# Visualisation
# of habitat measures
# by means of photo scenarios

**Berit Köhler**
**NINA  Lillehammer**

**EcoManage** project
In cooperation with:
David N. Barton, NINA
Bjørnar Dervo, 3D smia
Hans-Petter Fjeldstad, Ana Adeva Bustos, Peggy Zinke, SINTEF
Svein Haugland, Aleksander Andersen, Agder Energi

## CEDREN
Centre for Environmental Design of Renewable Energy

# EcoManage (2012-2015)


Photo: Edelpix

**Main objective**:

test, evaluate and adapt new concepts & methods for the improved development & management of energy and water resources.

Project lead: Håkon Sundt (SINTEF)

**NINA part**: decision support for habitat restoration and environmental flow measures in regulated rivers
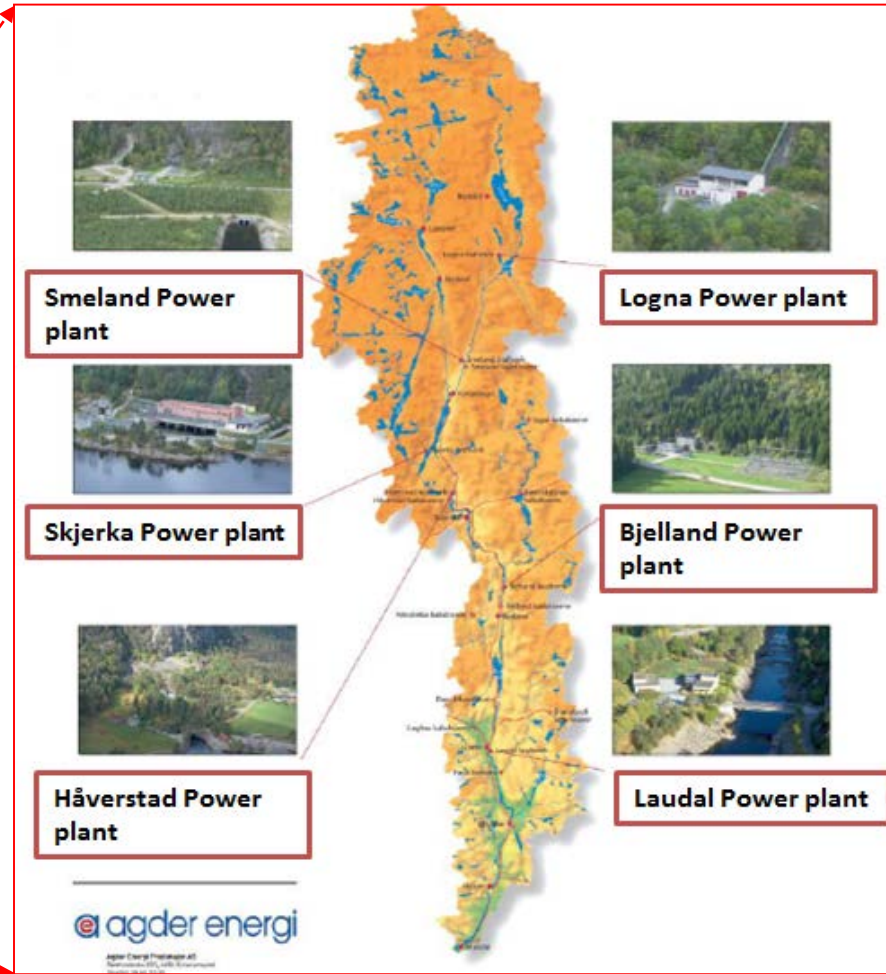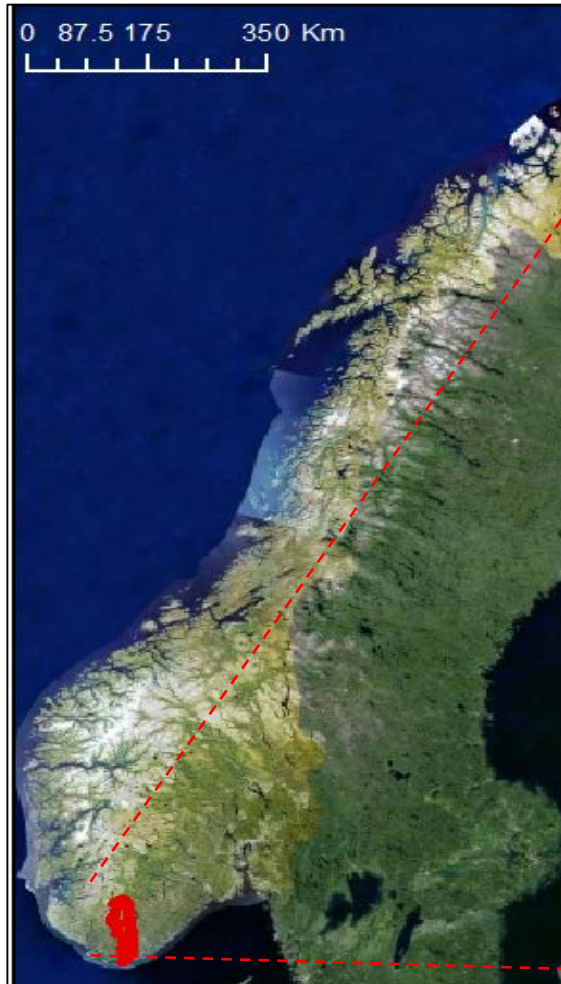
→ method development

Case study: Mandalselva (Laudal/Bjelland)

