Introduction to ecological restoration businesses in Korea

- Focusing on river restoration -

August 17, 2022

Korea Environment Corporation

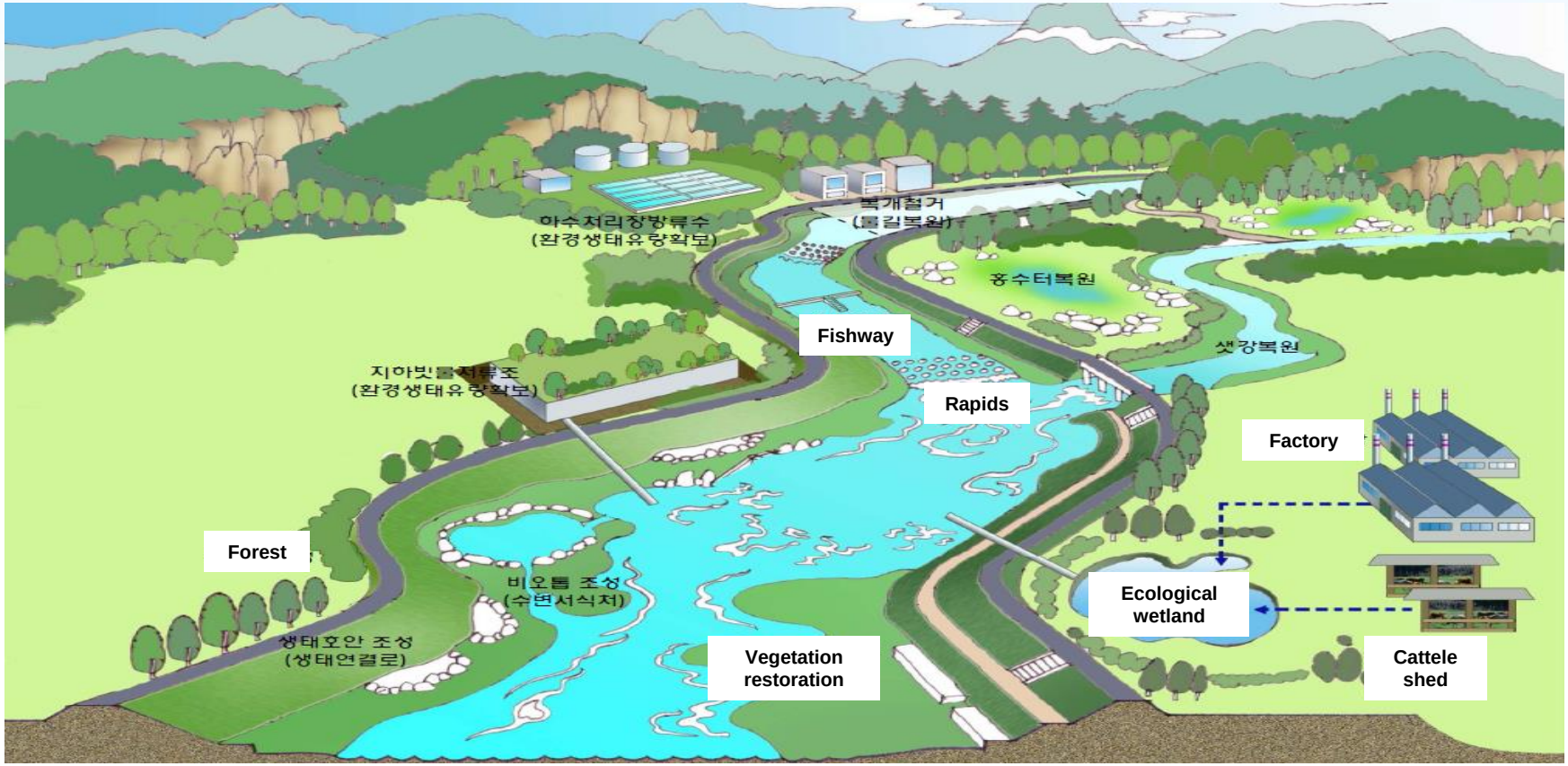
Contents

Background

1. Background

1 Definition of river restoration

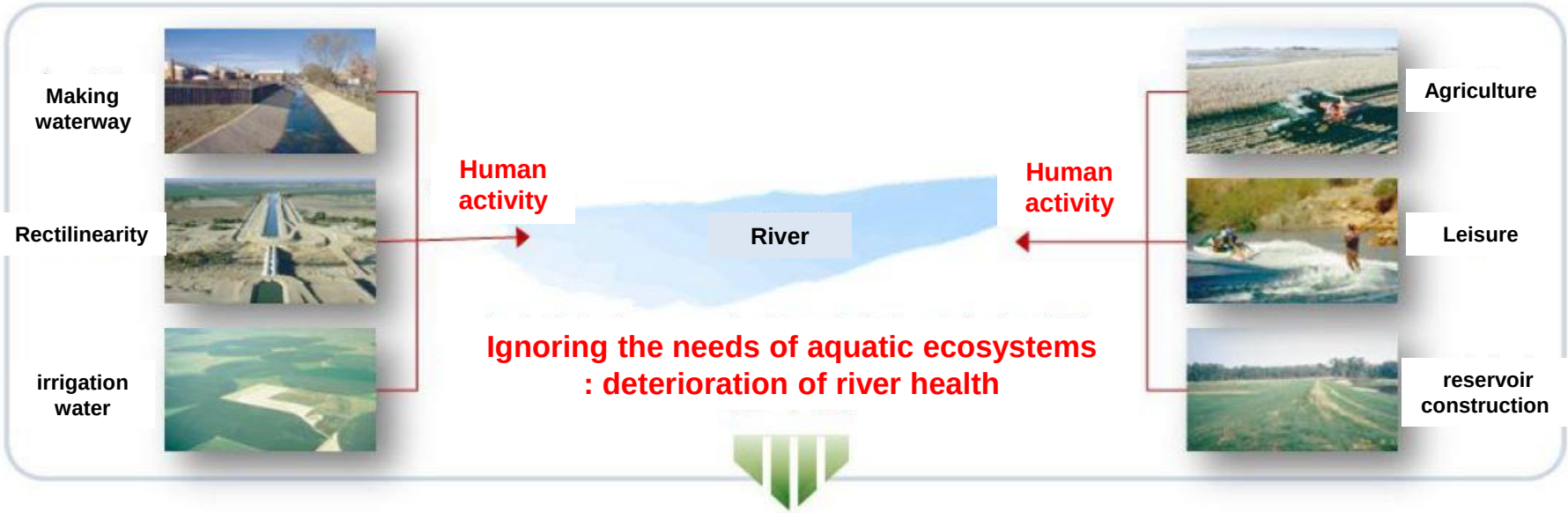
☑ River restoration is a project to restore the water quality of rivers and the health of aquatic ecosystems damaged by water pollution, covering river and Straight river and



2 The Need for Restoration of Ecological Rivers

Decreased river dynamics, decreased water quality, and reduced biological habitat by promoting river management including flood control and river conservation projects centered on human activities

causing environmental problems, Social, cultural and economic value risk



Growing interest in social, economic, environmental sustainability, and ecological health

Change in river management strategy
Restoring the dynamics of rivers

3 Cause of ecological damage - 1

- ☑ Flood control-centered river improvement → straightened concrete revetments & Reduction of Biotic habitat
- ☑ Human-centered use of river → severance of biological connection by installing riverside road & parking lots
- ☑ Fixed crossing structures that ecological path are not considered → servarance of upper-down river

Flood control –centered river improvement

Human-centered use of river

Fixed crossing structures

3 Cause of ecological damage - 2

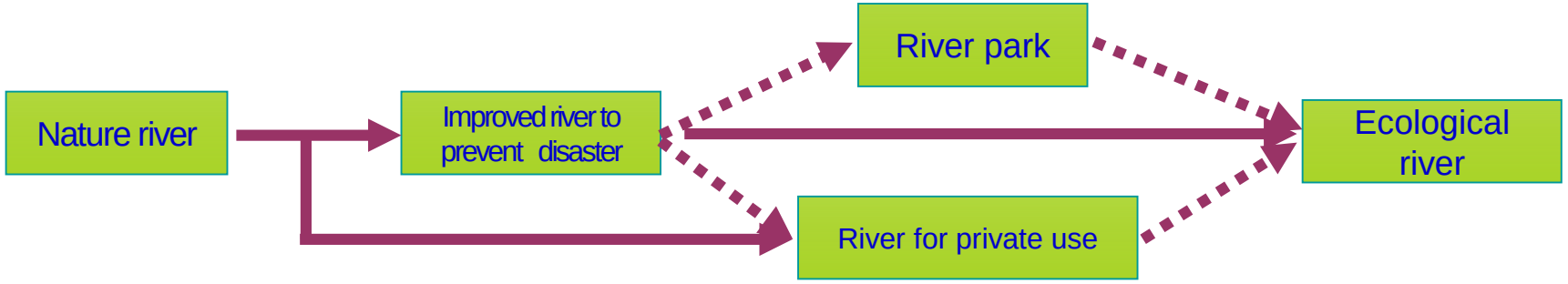
- ☑ Inadequate sewage pipe ➡ inflow of pollutant & decline in the quality of water
- ☑ Expansion of Illegal farmland & impermeability layer ➡ various non point pollution sources
- ☑ Damage of ditch & stream ➡ Water pollution & Set up a poor environment

Inadequate sewage pipes

Expansion of illegal farmland & Impermeability layer

Damage of ditch & stream

4 Changing process of river restoration



5 Aims of river restoration

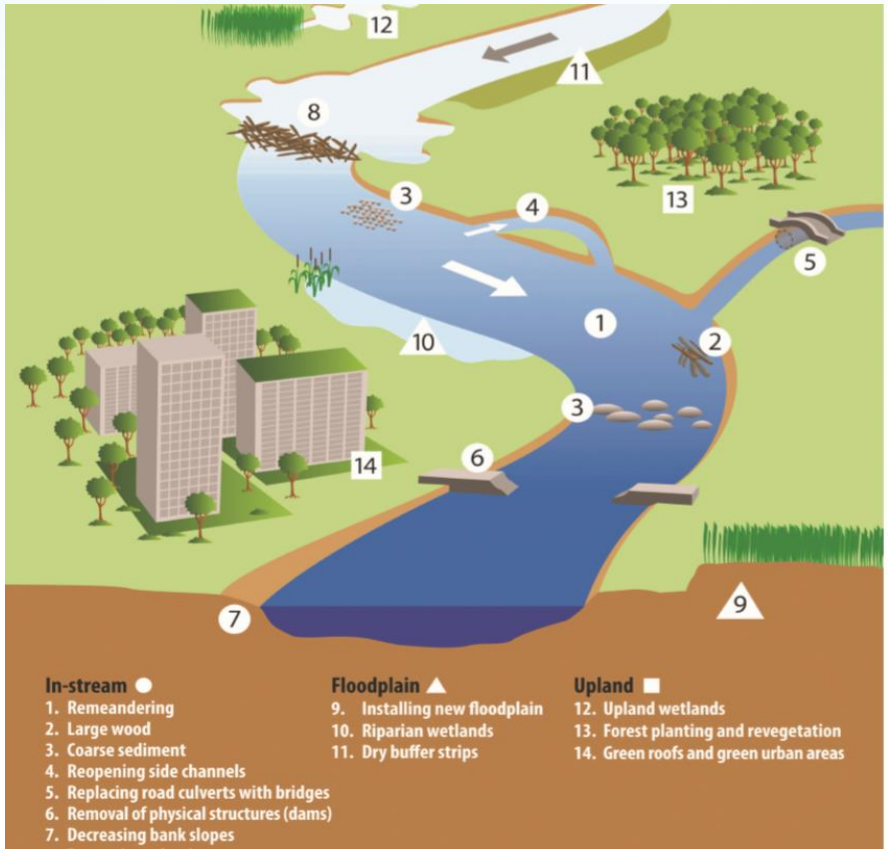
Nature
Learning and imitating nature
Utilization and Conservation

Cycling
water resources, energy regeneration, nutrient cycle

Function
ecology, environmental purification, Flood Reduction

6 Direction of river restoration 1

☑ **Change from linear river restoration in a specific river area to a river restoration based on integrated watershed management**



Direction of river restoration

- ✓ **Integrated river management based on watershed concept**
- ✓ **Restoration of aquatic ecosystem health**
- ✓ **water quality improvement**
- ✓ **Species restoration**
- ✓ **Restoration of waterways in urban rivers and Creation of ecological space**
- ✓ **Consider river characteristics**

6 Direction of river restoration 2

Securing the vertical & horizontal connectivity of ecosystem

source

Tributary

Main River

River mouth

Coast ecosystem

Basin ecosystem ↔ Watershed ↔ River ↔ Watershed ↔ Basin ecosystem

6 Direction of river restoration 3

Carry out Flagship species and ecosystem restoration centered projects

☑ After choosing 'Flagship species' as the indicator of restoration, carry out the projects to restore them


Korean rose bitterling in Tan-Chon


Long-Billed Ring Plover in Pocheon-chon


Otter in Gyeongpo-chon

➡ Flagship Species is the symbol that reflects the ecological, regional and cultural characteristics, they can preserve the other species by conserving and restoring of these species

Implementation system of Flagship species restoration centered projects

☑ Ecosystem research ➡ Flagship species centered planing ➡ Design & build ➡ Continuous monitoring

Figure out damaged ecosystem ➡ carry out ecosystem ➡ restoration projects(feedback management)

