.00**	0.04	**0.00**	0.01	0.30	**0.00**	0.01	0.68	0.42	0.55	**0.00**	0.03	**0.00**	0.16	0.46	**0.00**	0.01
n_sp_Repro_LITH	0.36	0.35	0.10	0.23	0.05	0.06	0.57	**0.01**	0.64	**0.01**	0.36	0.03	0.19	0.12	0.83	0.20	0.82	**0.00**	0.37	**0.01**
perc_sp_Repro_LITH	0.51	0.17	0.02	**0.00**	**0.00**	**0.00**	0.10	**0.00**	**0.01**	**0.01**	0.51	0.11	0.05	**0.00**	0.03	**0.00**	0.36	**0.00**	**0.01**	**0.01**
kg_ha_Atroph_OMNI	0.25	0.16	0.87	0.02	0.08	**0.00**	0.02	0.28	**0.00**	0.12	0.25	0.36	0.97	0.67	0.02	**0.00**	0.09	**0.00**	0.02	0.12
perc_kgha_Atroph_OMNI	0.63	0.31	0.80	**0.01**	0.04	**0.00**	0.02	0.69	**0.01**	0.12	0.63	0.85	0.54	0.33	**0.01**	**0.01**	0.07	0.04	0.03	0.12
n_ha_Atroph_OMNI	0.49	0.36	0.80	**0.01**	0.01	**0.00**	0.02	0.87	**0.00**	0.11	0.49	0.65	0.61	0.27	**0.01**	**0.01**	0.09	0.17	0.03	0.11
perc_nha_Atroph_OMNI	0.65	0.34	0.97	**0.01**	0.05	**0.00**	0.02	0.68	**0.01**	0.11	0.65	0.82	0.55	0.22	**0.01**	0.01	0.07	0.05	0.05	0.11
n_sp_Atroph_OMNI	0.63	0.49	0.73	0.01	0.09	**0.00**	0.01	0.89	**0.01**	0.11	0.63	0.89	0.53	0.24	0.02	0.01	0.06	0.34	0.04	0.11
perc_sp_Atroph_OMNI	0.61	0.41	0.83	0.02	0.20	**0.00**	0.03	0.71	**0.01**	0.11	0.61	0.87	0.53	0.29	0.03	0.01	0.05	0.20	0.06	0.11
kg_ha_Mig_POTAD	0.63	0.47	0.33	0.19	**0.01**	**0.00**	0.31	0.35	**0.00**	0.26	0.63	0.96	0.55	0.01	**0.00**	0.02	0.24	0.95	0.26	0.26
perc_kgha_Mig_POTAD	0.30	0.81	0.14	**0.00**	0.16	**0.00**	**0.01**	0.55	0.05	0.09	0.30	0.37	0.27	**0.01**	0.19	0.02	0.15	0.28	0.04	0.09
n_ha_Mig_POTAD	0.47	0.03	**0.00**	**0.00**	**0.00**	**0.00**	0.27	**0.00**	**0.00**	0.98	0.47	0.08	0.01	**0.00**	**0.00**	0.03	0.47	**0.00**	0.05	0.98
perc_nha_Mig_POTAD	0.83	0.58	0.88	0.03	0.21	**0.00**	**0.00**	0.44	**0.00**	0.01	0.83	0.64	0.79	0.04	0.01	**0.00**	0.24	0.34	**0.00**	0.01
n_sp_Mig_POTAD	0.51	0.26	0.14	0.98	0.39	0.02	0.92	0.51	0.35	**0.00**	0.51	0.13	0.35	0.35	0.96	0.13	0.82	**0.00**	0.17	**0.00**
perc_sp_Mig_POTAD	0.80	0.72	0.18	0.03	**0.01**	**0.00**	0.11	0.46	**0.00**	0.10	0.80	0.55	0.31	**0.01**	0.02	**0.01**	0.40	0.03	0.02	0.10
kg_ha_Hab_RH	0.66	0.58	0.65	0.53	0.06	**0.00**	0.39	0.83	**0.00**	0.28	0.66	0.47	0.98	0.03	**0.01**	0.03	0.28	0.66	0.31	0.28
perc_kgha_Hab_RH	0.07	0.05	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	0.23	0.07	**0.00**	**0.00**	**0.00**	**0.00**	0.03	**0.00**	**0.00**	0.03	0.23
n_ha_Hab_RH	0.66	0.17	0.03	0.02	**0.00**	**0.00**	0.11	0.03	**0.00**	0.74	0.66	0.73	0.15	**0.00**	**0.00**	0.01	0.42	**0.00**	0.02	0.74