Project lead NINA part: David N. Barton

# **EcoManage** case study Mandalselva
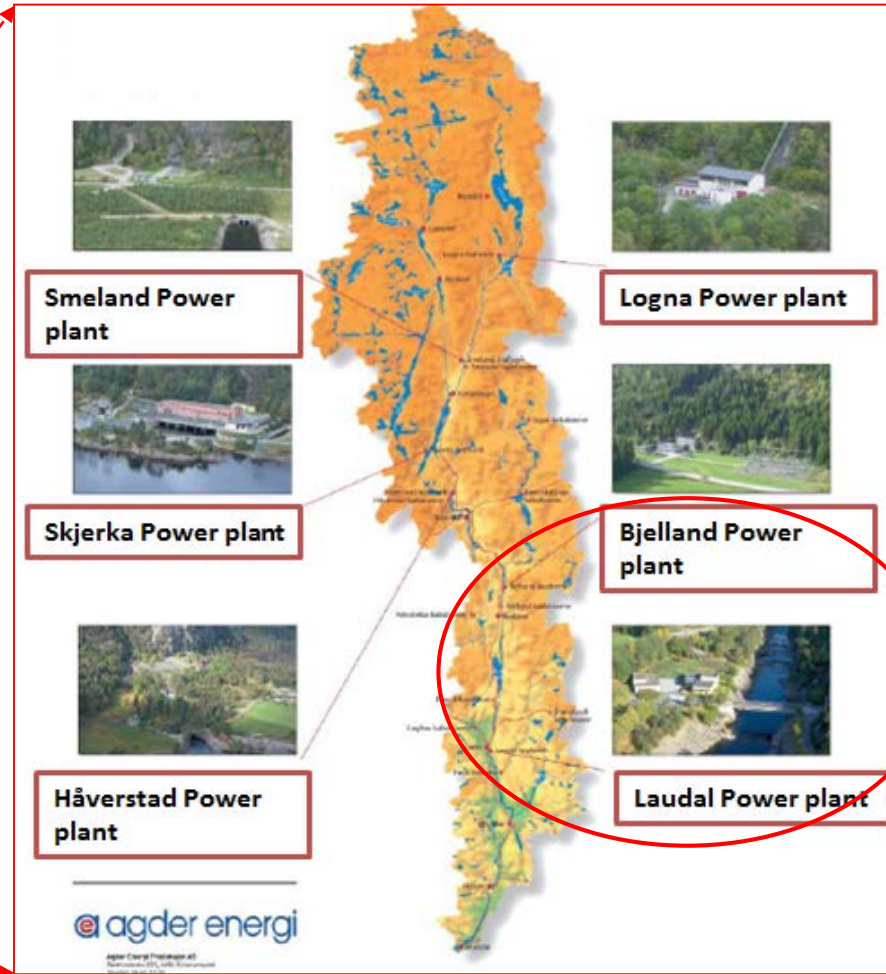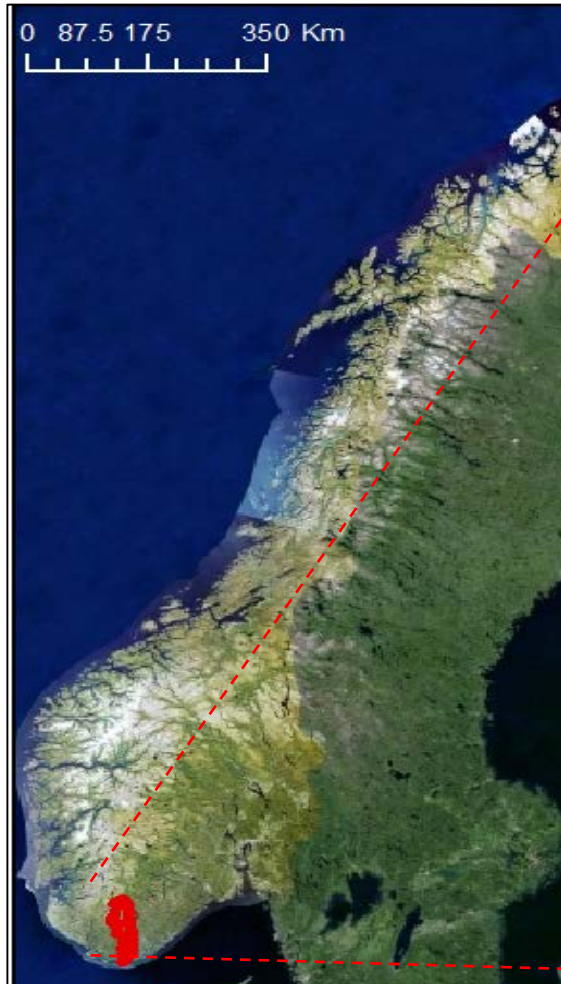
Mandalselva Basin located in Southern Norway

Mandalselva is regulated by 6 power plants (Agder Energi).