6 Direction of river restoration 4

Set up the healthy water cycle system

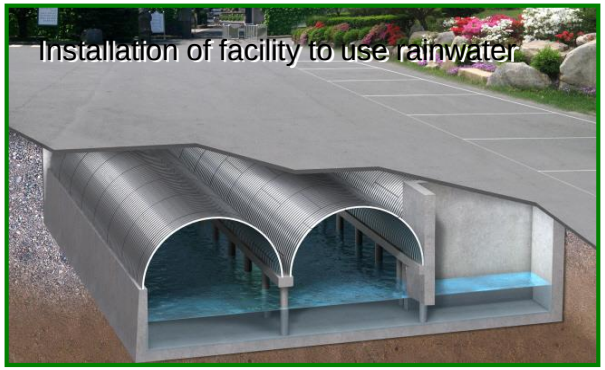
☑ By reusing treated sewage water & rainwater retention and creating brooklet & wetland in downtown, built a living and breathing Eco-city

6 Direction of river restoration 5

Solve the drying rivers & Climate change response

☑ **Securing river maintenance flow and against climate change**

- Introduction of impervious layer index
- Expanding mandatory installation of facility to use rainwater
- Construction of washlands
- Expanding installation of facility to reuse treated water supply



6 Direction of river restoration 6

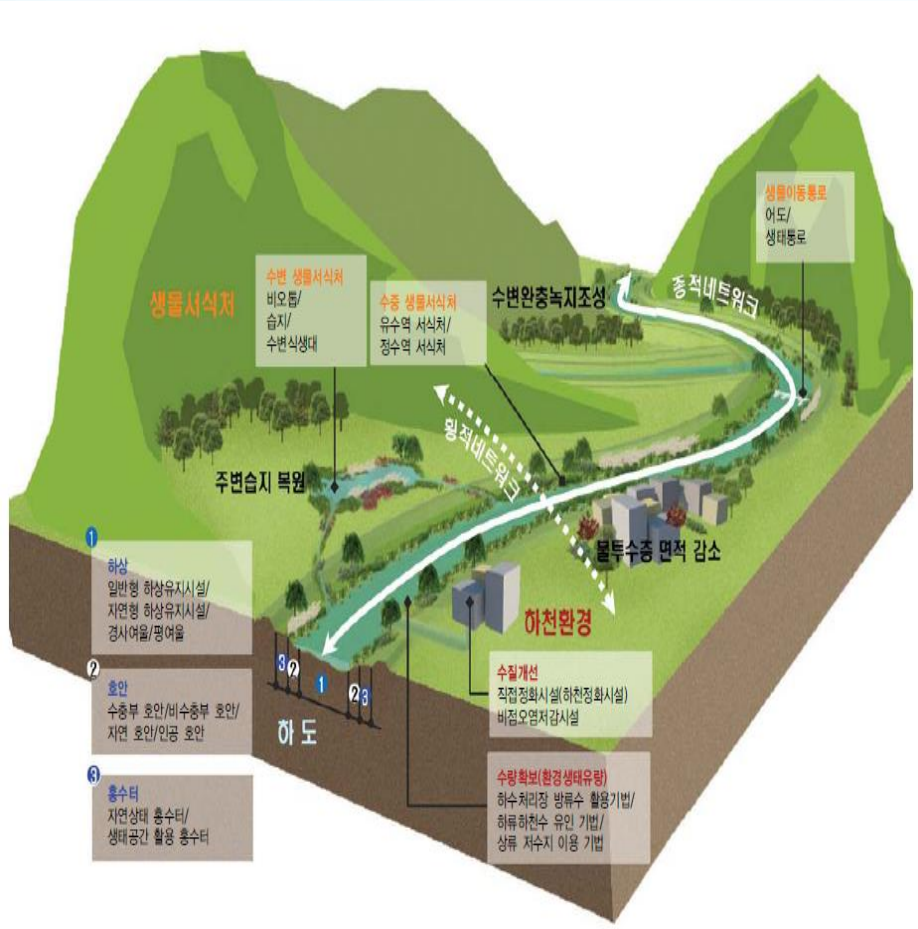
River with the history, culture, ecosystem in harmony

☑ **Developing the regional specialization program associated with history, culture, ecosystem**

- Developing the sustainable culture of river

6 Direction of river restoration 6

☑ **Promotion of projects for water environment improvement and ecological education**



Project details

- ✓ **Physical environment improvement**
  - small dams demolition, etc
- ✓ **water quality improvement**
  - Artificial Wetland Construction
- ✓ **Improving the Health of Aquatic Ecosystems**
  - Flagship species restoration
- ✓ **eco-education**
  - Eco trails construction

Ⅱ Ecological Restoration Project

2. Ecological Restoration Project

1 Project procedure

Implementation from a comprehensive perspective including planning, design, and follow-up management
so that river characteristics can be reflected after setting restoration goals

municipality keco municipality keco municipality keco municipality keco municipality

Planning

Preliminary river survey and Identification of problems

Detailed survey

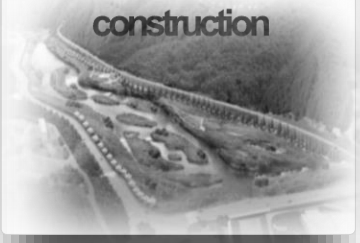
physical, chemical, and biological investigation

Establishment of restoration plan

Comply with the Restoration Concept

Design and construction

Considering natural characteristics, ecosystem base, and appearance after construction