perc_nha_Hab_RH	0.02	0.01	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.02	0.21	0.02	**0.00**	**0.00**	**0.00**	**0.00**	0.07	**0.00**	**0.00**	0.07	0.21
n_sp_Hab_RH	0.21	0.30	0.10	0.22	0.05	0.01	0.45	**0.00**	0.42	**0.00**	0.21	0.01	0.11	0.17	0.81	0.07	0.63	**0.00**	0.16	**0.00**
perc_sp_Hab_RH	0.06	0.04	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.01	0.19	0.06	**0.00**	**0.00**	**0.00**	**0.00**	0.06	**0.01**	**0.00**	0.06	0.19
P-INSE (EFI)	0.09	0.03	0.02	0.47	0.81	0.10	0.75	**0.00**	0.26	0.82	0.09	0.35	0.05	0.04	0.25	0.81	0.76	**0.00**	0.91	0.82
P-OMNI (EFI)	0.10	0.03	0.63	0.13	0.02	**0.00**	0.30	0.16	**0.00**	0.43	0.10	0.20	0.67	0.80	0.12	0.01	0.90	0.27	**0.01**	0.43
P-PHYT (EFI)	0.86	0.92	0.23	0.12	0.11	0.05	0.73	0.06	0.03	0.06	0.86	0.30	0.78	0.10	0.54	0.36	0.07	**0.00**	0.21	0.06
P-BENT (EFI)	0.25	0.46	0.54	0.07	0.01	**0.00**	0.27	0.31	**0.00**	0.31	0.25	0.61	0.86	0.15	0.09	**0.00**	0.43	0.88	**0.00**	0.31
P-RHEO (EFI)	0.27	0.60	0.68	0.41	0.94	**0.00**	0.89	0.03	**0.00**	0.37	0.27	0.06	0.43	0.98	0.28	**0.00**	0.21	0.12	0.03	0.37
P-LONG (EFI)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.73	0.01	**0.00**	0.79	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	0.04	0.47	0.29	**0.00**	0.72	**0.01**
P-POTA (EFI)	0.66	0.69	0.90	1.00	0.58	**0.00**	0.43	0.48	**0.00**	0.04	0.66	0.34	0.67	0.90	0.21	**0.00**	0.86	**0.00**	0.02	0.04
P-LITH (EFI)	0.74	0.44	0.02	**0.00**	**0.00**	**0.00**	0.22	0.01	**0.00**	0.15	0.74	0.11	0.13	**0.00**	**0.01**	0.01	0.82	**0.00**	0.02	0.15
P-INTO (EFI)	0.43	0.46	0.69	**0.01**	**0.00**	**0.00**	0.53	0.83	**0.00**	0.10	0.43	0.88	0.70	0.17	0.07	**0.00**	0.50	0.23	**0.00**	0.10
P-TOLE (EFI)	0.49	0.20	0.02	**0.00**	**0.00**	0.04	0.21	**0.00**	0.07	0.13	0.49	0.03	0.02	**0.01**	0.49	0.43	1.00	**0.00**	0.33	0.13
FAME Index	0.38	0.22	0.70	0.08	0.09	0.37	0.95	0.98	0.99	0.21	0.38	0.89	0.84	0.81	0.87	0.55	0.94	0.05	0.94	0.21
MetHINTOL150 (EFIplus)	0.52	0.52	0.74	0.17	**0.00**	0.69	0.70	0.02	0.27	0.19	0.52	0.42	0.48	0.22	0.23	**0.01**	0.99	0.07	**0.00**	0.19
MetO2INTOL (EFIplus)	0.90	0.58	0.24	0.01	**0.00**	**0.00**	0.05	0.29	**0.00**	0.23	0.90	0.80	0.36	0.06	**0.01**	**0.00**	1.00	0.06	**0.00**	0.23
MetRHPAR (EFIplus)	0.03	0.04	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	-	-	0.03	**0.00**	**0.00**	**0.00**	0.11	-	0.56	**0.01**	-	-
MetLITH (EFIplus)	0.09	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	-	-	0.09	**0.00**	**0.00**	**0.00**	0.06	-	0.76	**0.00**	-	-
EFIplus Index	0.08	0.11	0.03	**0.00**	**0.00**	**0.00**	0.01	**0.00**	0.75	0.85	0.08	**0.00**	0.01	**0.00**	0.02	0.11	0.58	0.03	0.02	0.85