Smeland Power plant

Logna Power plant

Skjerka Power plant

Bjelland Power plant

Håverstad Power plant

Laudal Power plant

agder energi

# EcoManage case study Mandalselva

Mandalselva Basin located in Southern Norway

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Smeland Power plant

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agder energi

# EcoManage case study Mandalselva

**Laudal HPP**
1977: License
1981: In operation
**No salmon production**

↓

1997: Liming program re-stocking strategy

↓

2001: 11 tons of salmon
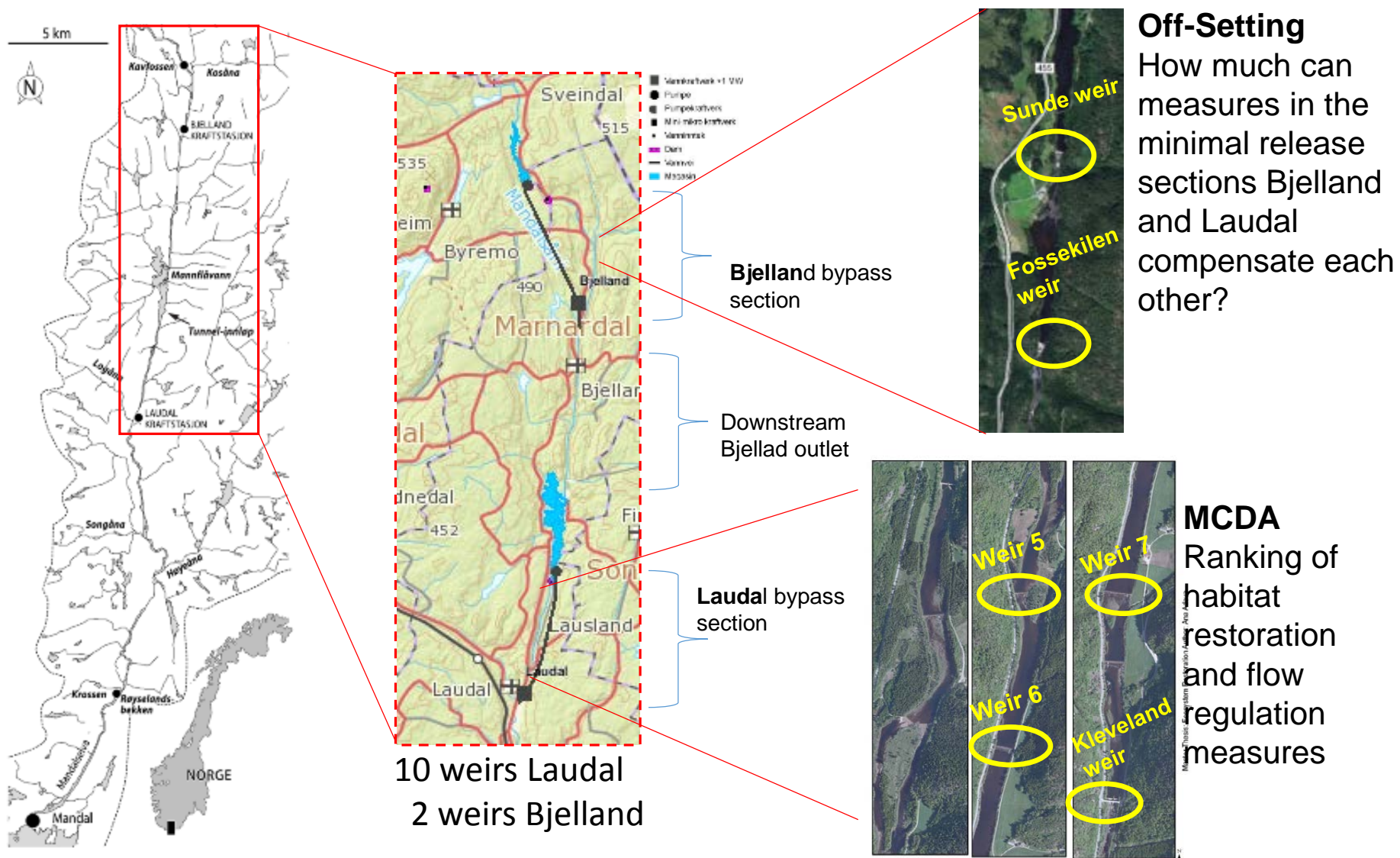**Salmon production back**



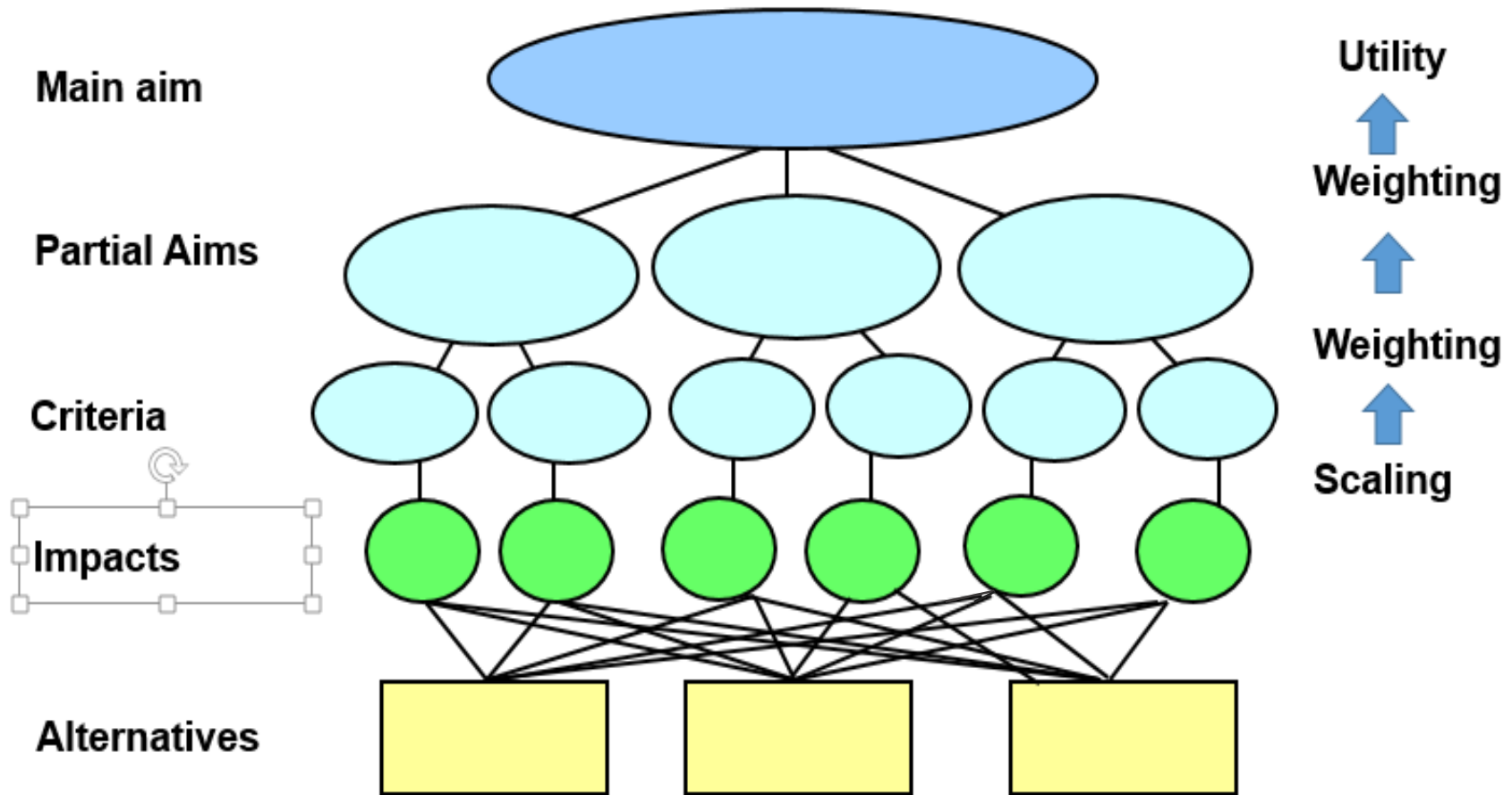Until 2012
- 1.5 $m^3s^{-1}$ in winter
- 3 $m^3s^{-1}$ in summer