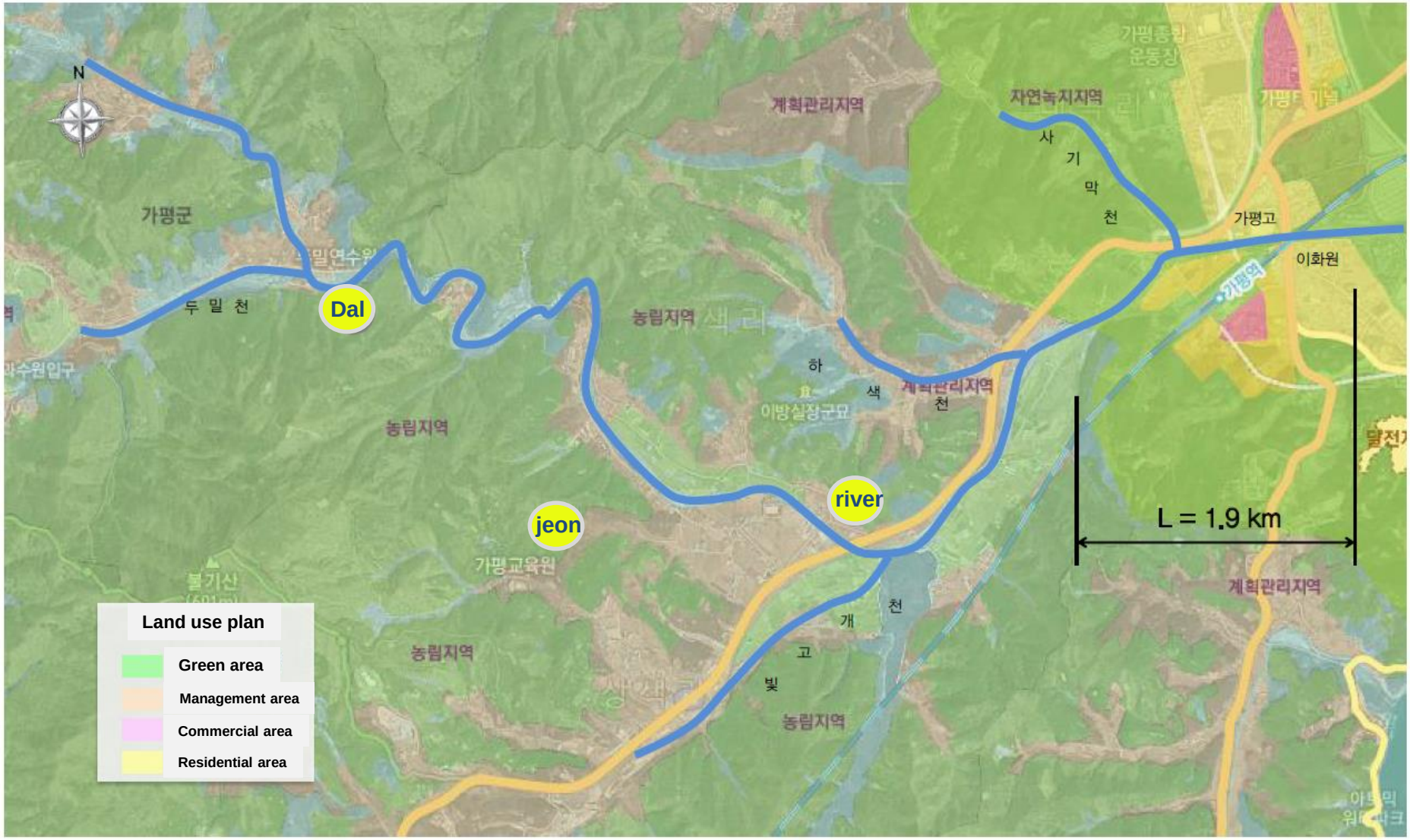


Post-projedcts management

monitoring, management and evaluation

2. Ecological Restoration Project

1 Planning 1 (River & land use current state)



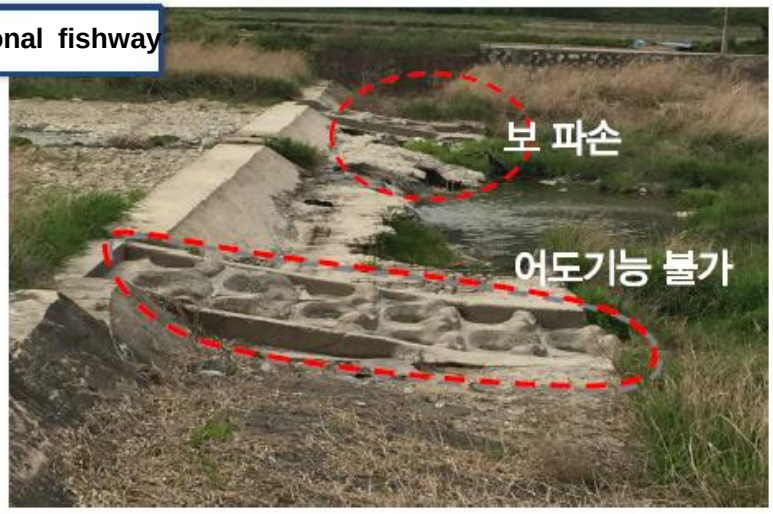
2. Ecological Restoration Project

1 Planning 2 (Preliminary river survey)

Illegal cultivation

disconnection

Unfuntional fishway



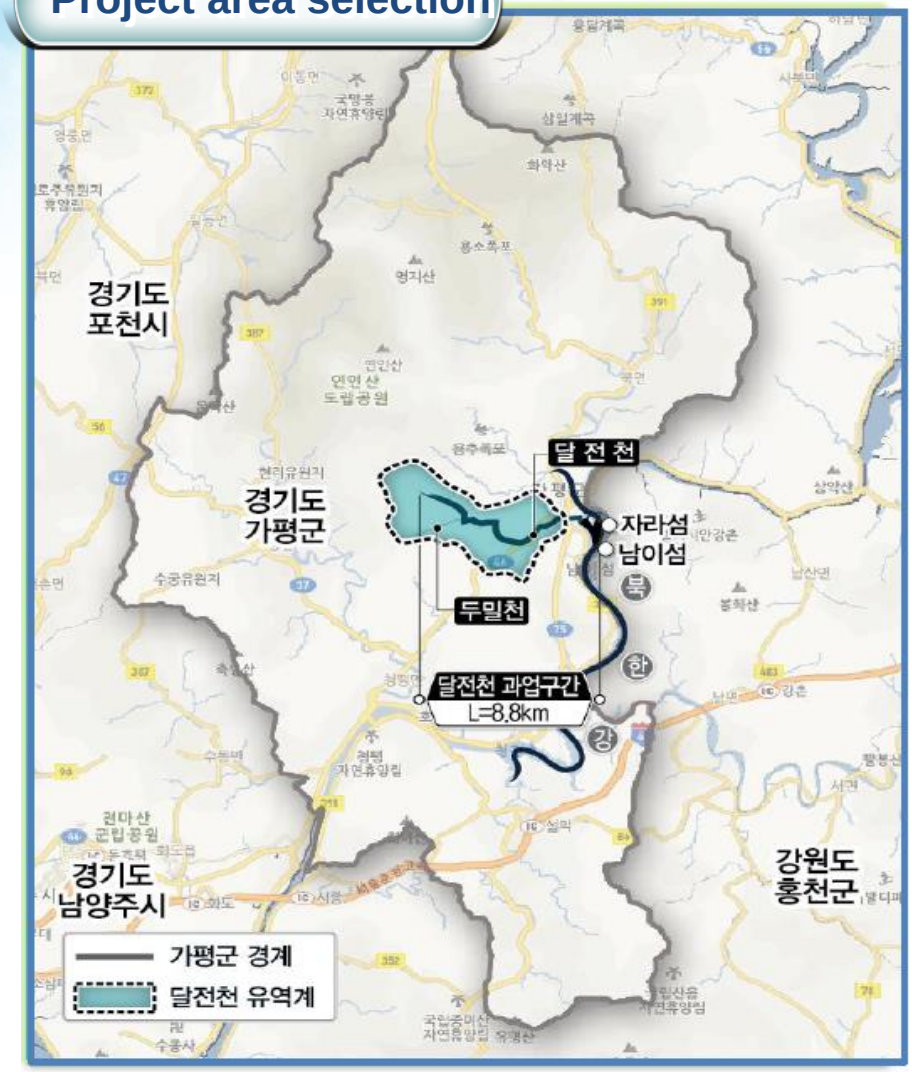
discarded pipes

Ecological River Restoration Required

2. Ecological Restoration Project

1 Planning 3 (Selection of project target site)

Project area selection



Project Purpose

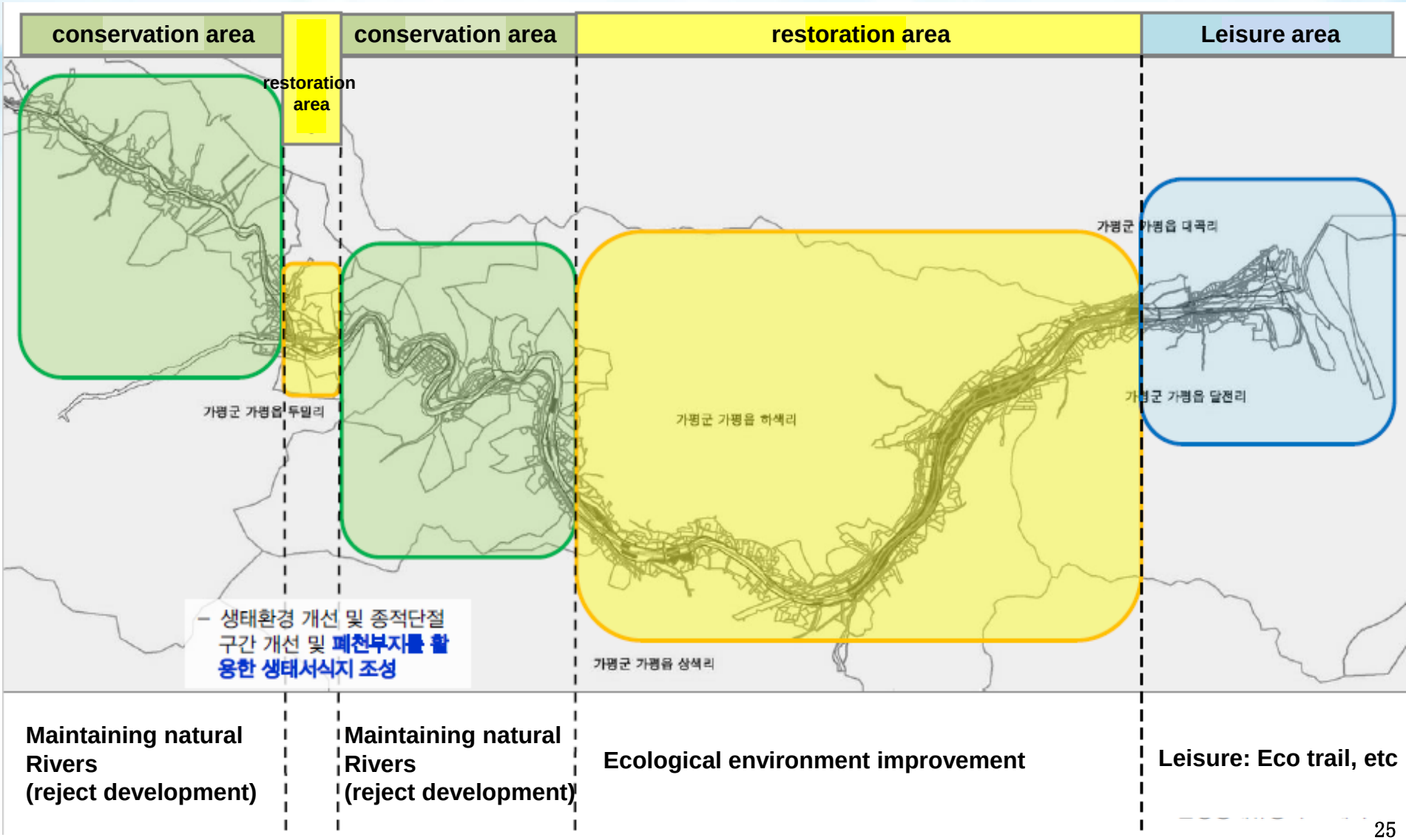
- ☑ **Restoration of water quality and health of aquatic ecosystems**
- ☑ **Securing flow and improving water quality**
- ☑ **Improving the value of cultural infrastructure by preserving the natural ecology and uniqueness of Gapyeong**

Project summary

Name of River	Location		Project Area length (km)	River Length (km)
	Starting point	Ending point		
Dal jeon	Gapyeong	Bukhan river Joining point	8.8	10.8
Project detail	**Habitat Restoration, A small dam improvement Installation of facilities to secure ecological flow**			

2. Ecological Restoration Project

3 Planning 4 (Division of area)



2. Ecological Restoration Project

2 Detailed survey 1

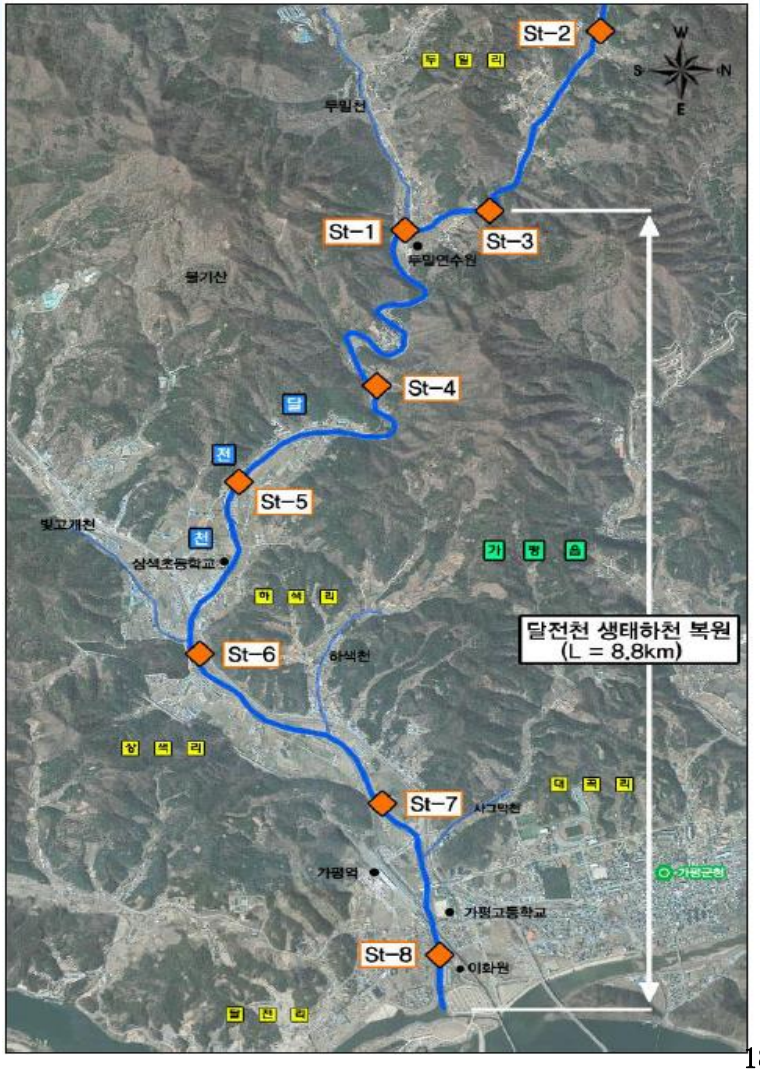
Ecological Survey

※ F(family), S(species)

Divison		Field Survey	Major Species	Protected Species
Flora		74F, 246S	Common reed,	-
Fauna	Mammal	9F, 12S	Elk, Racoon	-
	Bird	27F, 45S	Kestrel (Natural Monument)	
	Herpeto Fauna	5F, 10S	Viper snake	-
	Insect Fauna	21F, 56S	Butterflie,	-
Aquatic Fauna	Fish	4F,10S	Chinese Minnow	-
	Macrobenthic fauna	31F, 57S	Marsh snail,	-
	Benthic Algae	87S	Diatom	-

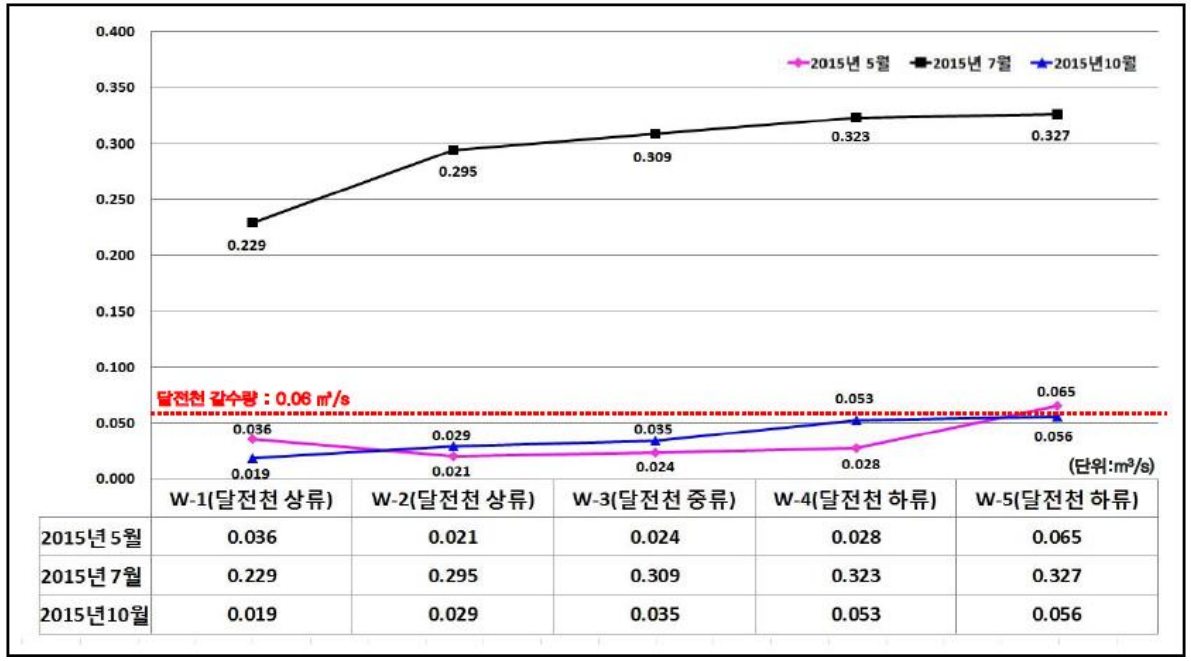
Survey Items	Survey Rating Grades	
Trophic Diatom Index **(TDI)**	67.7 ~ 42.3	A ~ C(best~average)
Benthic Macroinvertebrates Index **(BMI)**	89.2 ~ 64.9	A ~ B(best~good)
Fish Assessment Index **(FAI)**	66.7 ~ 41.7	B ~ C(good~average)
Habitat and Riparian Index **(HRI)**	74.5 ~ 35.5	B ~ C(good~average)

Survey Sites



2 Detailed survey 2

☑ Water quantity research



	W-1(달전천 상류)	W-2(달전천 상류)	W-3(달전천 중류)	W-4(달전천 하류)	W-5(달전천 하류)
2015년 5월	0.036	0.021	0.024	0.028	0.065
2015년 7월	0.229	0.295	0.309	0.323	0.327
2015년10월	0.019	0.029	0.035	0.053	0.056