↓

NVE suggestion:
- 6 $m^3s^{-1}$ in winter
- spill during smolt migration
- 8-25 $m^3s^{-1}$ summer
- 5 years trial period (2013-2017)

# **EcoManage** Method development for MCDA support



5 km

10 weirs Laudal
2 weirs Bjelland

**Bjelland** bypass section

Downstream Bjellad outlet

**Laudal** bypass section

**Off-Setting**
How much can measures in the minimal release sections Bjelland and Laudal compensate each other?

Sunde weir

Fossekilen weir

**MCDA**
Ranking of habitat restoration and flow regulation measures

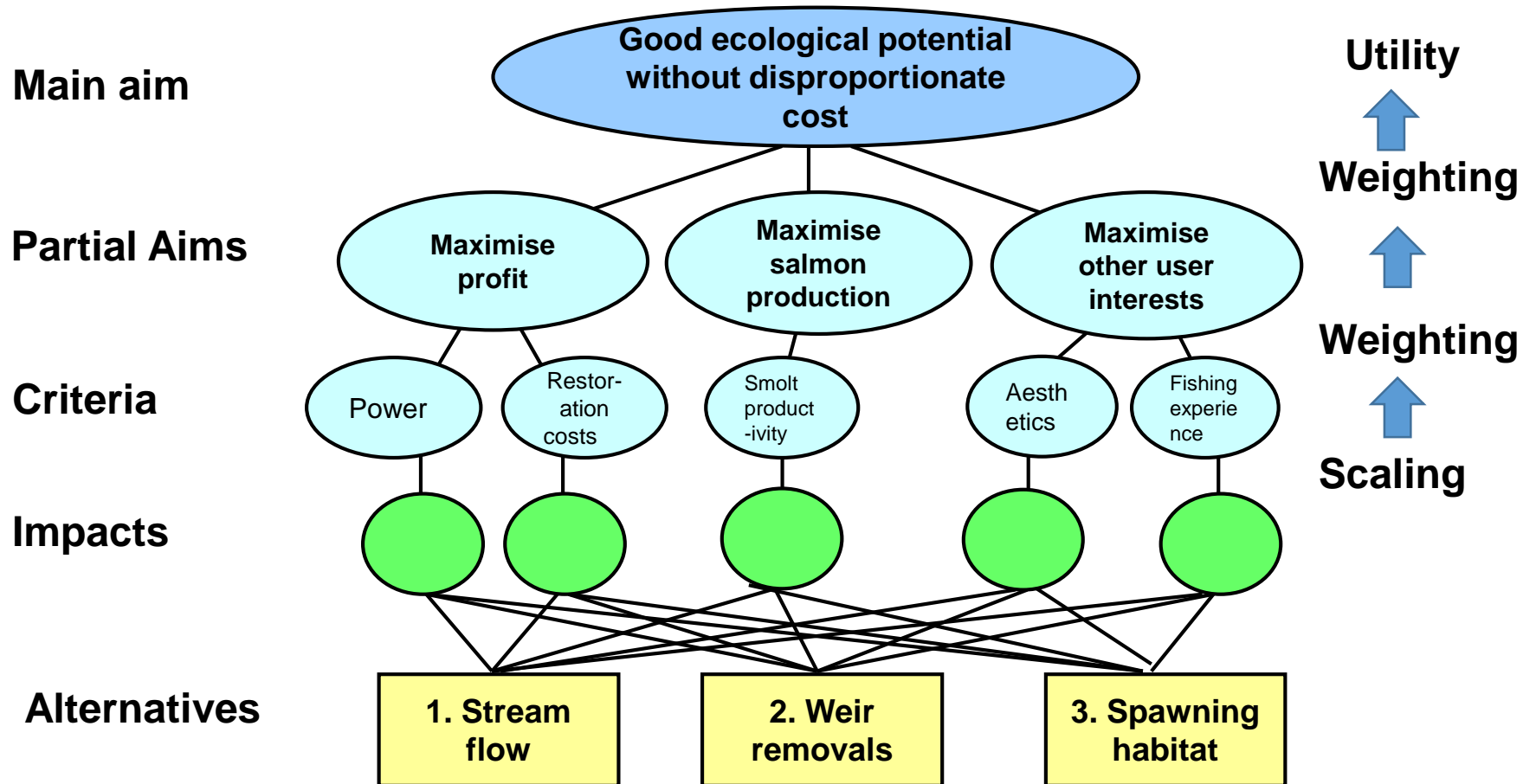Weir 5

Weir 7

Weir 6

Kleveland weir

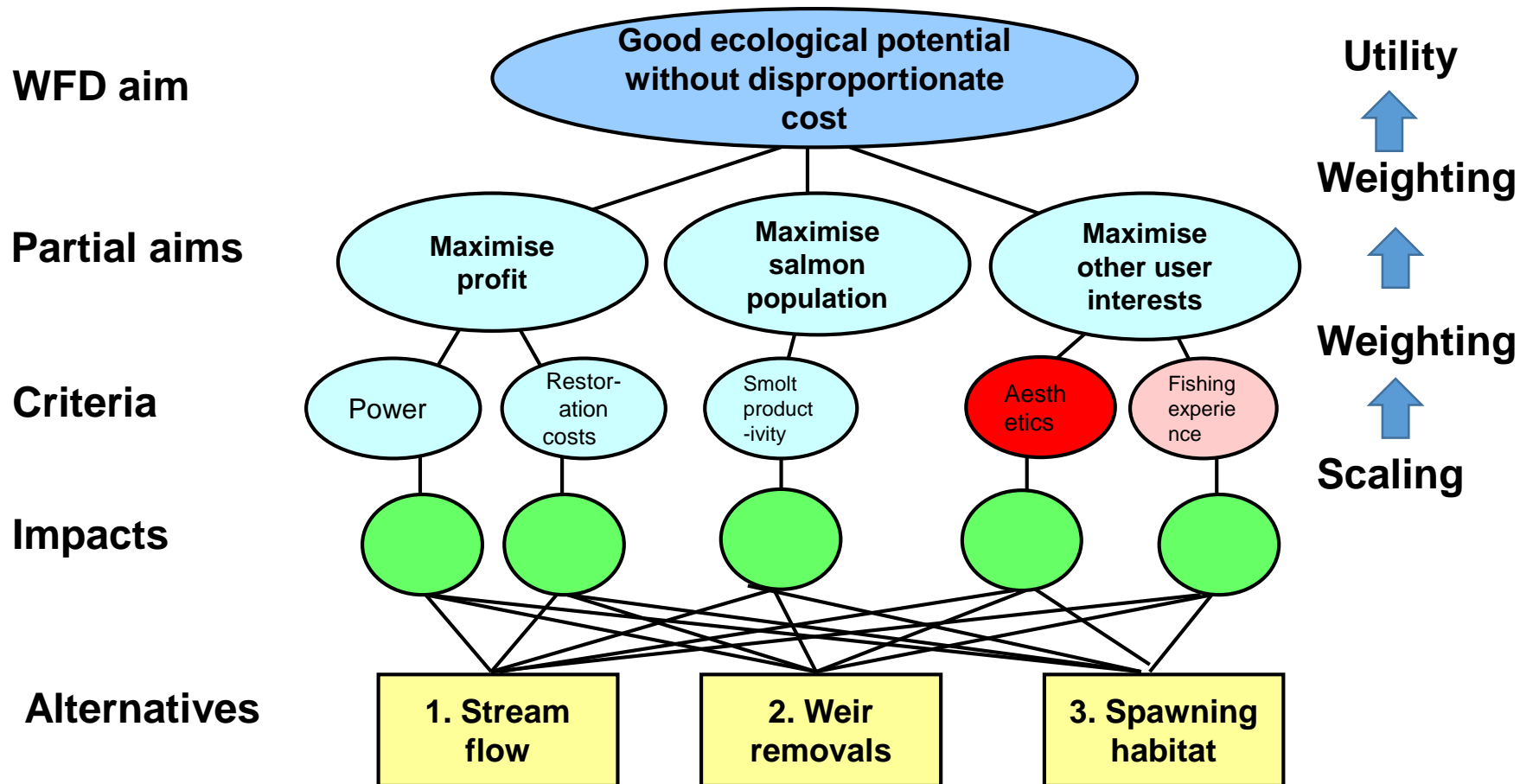# Multi-criteria decision analysis (MCDA)



MCDA: Systematic structuring of decisions in a hierarchy of aims, criteria & alternatives

# EcoManage: Multi-criteria decision analysis for Mandalselva



**Main aim** — Good ecological potential without disproportionate cost

**Partial Aims** — Maximise profit · Maximise salmon production · Maximise other user interests

**Criteria** — Power · Restor-ation costs · Smolt product-ivity · Aesthetics · Fishing experience

**Impacts**

**Alternatives** — 1. Stream flow · 2. Weir removals · 3. Spawning habitat

Utility ↑ Weighting ↑ Weighting ↑ Scaling

# EcoManage: Photo scenario development for Mandalselva

measure stakeholder preferences

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# Photo scenario method



- Aesthetic preferences as visual evaluation of sites

- No detour of evaluation through textual description or maps of sites

- Series of computerized visual simulations of scenarios depicting concrete management alternatives for the status quo situation in a standardized way