Bukhangang River intake point - an abundance of water

Omok Bridge area - downstream a shortage of wate

jamsu bridge- keep quantity

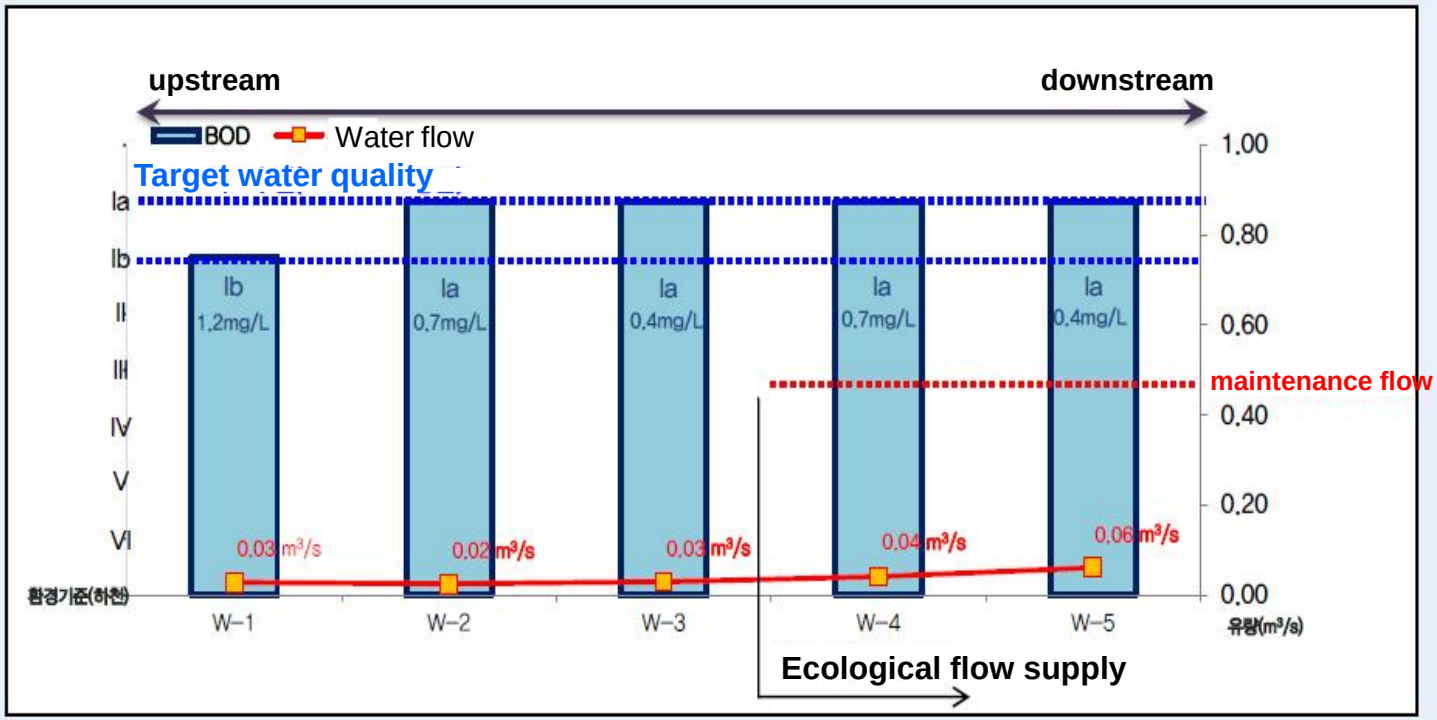
Moomyeong2 dam - keep quantity

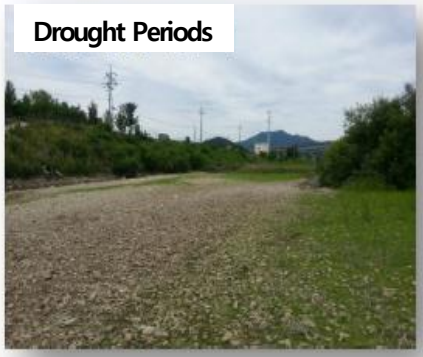
Dalcheon2 Bridge area - keep quantity

2. Ecological Restoration Project

3 Establishment of restoration plan 1 (Data review)

☑ **Water quality is good, but it is necessary to secure ecological flow due to insufficient flow during dry season**





Analysis result & goal

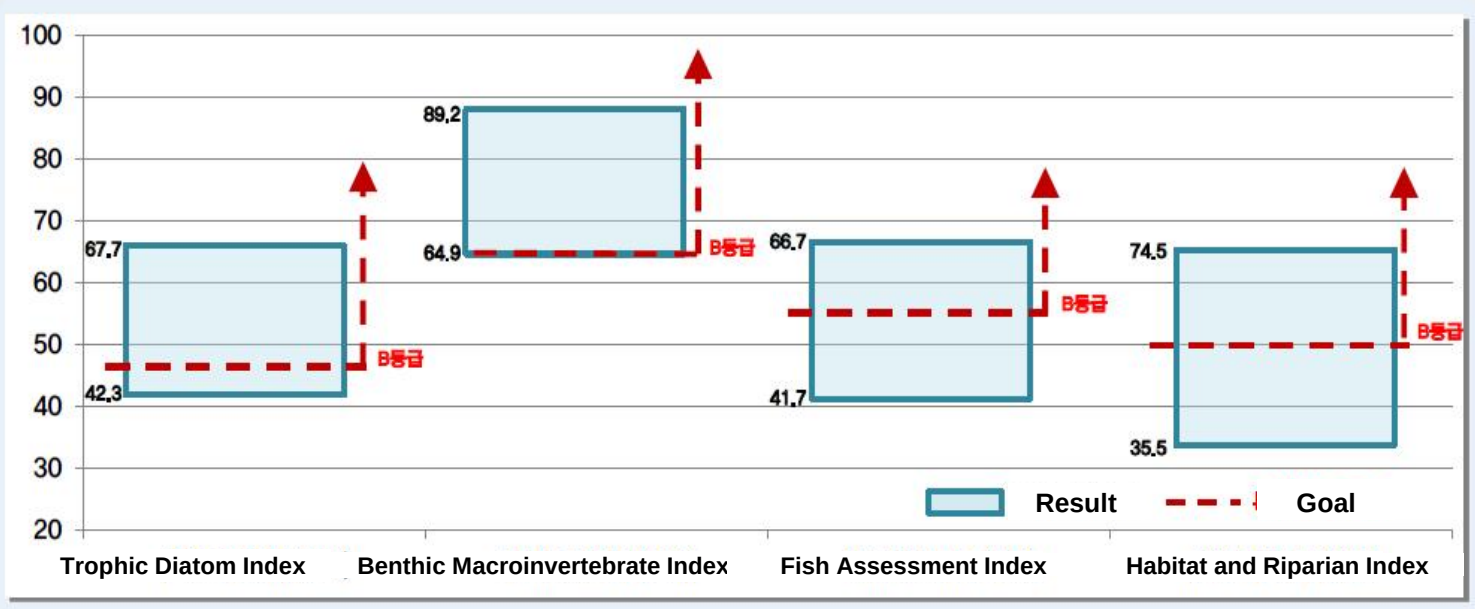
Name	Water quality analysis result		Restoration goal	
	BOD(mg/L)	Rating	BOD(mg/L)	Rating
Daljeon	0.4~1.2	Very good~good	1.0~2.0 ↓	Very good~good

Water flow goal

Name	Necessity flow (m³/s)	Minimum flow (m³/s)	maintenance flow (m³/s)	Water level (m)
Dal jeon	0.40	0.06	0.46	0.2

3 Establishment of restoration plan 2 (Establish ecosystem health goals 1)

☑ **Grade C or lower improves to Grade B or higher**



조사 항목	Result		Restoration goal	
Trophic Diatom Index	67.7 ~ 42.3	A~C (최적~보통)	100≥TDI≥45	A~B (최적~양호)
Benthic Macroinvertebrate Index	89.2~64.9	A~B (최상~양호)	100≥BMI≥60	A~B (최상~양호)
Fish Assessment Index	66.7~41.7	B~C (양호~보통)	100≥FAI≥56.2	A~B (최적~양호)
Habitat and Riparian Index	74.5~35.5	B~C (양호~보통)	100≥HRI>50	A~B (최상~양호)

3 Establishment of restoration plan 3 (Selection of flagship species)

☑ Selection of flagship species

Selection of flagship

- A flagship species is a species chosen to raise support for biodiversity conservation in a given place or social context

Selection Criteria

- A regional representative species
- Species with easy restoration evaluation

Reason for selection

- Inhabitation from upstream to downstream
- Consideration of river environment and habitat

Selection of flagship species

- upstream: Chinese minnow
- downstream: Korean dark chub

Chinese minnow

Korean dark chub

☑ A habitat environment

구 분	참갈겨니	버들치
habitat	coarse gravel	a clean, cool stream
spawnin	May~Aug on sand or gravel	May~Jun sand and gravel mix
feed	aquatic insects	aquatic insects, attached algae

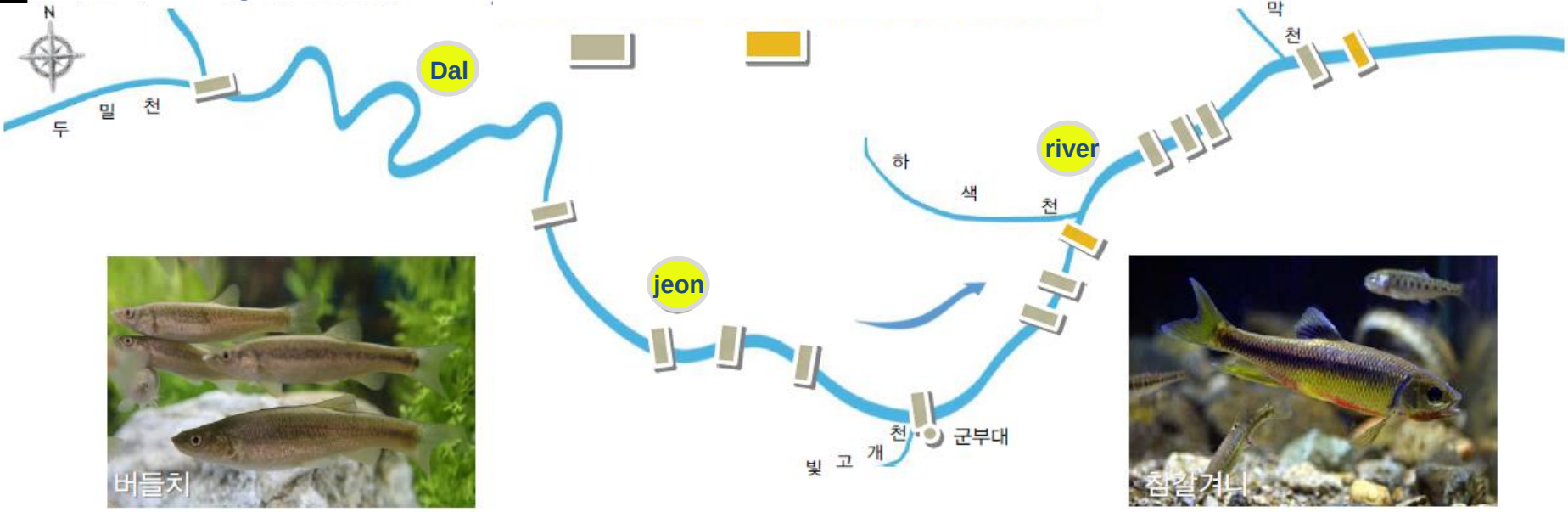
☑ (ex) Korean dark chub habitat environment

구 분	Breeding season	Fry season	Adult fish season
depth (cm)	5~30	10~20	20~50
Speed (m/s)	0.05~0.10	0.20~0.30	0.30~0.80

2. Ecological Restoration Project

3 Establishment of restoration plan 4 (Establish restoration goal 2)

☑ Restoration goal



Upstream flagship specie: Chinese minnow

Downstream flagship specie: Korean dark chub

구 분	Content
Ecosystem Restoration	- Flagship species: Chinese minnow, Korean dark chub - Vertical connectivity 100% restoration
Aquatic environment	- Water quality target maintain - Water level(0.4m) maintain

2. Ecological Restoration Project

3 Establishment of restoration plan 5 (regional characteristic)

☑ Design Keyword

ECO

Autumnal tints

Ecological stream

the sound of water

healing

Korean dark chub

memory

Jazz Festival

comfortable

Jarasum

quality of life

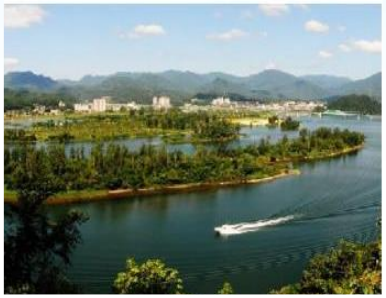
Tourist Attractions

COMMUNITY

Culture

☑ 대표 Keyword 추출

1) Jarasum



- A tourist attraction where natural resources and culture coexist
- An island resembling a turtle

2) Korean dark chub

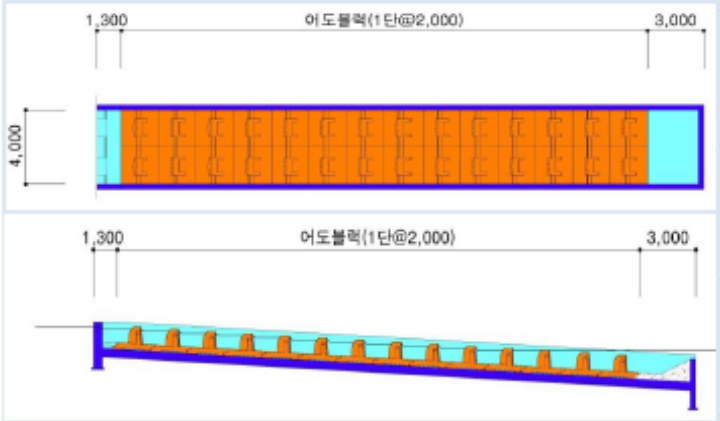
- The representative ecological species of Dalcheon Stream, including otters
- Bright color arrangement of red, yellow and blue

3) Jazz Festival

- representative festival that provides comfortable rest through the music of Jazz
- International Jazz Festival Representing Asia

4 Design & Construction 1 (Applied technology review 1)

☑ Fishway location and plan



Fishway number	10개소 (평어울 2개소 어로 제외)
Fishway type	아이스하버식
Fishway slope	1/20

보 명칭	어도 규모
무명3보	4.6mW × 32.3mL
진양보	4.6mW × 70.3mL
무명2보	4.6mW × 36.3mL
무명1보	4.6mW × 24.3mL
회관앞보	4.6mW × 48.3mL
상색보	4.6mW × 36.3mL
하색1보	4.6mW × 58.3mL
하색2보	4.6mW × 52.3mL
대곡보	4.6mW × 74.3mL
달전 제1낙차공	4.6mW × 26.3mL

4 Design & Construction 2 (Applied technology review 2)

- Study of fish characteristics for native fish species 『Korean dark chub and Chinese minnow』

Category	General features			Condition of inhabitation			Leaping power
	Length	Breeding	Distribution	Habitat	Depth of water	Flow rate	
Chinese minnow	5~15cm	April~May	Upstream water systems nationwide(Except for the eastern coast)	Watershed Pool	20~50cm	0.1~0.5m/s	2~5cm
Korean Dark Chub	5~20cm	May~July	Rivers nationwide (Except for the northern Yeongdoing region)	Middle and upper stream Where the flow is relatively fast	20~100cm	0.1~1.0m/s	2~10cm