# Example from Swiss study on river restoration

**representative photo test survey of attitudes towards river restoration**

computer-aided editing of one basis-photo

ecological integrity measured by eco-morphological quality

here: classification according to Swiss Module-Step Concept (MSC),

　　　and expert validation

use in a Switzerland-wide representative survey



no restoration

MSC-Level: 1

lowest rest. effort

MSC-Level: 2

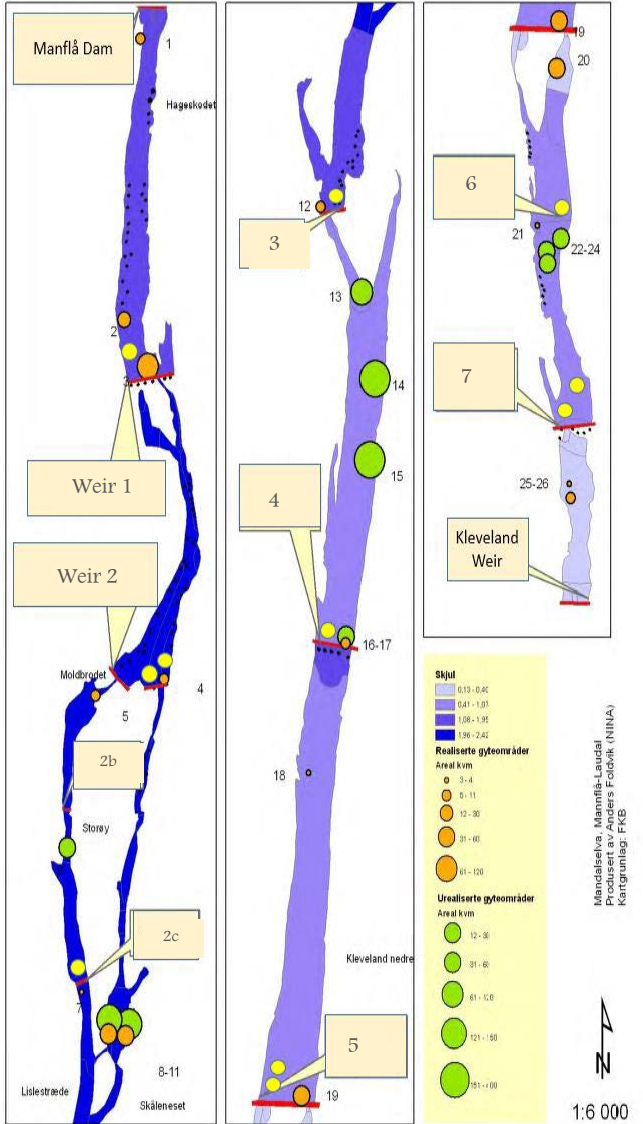medium restoration effort

MSC-Level: 3

considerable rest. effort:

MSC-Level: 4

Junker, B. and Buchecker, M. (2008) «Aesthetic preferences versus ecological objectives in river restorations.» Landscape and Urban Planning 85, 141-154.

# EcoManage: Photo scenario development for Mandalselva

1. step: baseline photos of all 12 existing weirs  (july 2014)

# EcoManage: Photo scenario development for Mandalselva

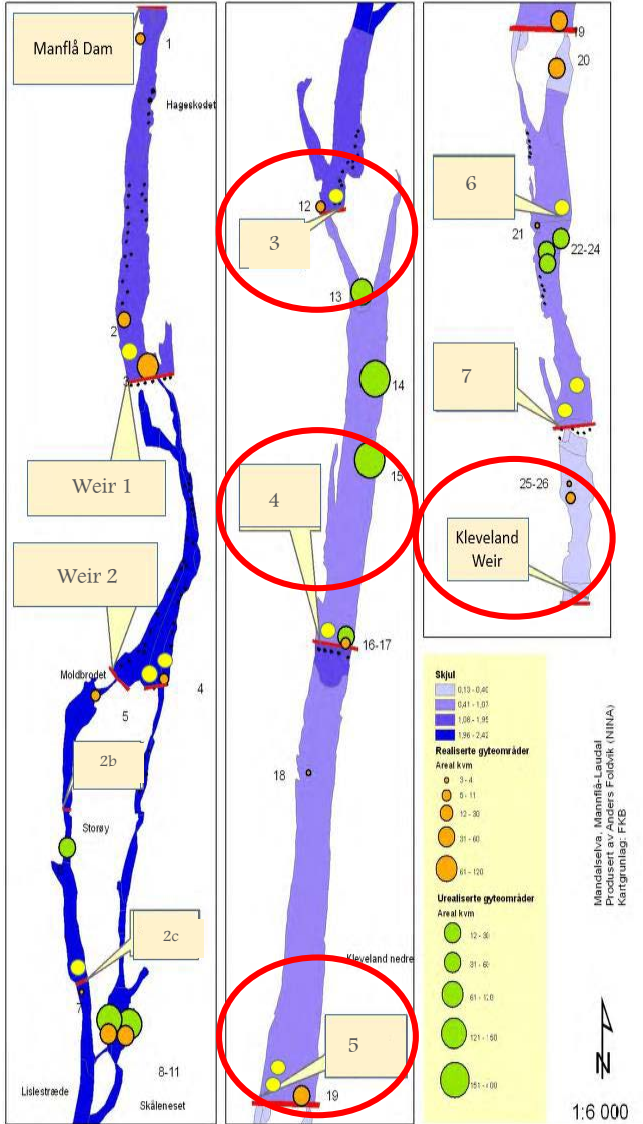1. step: baseline photos in july 2014 of all existing weirs



Photos: Berit Köhler

Standardized: perspective /distance to weirs / angles / weather/light / no people.

# EcoManage: Photo scenario development for Mandalselva



2. step: reduction of sites for scenario development



5 sites:

highest conflict potential

management decisions to become relevant

Photos: Berit Kohler

# EcoManage: Photo scenario development for Mandalselva

3. step: decision on scenario simulation criteria (habitat measures)

| Fossekilen weir | weir 3 | weir 4 | weir 5 | Klevland bru |
|---|---|---|---|---|
| weir | | | | |
|  |  |  |  |  |
| Weir removal $6m^3/s$ discharge | Weir removal $6m^3/s$ discharge | Weir removal $6m^3/s$ discharge | Weir removal $6m^3/s$ discharge | Weir removal $6m^3/s$ discharge |
| Weir removal $3m^3/s$ discharge | Weir removal $3m^3/s$ discharge | Weir removal $3m^3/s$ discharge | Weir removal $3m^3/s$ discharge | Weir removal $3m^3/s$ discharge |
| Weir removal $15m^3/s$ discharge | Weir removal $15m^3/s$ discharge | Weir removal $15m^3/s$ discharge | Weir removal $15m^3/s$ discharge | Weir removal $15m^3/s$ discharge |