- Establish fishway design standards

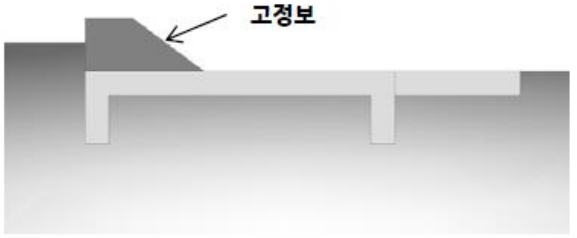
Category	Design criteria	Category	Design criteria	
Flow rate in the fishway	Designed to maintain 0.5~1.0m/s	Inlet, Outlet	・Inlet: connected to the center line of the stream	・Outlet: structure to reduce flow rates
Slope	1/20 or less(1/25 or less for vertical slot type)	Flow rate	Drain all remaining water during the dry season into the fishway	

- Comparison by fishway type

Category	Proposal1(Ice harbor type)	Proposal2(Baffled type in channel)	Proposal3(Hinterland waterway type)
Example			
Study results	・Determination of the fishway slope considering the swimming speed of fish and the arrangement of rest areas through the creation of downstream pools ・The flagship species of the Gapyeong region is the Korean dark chub, so the ice harbor type is considered to be outstanding		

4 Design & Construction 3 (Applied technology review 3)

☑ Securing water flow plan

구 분	Movable small dam	Fixed small dam
Picture		
Cross-sectional diagram		
Feature	- Water level adjustable - Securing available flow rates - construction cost is high - difficult maintenanc	- water level cannot be adjusted - low construction cost
Selection		◎

4 Design & Construction 5 (Applied technology review 5)

☑ Habitat

- Providing a variety of habitats for living things using natural materials

곤충호텔 이미지


돌무더기


다공질공간


곤충관찰 Bed


곤충서식 공간

4 Design & Construction 6 (Applied technology review 6)

☑ How to reduce non-point pollutions

Category	Utilization of Ecological Habitat	Pollution-reducing waterway (supplement section, the rear a bank)
Live example		
Features	・Active utilization of natural purification capabilities ・Not artificial and easy to maintain ・Retention effect when flooding ・Various ecological activities are possible as ecological habitats	・Active utilization of natural purification capabilities ・A separate site (private land) for purification facilities is not required ・Not artificial and easy to maintain ・Formation of Small Ecosystems(habitat) along the bank

5 Post management (monitoring)

Monitoring planning

– Reflected the monitoring implementation plan during construction in the basic and implementation design so that the design direction of the ecological river restoration project and the achievement of the project goal can be confirmed.

※ Monitoring costs during construction are covered by the national treasury subsidy project support

Monitoring items and cycle

– Refer to water quality and aquatic ecosystem monitoring items and survey cycles, but can be adjusted according to regional settings such as river environment.

Monitoring period

– Conducted from the start of ecological river restoration work to the time of completion

Result report

– Prepare a monitoring result report based on the end of each year and submit it to the City / Province and Basin (Regional) Environment Agency (until January 15 of the following year)

Monitoring cost

– 163 million won (construction period 1 year, reflecting basic and implementation design)

※ Calculated based on water quality, aquatic ecosystem monitoring items, survey cycle and preliminary survey point (Daljeon river 8.8km)

☑ Monitoring items and cycle

Monitoring items		Detailed items	Monitoring method	Monitoring cycle
Hydrogeology		Flow velocity, water depth, flow rate, precipitation	Water pollution process test method (Environment Department), Meteorological Agency, Flow Observatory data	Twice a year (before and after the rainy season)
Chemistry	Water quality	Water temperature, BOD, COD, DO, SS, pH, TN, TP, etc.	Water pollution process test method (Environment Department)	By season
Biodiversity	Flora Insects Amphibian ▪ reptiles mammalian birds	Species composition, dominant species, etc.	National Natural Environment Survey Guidelines (Environment Department)	Twice a year (before and after the rainy season)
Aquatic ecosystem health	Diatom, benthic invertebrates, fishes	Species composition, dominant species, index, etc.	Aquatic Ecosystem Health Survey and Evaluation Test Standards (Ministry of Environment)	Once a year (May or September)
	Habitatside environment	Natural vertical and horizontal sandbars, degree of naturalness of river channel maintenance and river channel characteristics, flow velocity diversity, riverside width, reservoir riverbank construction, embankment riverbank material, sediment state horizontal structure, excluded land land use, embankment land use ※ Ecological River Restoration Survey/ Evaluation and Diagnosis Manual (August 2014) See pages 219-224	Aquatic Ecosystem Health Survey and Evaluation Test Standards (Environment Department)	Once a year (May or September)

5 Ecological Restoration Effects

Water quality improvement

☑ Improving water quality by removing and purifying various pollutants and improving the self-cleaning ability of rivers

Restoration of aquatic ecosystems

☑ Restoration of ecosystems such as increased species diversity by creating habitats and diverse untapped terrain

- (Anyangcheon, Gunpo-si) Discovered various biota such as fry, water snails, snakes, crayfish, crabs, etc.
- (Geumsancheon, Geumsan-gun) Increase of aquatic life such as goby minnow, Chinese minnow, dark chub, pale chub, crucian carp, etc.

Other environmental effects

☑ Reduction of air pollution and noise damage by reducing city temperature and traffic volume

- Cheonggye river: 0.3~3.3℃ temperature reduction effect after ecological restoration

Eco-friendly and economic effect

☑ Creation of jobs, revitalization of the local economy by improving the environment of the old city center, provision of leisure and rest areas for citizens, etc.

Best Practice

Best Practice

Case 1. Ul-jin Wangpi river

3. Best Practice

1 Background

- ☑ Due to the agricultural reservoir installed in Wangpicheon river(Uljin-gun, Gyeongsangbuk-do), disconnecting the aquatic ecosystem(Regressive fish : sweet fish, Salmon, etc)
- ☑ Restoration of disconnected aquatic ecosystems rather than improving water quality in order to secure biodiversity and improve health

3. Best Practice

2 Project Overview

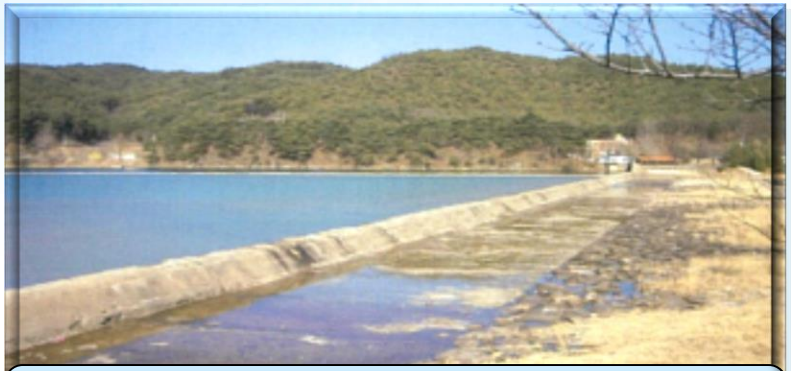
- ☑ Target river : Wangpicheon river (Uljin-gun, Gyeongsangbuk-do, Korea)
- ☑ Project name : Restoration of Ecological river in Wangpicheon river basin(sweet fish way)
- ☑ Period : 2011 to 2016 (4 years)
- ☑ Expenses : $ 4 Million(KRW 5 Billion : National(KRW 3 Billion) + Local(KRW 2 Billion)
- ☑ Details : 10 Fishway improvement, 1 Fishway removal

3 Progress

- ☑ October 2005 : Designation of Ecological Landscape Conservation Area
- ☑ April 2009 : Establishment of the Basic Plan
- ☑ 2011-2013 : 1st construction(1 Fishway improvement)
- ☑ 2014-2016 : 2nd construction(9 Fishway improvement, 1 Fiishway removal)
- ☑ After 2017 : Monitoring

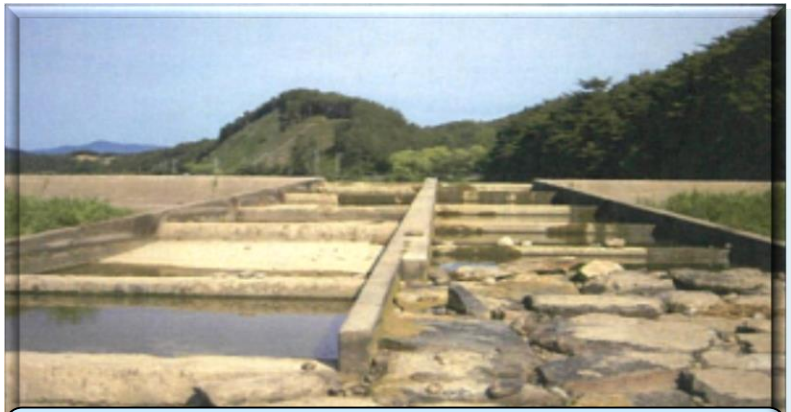
4 Project details 1

Susan reservoir



- Due to low water level, disconnecting river

- Movable weir installation



- Fishway entrance above water level
- Low water level around the fishway

- Improvement of ecological fishway (Ice-Harbor Type)

4 Project details 2

No-eum reservoir & Keun reservoir

- Damaged small dams and river flows two parts

- Fishway and Hydrological improvement

- Fishway entrance above water level
- Low water level around the fishway

- Fishway and Hydrological improvement

4 Project details 3

Habopyeong reservoir & Bi-sab reservoir

- Fishway entrance above water level
- Low water level around the fishway

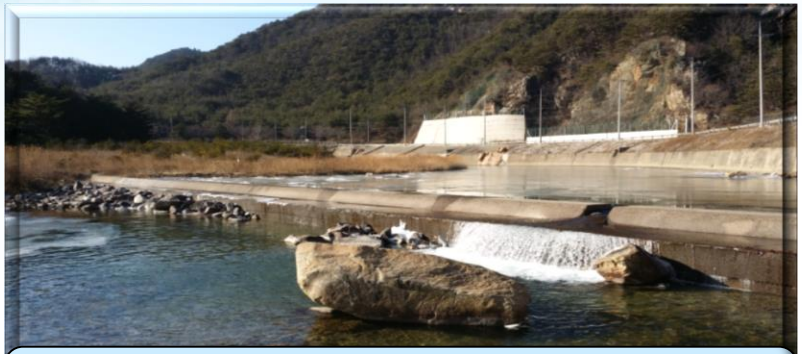
- Fishway and Hydrological improvement

- Fishway entrance above water level
- Low water level around the fishway

- Fishway and Hydrological improvement

4 Project details 4

Haeng-gok reservoir & Jung-gu-deul reservoir



- Disconnecting the aquatic ecosystem (There is no fishway)

- Fishway and Hydrological improvement

- Fishway entrance above water level
- Need to clean up sediments

- Fishway and Hydrological improvement

4 Project details 5

Dong-mak reservoir & Mae-hwa reservoir

- River bed erosion
- Need to clean up sediments

- Fishway and Hydrological improvement

- Low water level
- Need to clean up sediments

- Fishway and Hydrological improvement

4 Project details 6

Sin-gye-dab reservoir & Gu-gok reservoir

- Disconnecting the aquatic ecosystem (There is no fishway)

- Fishway and Hydrological improvement

- Reservoir in the rocky area
- Steep slope river bed

- Due to reservoir removal, preserve the ecological scenary

3. Best Practice

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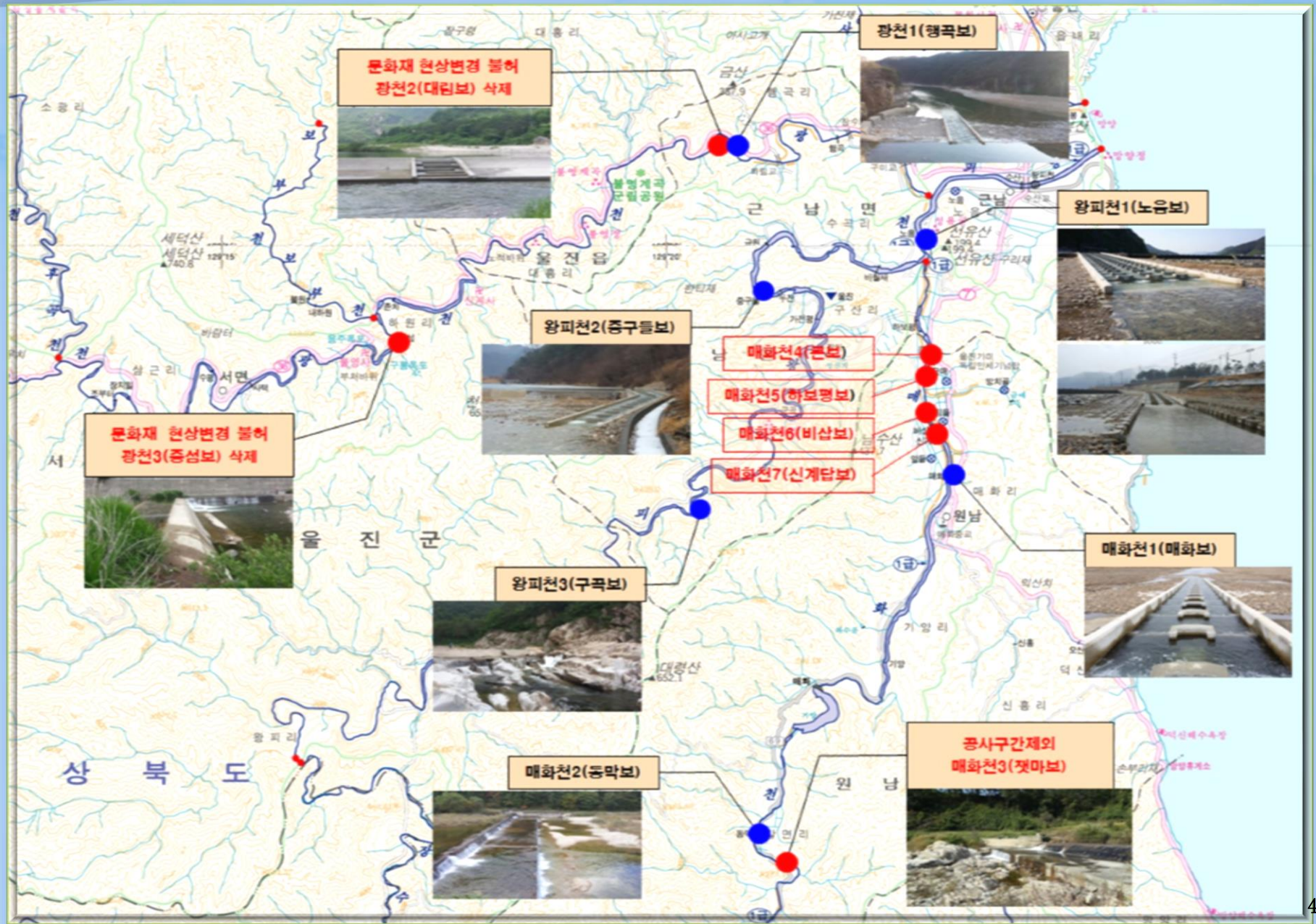