# 4. step: photo scenario development

| Habitat measure |
|---|
| Stream flow adjustment (3,6 or 15 m³/s)    Weir removal (yes/no) |

→

| Parameter | Type of inputdata/model used |
|---|---|
| wetted area | Data from field work Miljødesign Mandalselva → HEC-RAS* 1D model & GIS (HEC-GeoRAS) ** |
| water level | Data from field work Miljødesign Mandalselva → HEC-RAS 1D model & GIS (HEC-GeoRAS) ** |
| water velocity water depth | Data from field work Miljødesign Mandalselva → HEC-RAS 1D model & GIS (HEC-GeoRAS) ** |
| → water surface structure light,colour,shadow | Qualitative expert knowledge (Hans-Petter Fjeldstad) |

*HEC-RAS: Hydrologic Engineering Centers
River Analysis System.
**expert knowledge (H-P. Fjeldstad) also used for data gaps

# 4. step: photo scenario development

Changes in wetted area, water velocity and water depth: HEC-GeoRAS modeling
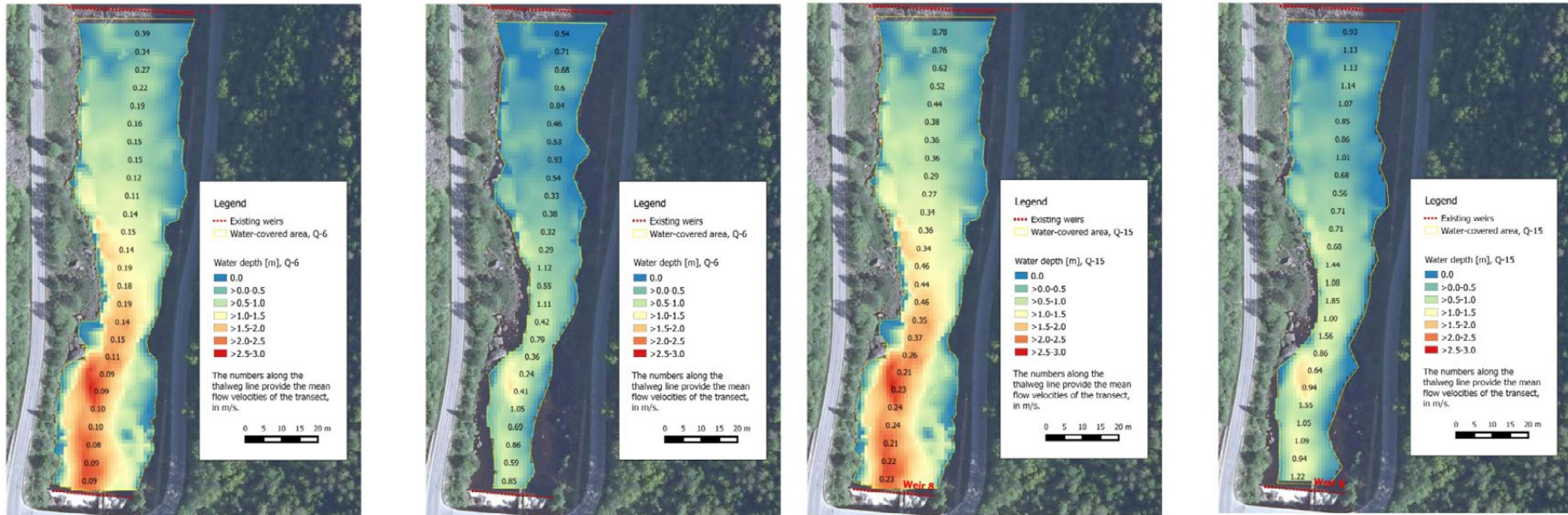


Modeling illustration examples of data input to photo scenario development

Source: H.-P. Fjellstad, P. Zinke, A.A. Bustos, S.E. Gabrielsen: Foreløpig SINTEF Energi AS Rapport TR F7450 (2014): «Fjerning av terskler ved Laudal i Mandalselva»

# 4. step: photo scenario development



|  | **Fossekilen weir** | **weir 3** | **weir 4** | **weir 5** | **Klevland bru weir** |