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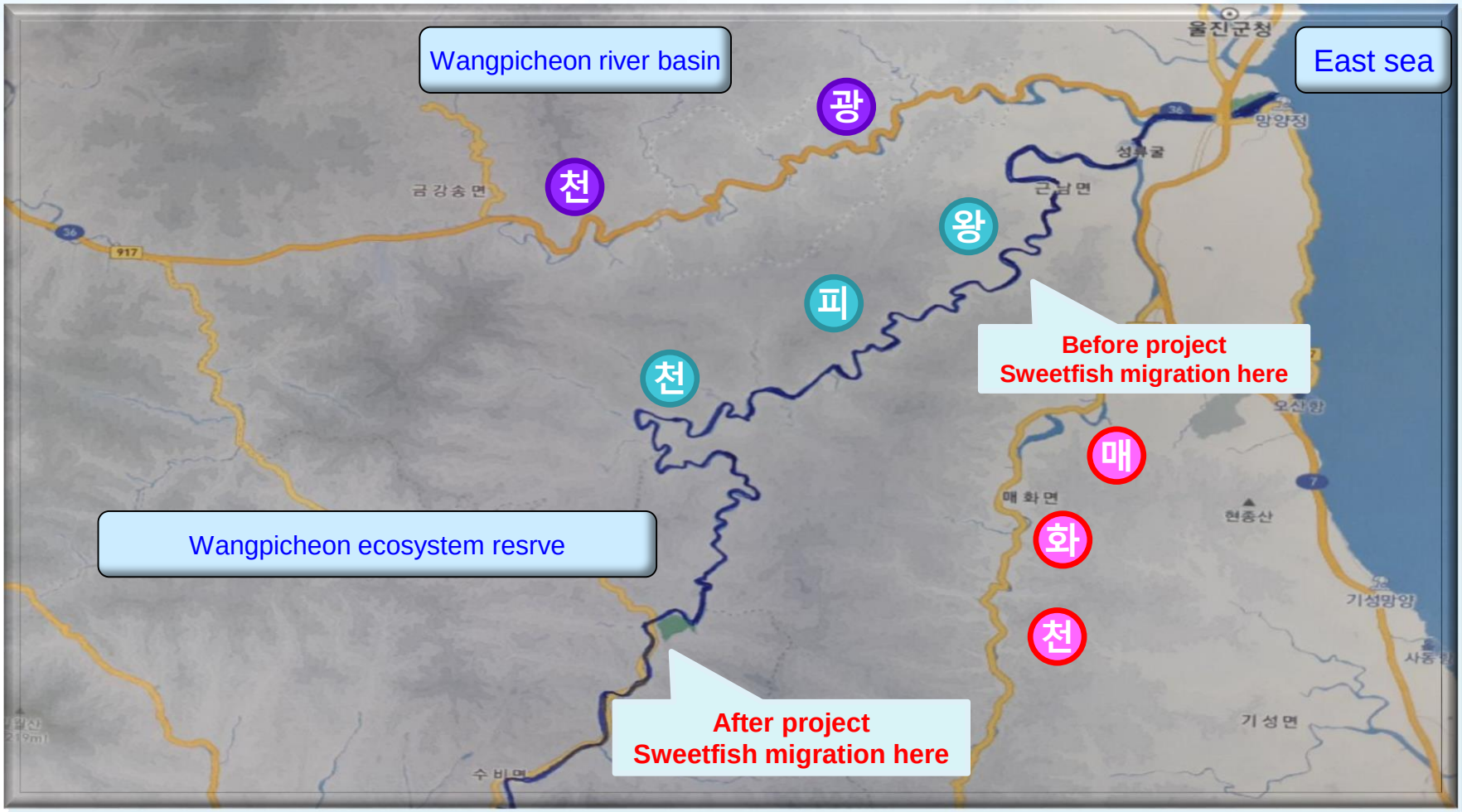
5 Outcome 1

☑ **Flagship species sweetfish migration way restoration**



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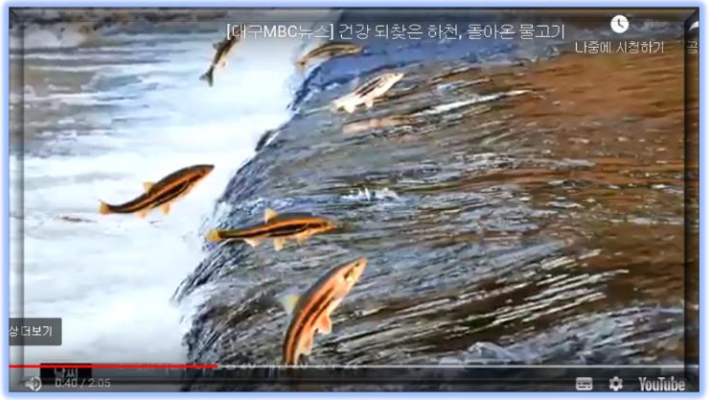
5 Outcome 2

☑ **MBC 2018.4.12**

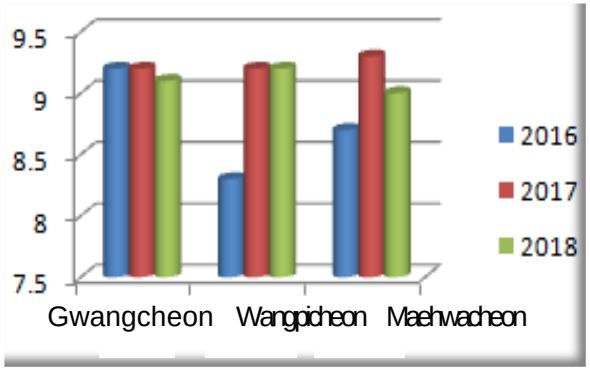


5 Outcome 3

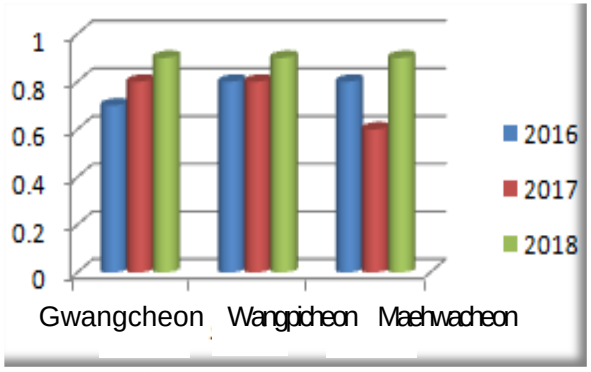
☑ **Improve water quality**

구분	DO			BOD			SS		
	2016	2017	2018	2016	2017	2018	2016	2017	2018
Gwangcheon	9.2	9.2	9.1	0.7	0.8	0.9	1.4	2.6	1.1
Wangpicheon	8.3	9.2	9.2	0.8	0.8	0.9	1.4	2.0	0.4
Maehwacheon	8.7	9.3	9.0	0.8	0.6	0.9	2.2	1.7	0.8
Rating	**1a**	**1a**	**1a**	**1a**	**1a**	**1a**	**1a**	**1a**	**1a**

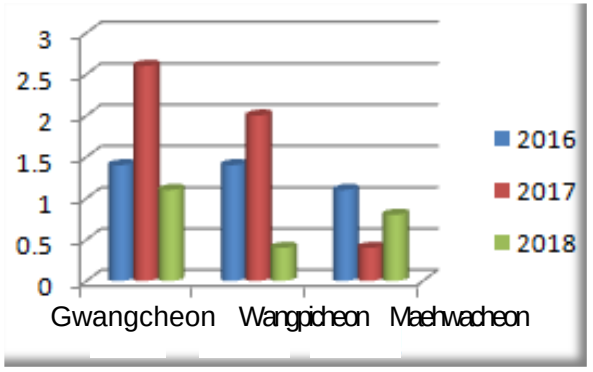
DO



BOD



SS



5 Outcome 4

☑ Biodiversity

Category	2017 (1st)	2018 (2nd)	Growth Rate	Key Species
Plant	234 Species	276 Species	30%	Japanese bindweed, *Stachys japonica*, *Corydalis speciosa*, *Dicentra spectabilis*, *Styrax japonicus*, *Iris pseudacorus L.*, Wild marigold, etc
Mammal	10 Species	13 Species	30%	European otter (N.M, E.S 1), Leopard Cat (E.S 2) Water deer, raccoon dog, weasel, Korean squirrel, etc
Bird	48 Species	50 Species	4%	Mandarin duck (N.M), Water eagle (E.S 2), Sparrow hawk (N.M, E.S 2), Long-billed ringed plover (E.S 2), Great tit, Mallard, Parrotbill, Gray starling, etc
Insect	75 Species	168 Species	124%	Beetle, Butterfly, Fly, Bee, Dragonfly, Orthoptera, etc
Fish	23 Species	25 Species	9%	River Sculpin (E.S 2), Ayu, Salmon, Big-scaled redfin, Korean dark chub, Chinese minnow, Goby minnow, Korean dark sleeper, etc
Zoobenthos	47 Species	70 Species	49%	Melanian snail, Viviparidae, Diving beetle, Water strider, Palaemon paucidens, *Hydropsyche kozhantshikovi*, *Tabanus kinoshitai Kono*, etc