original 6 m³/s*

w/o weir 6 m³/s

w/o weir 3 m³/s

w/o weir 15 m³/s

* The original discharge was 2 m³/s; 6 m³/s scenario exists

Scenarios: Bjørnar Dervo, 3D smia

Klevland bru
original, with weir
6 m³/s

Photo: Berit Kohler

Klevland bru
without weir
6 m³/s

Scenario: 3D smia

Klevland bru
without weir
3 m³/s

Scenario: 3D smia

Klevland bru
without weir
15 m³/s

Scenario: 3D smia

Weir 5
original, with weir
6 m³/s

Photo: Berit Kohler

Weir 5
without weir
6 m³/s

Scenario: 3D smia

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Weir 5
without weir
3 m³/s

Scenario: 3D smia

Weir 5
without weir
15 m³/s

Scenario: 3D smia

Fossekilen weir
original, with weir
2 m³/s

Photo: Berit Kohler

Fossekilen weir
without weir
3 m³/s

Scenario: 3D smia

CEDREN  Centre for Environmental Design of Renewable Energy

Fossekilen weir
without weir
6 m³/s

Scenario: 3D smia

CEDREN Centre for Environmental Design of Renewable Energy

Fossekilen weir
without weir
15 m³/s

Scenario: 3D smia

CEDREN Centre for Environmental Design of Renewable Energy

# EcoManage: use of photo scenarios Mandalselva

5. step: application in focus group interviews with local stakeholders

**Best=9**

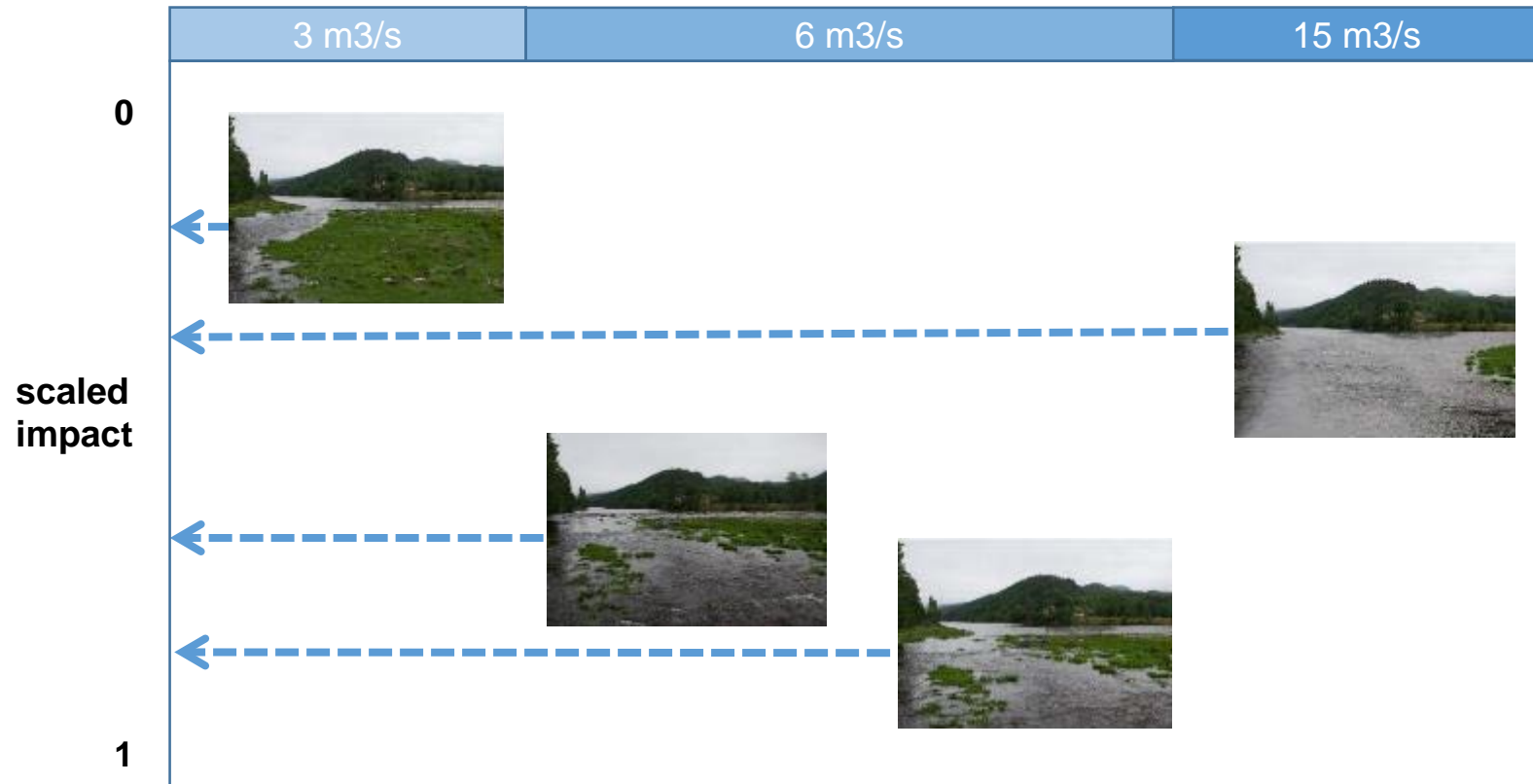| 3 m3/s | 6 m3/s | | 15 m3/s |
|---|---|---|---|



**Worst=1**

**Ex. question: «Please rank the following scenes on a scale from 1 (worst) to 9 (best) according to how attractive they are for you!»**

# **EcoManage:** use of photo scenarios Mandalselva in MCDA

5. step: application in focus group inteviews with local stakeholders



**Q: How do we scale impact in MCDA ?**

# EcoManage: use of photo scenarios Mandalselva in MCDA

Without weir 3m³/s

wetted area = 4,86 m²

With weir 6m³/s

wetted area = 40,33 m²

Without weir 6m³/s

wetted area = 7,77 m²

Without weir 15m³/s

wetted area = 14,67 m²

Interviews stakeholders

**Wetted area** (m² intervals) **input tabel Hugin/BBN**

Scaling 3

| Wetted Area (m2, spring, Laudal) | 2773000 - 2863400 | 2863400 - 2953700 | 2953700 - 3044100 | 3044100 - 3134400 | 3134400 - 3224800 |
|---|---|---|---|---|---|
| 0 - 0.1 | ███ | | | | |
| 0.1 - 0.2 | | ███ | | | |
| 0.2 - 0.3 | | | | | |
| 0.3 - 0.4 | | | | | |
| 0.4 - 0.5 | | | | | |
| 0.5 - 0.6 | | | | | |
| 0.6 - 0.7 | | | | | |
| 0.7 - 0.8 | | | ███ | | |
| 0.8 - 0.9 | | | | ███ | |
| 0.9 - 1 | | | | | ███ |

**scaled impact (0-1)**

Slide adapted from: David N. Barton (work in progress)

Fossekilen weir scenario 6m3/s

**Visualisation of habitat measures by means of photo scenarios**
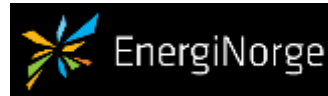
**Thank you!**     **Comments, questions?**

Scenario: 3D smia

# Industrial partners