*N.M : Natural Monument, **E.S : Endangered Species

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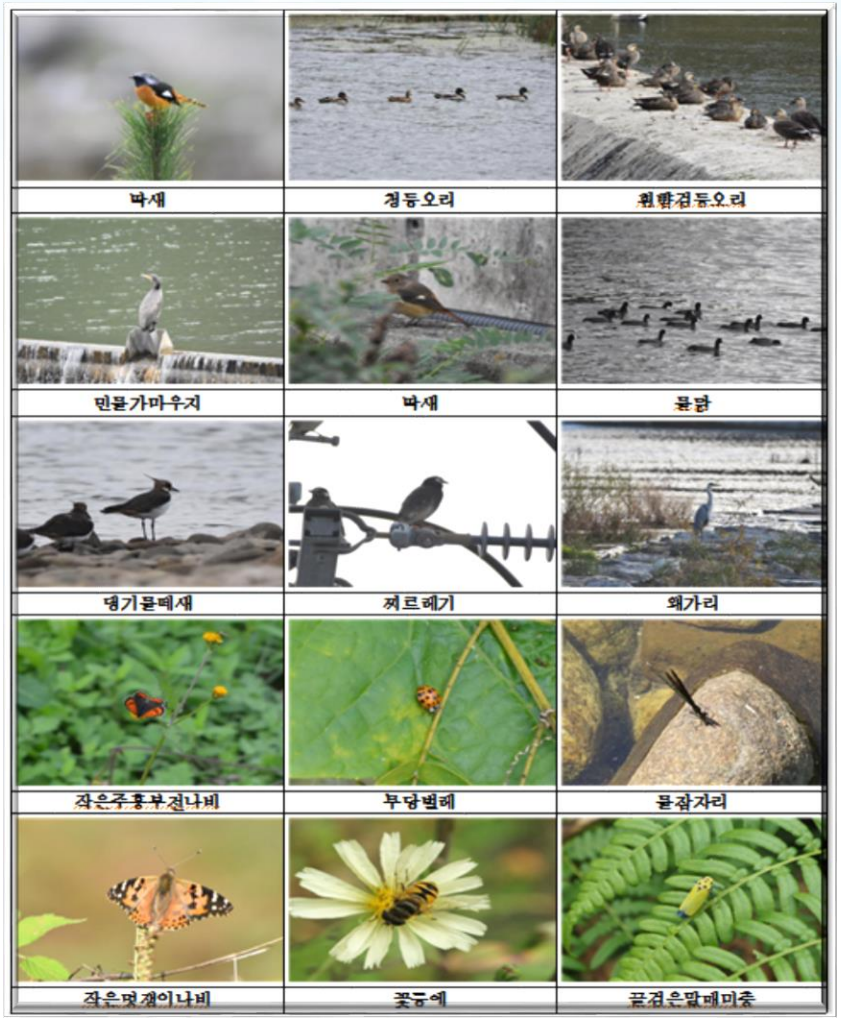
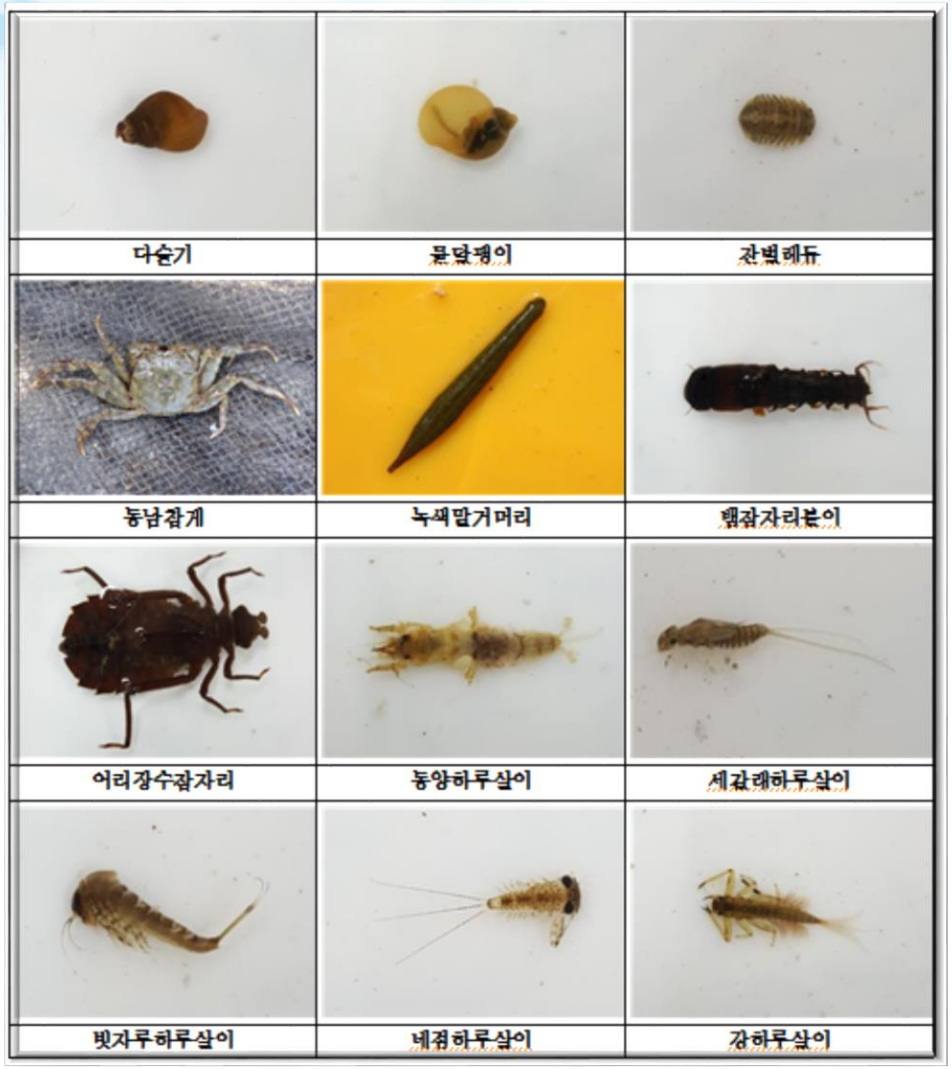
5 Outcome 5

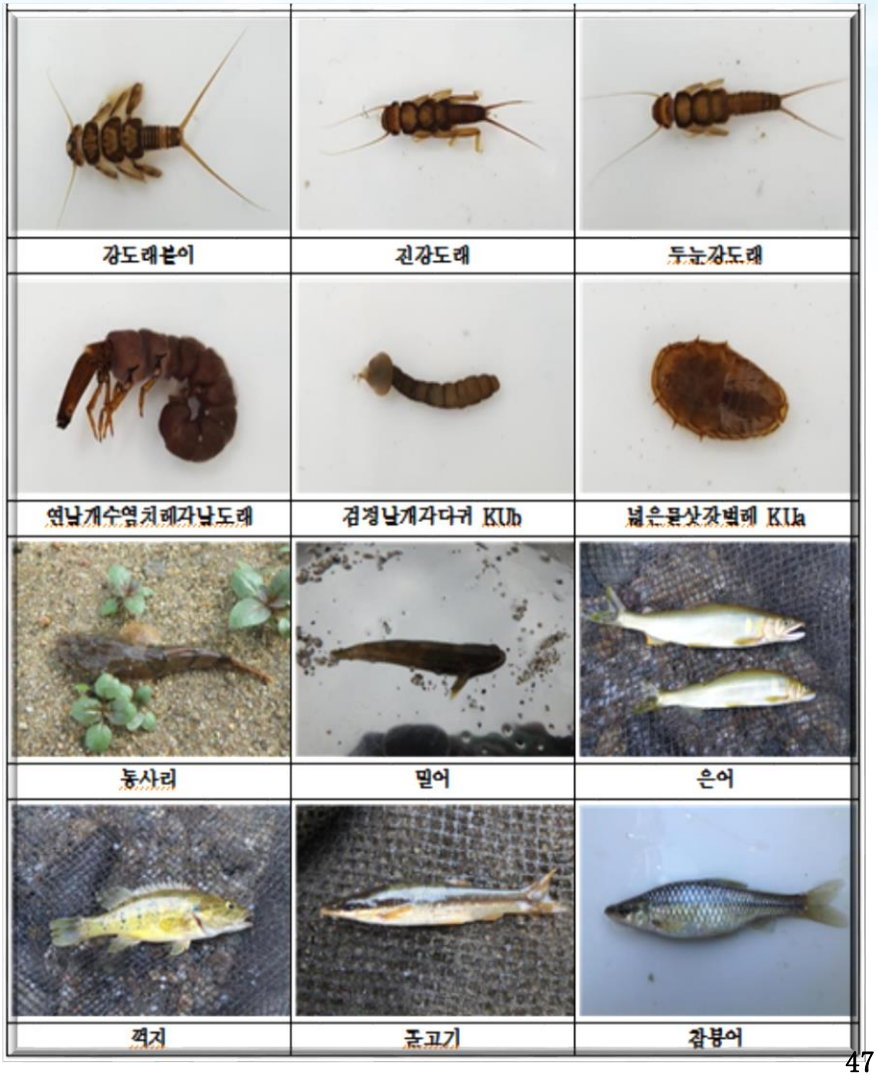
☑ Biodiversity



5 Outcome 6

☑ Biodiversity





5 Outcome 7

☑ Health of aquatic ecosystem

Division	2017(Primary)		2018(Secondary)		Rate of increase
	Index	Grade	Index	Grade	
Fish Assessment Index(FAI)	76.38	B	83.12	A	8.8%
Benthic Macroinvertebrate Index(BMI)	89.37	A	82.60	A	-7.6%
Trophic Diatom Index(TDI)	68.15	C	95.10	A	39.4%

☑ Improvement of fish-way utiliztion

~ 2015(Before)	2017(Primary)	2018(Secondary)	Rate of increase
5 families, 12 species, 422 population	7 families, 13 species, 554 population	7 families, 19 species, 4,693 population	**Species 58%, population 1,012%**

Ⅲ Best Practice

Case 2. An-yang Sambong river

1 Background

- ☑ Water quality and aquatic ecosystem health deteriorated due to inflow of wastewater and non-point pollutants from industrial complexes
- ☑ Started ecological river restoration project to improve the water environment of Anyang river, a typical urban river

2 Project Overview

- ☑ Location : Sambong-river, Anyangsi, Gyeonggi-do
- ☑ Name : Ecological river restoration project of Sambong-river
- ☑ Period : 2015 ~ 2017 (for 3 years)
- ☑ Business expenses: 2.6 billion(won)
- ☑ Contents : Making of habitat, Demolition of cover section, Maintenance of pipeline

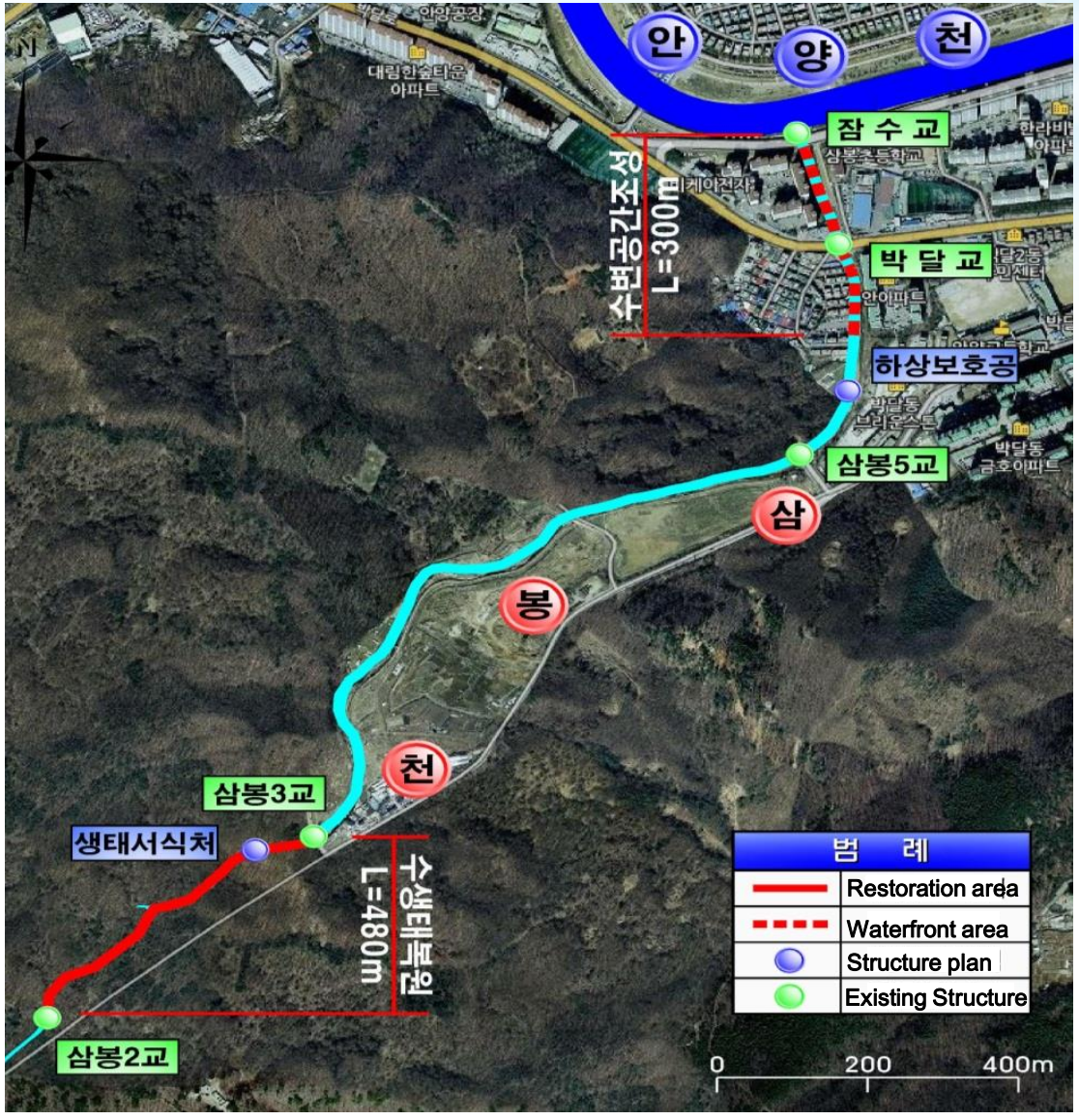
3 Progress

- ☑ 1999~2001 : Organize restoration planning team for Anyang river, Make a comprehensive plan
- ☑ 2001~2004 : Carry forward a project of ecological river restoration(Hakui-river,Tributary of Anyang river
- ☑ 2006~2007 : Carry forward a project of ecological river restoration(Anyang-river)
- ☑ 2008~2014 : Carry forward a project of ecological river restoration(Suam-river,Tributary of Anyang-river
- ☑ 2015~2017 : Carry forward a project of ecological river restoration(Sambong-river, Tributary of Anyang-river
- ☑ Ater 2018 ~ : Carry out post-monitoring

4 Project details 1

Project details

- ☑ Installation of pipeline for drainage and ecological revetment(shore protection)
- ☑ Demolishing covered river
- ☑ Maintenance of sewer
- ☑ Removing non-point pollution
- ☑ Planting & creating biohabitat



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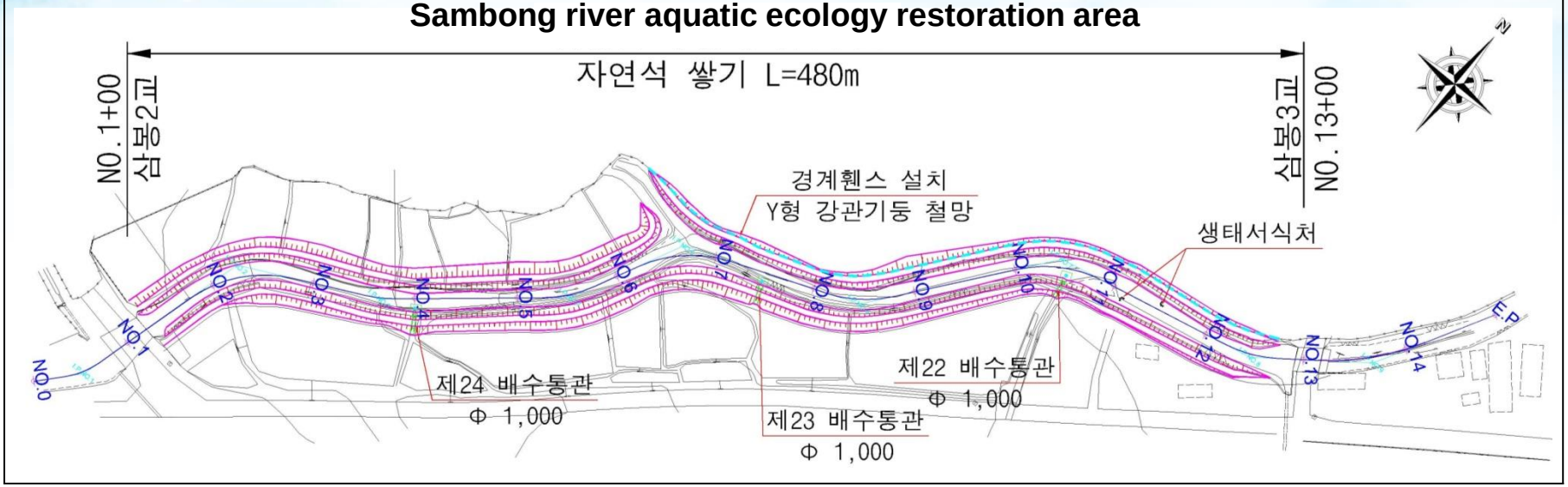
4 Project details 2

☑ Aquatic ecology restoration

Sambong river aquatic ecology restoration area

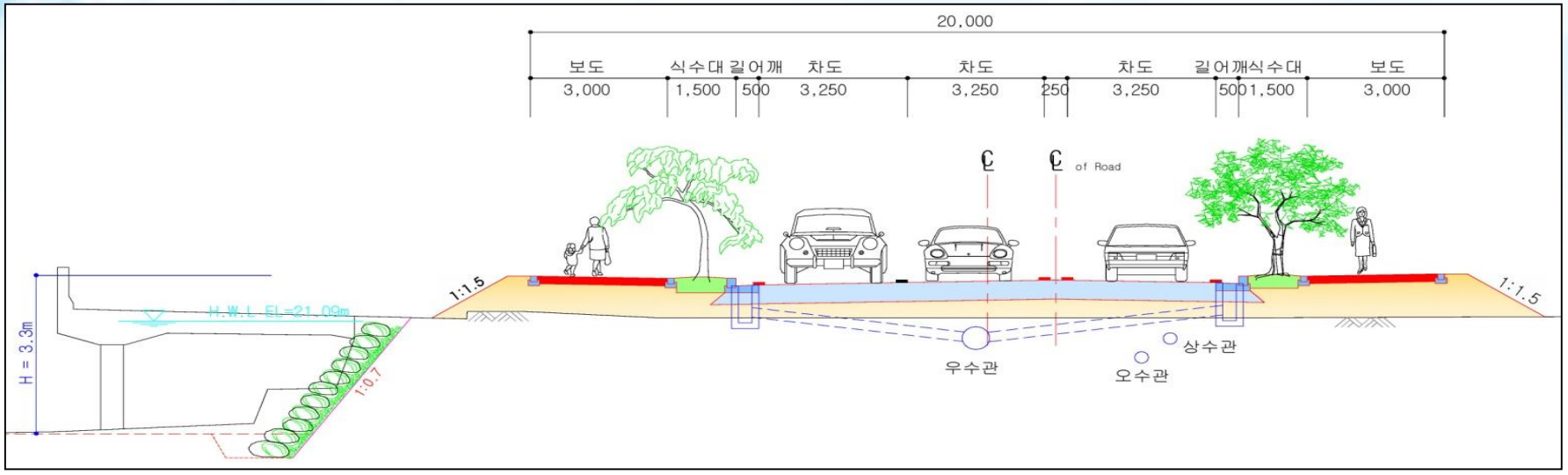


Before restoration

After restoration

4 Project details 3

☑ Covered river area partial demolition

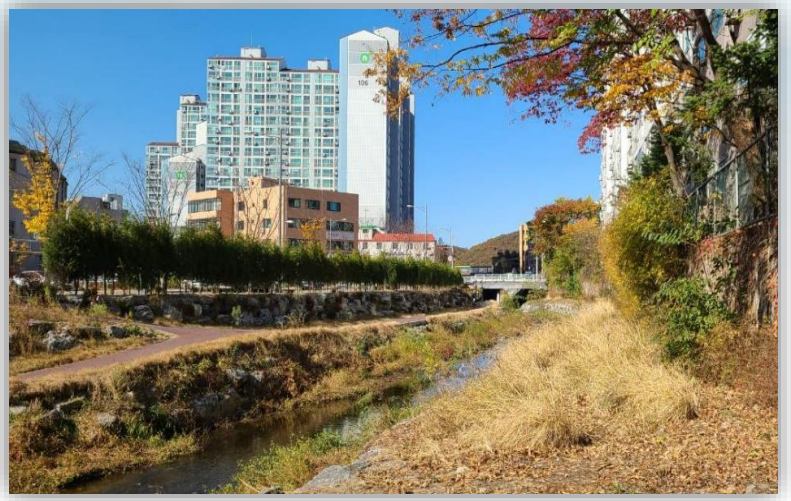


☑ Before restoration

☑ After restoration

4 Project details 4

☑ **Covered river area partial demolition**



5 Outcome 1

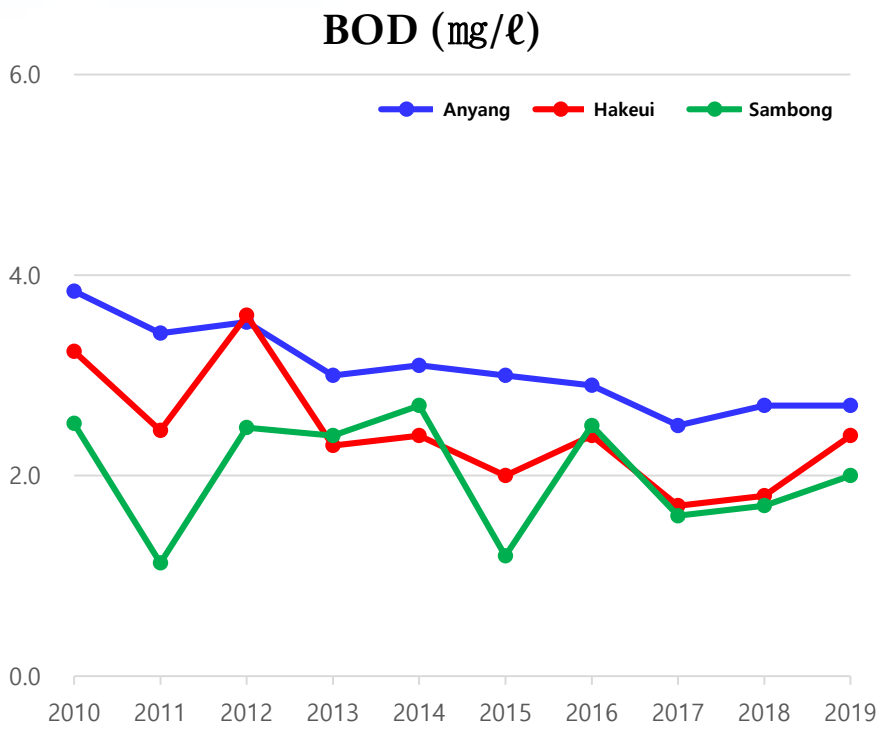
☑ **Water quality measurement**

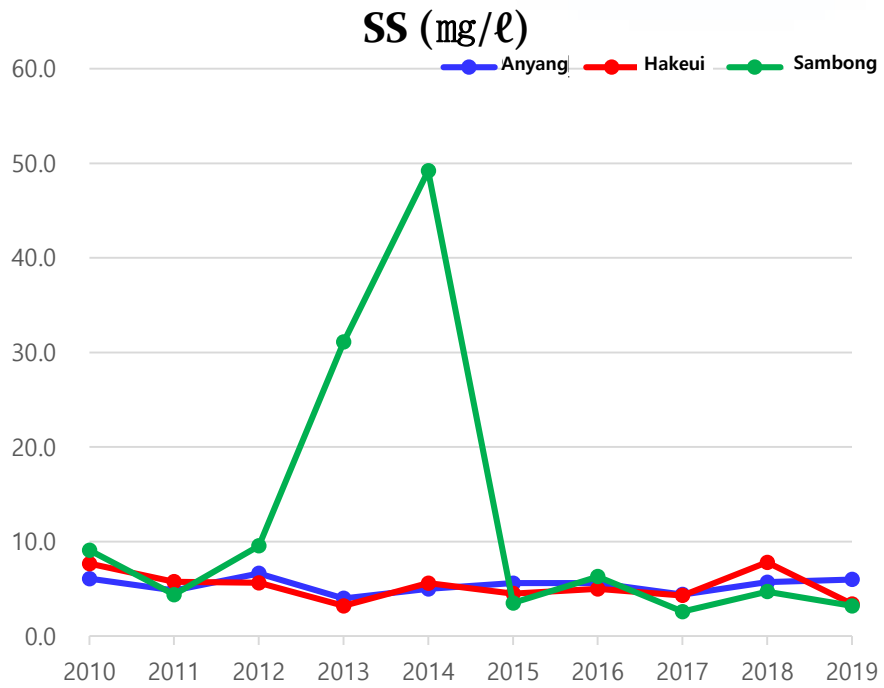
☑ **Measurement Point : Anyang river, etc 13 number of point**

5 Outcome 1

☑ Water quality improvement

- ✓ Anyang river is representative polluted river(1980s : BOD 193ppm)
- ✓ Sambong river BOD 2.5ppm (2010s) → 2.0ppm (2019s)
- ✓ Improvement of water quality through continuous river management





5 Outcome 2

☑ Biodiversity 1(Birds)

- **Sambong river : 20 species 282 individuals**
  - **Sambong river is surrounded by forest area where many mountain birds can be found**
  - **The habitat and breeding ground of Common kingfisher**

Category	Before restoration	After restoration	Note
Anyang river	18 species	65 species	

- Main species inhabiting the area : Common kingfisher, Little ringed plover, Green sandpiper, Bluebird


Common kingfisher


Little ringed plover


Green sandpiper


Bluebird

5 Outcome 3

☑ Biodiversity 2(Birds)

✓ **Legally protected Species** : Mandarin duck, kestrel, sparrow hawk, hobby appearance

Mandarin

hobby

long-billed plover

sparrow hawk

kestrel

5 Outcome 4

☑ Biodiversity 3(Fish)

- **Sambong river**

- Chinese minnow(dominant species), Korean spotted sleeper(subdominant species)
- Albino swamp eel and Eightbarbel loach were discovered only in Sambong river
- 2020. 10. 30, Students collected “Floating goby” where Sambong river and Anyang river meet

Category	Before restoration	After restoration	Note
Anyang river	9 species	27 species	-

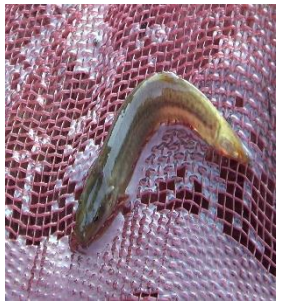
- Main species inhabiting the area : Goby minnow, Korean spotted sleeper, Pale chub, Striped shinner, Chinese minnow

☑ Main species inhabiting the area

Goby minnow

Sweet fish

Albino swamp eel(Sambong river)



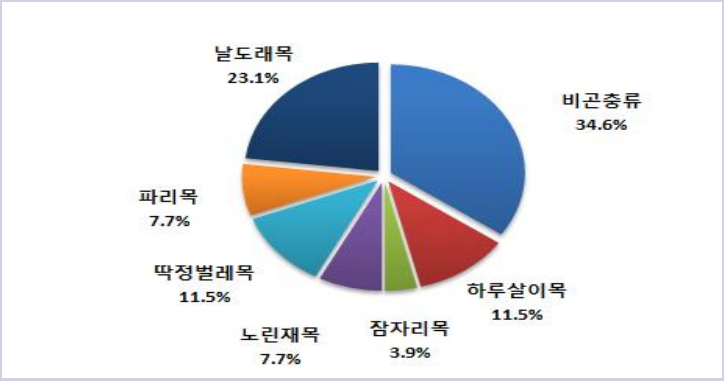
Eightbarbel loach(Sambong river)

5 Outcome 5

☑ Biodiversity 3(Aquatic insect)

- **Sambong river : 20 family 26 species (Mayfly, etc)**

  - Midge(dominant species), Scuds(subdominant species)
  - Being a natural body of water than reclaimed water, Sambong river is a good habitat



- **Anyang river and its tributary : 26 family 41 species**
- **'Serratella setigera', which can be found only in the cleanest bodies of water, was found in Anyang river**

Hydropsyche orientalis Martynov

Baetiella tuberculata

Serratella setigera

Epeorus pellucidus

6 Post management 1

☑ Participation of residents

6 Post management 2

☑ Participation in ecological learning

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Thank you