KOREAN GOLD-SPOTTED POND FROG (*Rana chosenica*) SPECIES CONSERVATION PLANNING WORKSHOP (SCP|PVA)

20-23 February 2023, Seoul, South Korea

Final Report

국립생태원 2013-2023 anniversary

IUCN SSC Species Survival Commission

CONSERVATION PLANNING SPECIALIST GROUP

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Many people contributed to the 2023 Korean Gold-spotted pond frog Species Conservation Planning | Population Viability Assessment Workshop and to the completion of this Korean Gold-spotted pond frog Conservation Action Plan. Their time and contributions are acknowledged here:

Workshop facilitator and modeller: Caroline Lees (CPSG)
Working group facilitators: Moonhyun Shin (NIE), and Hakbong Lee (NIE)
PVA data collection: Ju-Duk Yoon & NIE Fish & Amphibian Team (see PVA report, page 9)
Translators and documenters: Seongeun Yang (Translator), Hakbong Lee (documenter)

A full list of workshop participants is provided in Appendix I of this document and all are thanked for their contributions. **This document was compiled and edited** with help from Moonhyun Shin, Onnie Byers and Caroline Lees.

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CONTENTS

EXECUTIVE SUMMARY

INTRODUCTION

The Korean Gold-spotted pond frog, *Rana chosenica,* is found in the agricultural lowlands between the Yellow Sea and the Taebaek Range on the west coast of the Korean Peninsula. It is found in some natural wetlands, but mostly in ditches and small ponds between and around rice paddies, as the natural habitat of the species is close to being totally modified. Though formerly more widespread, the species' distribution is now limited to several isolated populations along the western side of Korea, to elevations of 300m. It is categorised as Vulnerable by the IUCN based on a suspected decline of >30% over less than 3 generations (18 years) between 2008-2016, resulting from habitat loss and degradation from agriculture, pollution and urbanisation (see below). In South Korea it has just been moved from Endangered Level II, to Endangered Level I (i.e. a higher level of risk).

In 2021, the IUCN SSC Conservation Planning Specialist Group (CPSG) was invited to work with South Korean experts and stakeholders, to help to plan a future for this species. Due to covid 19 restrictions, the face-to-face workshop had to be postponed but the communications, logistical preparations, and initial planning process steps continued, including a population viability assessment held in July 2022.

The Korean Gold-spotted pond frog species planning project is part of a larger, three workshop collaboration between IUCN and the South Korean Ministry of Environment. In addition to this project, a planning process took place earlier in February 2023 for the Korean Stumpy bullhead and a workshop for the Oriental stork is scheduled for September 2023. Importantly, this collaboration includes a capacity building element. Through an increasingly intensive series of training, mentoring and coaching sessions, the intent is to develop a South Korean team capable of conducting CPSG-style species conservation planning processes.

THE WORKSHOP

In February 2023, at the invitation of the National Institute of Ecology, more than 40 delegates gathered for four days in Seoul, South Korea to build a Korean Gold-spotted pond frog Conservation Action Plan. In attendance were representatives from 9 organizations including IUCN, Gyeongsang National University, Jeongeup City Hall, Kangwon National University, Holoce Ecosystem Conservation Research Institution, Seoul National University, Yesan Oriental Stork Park, Mulsari (NGO), and National Institute of Ecology

The event was organised by Ministry of Environment, co-hosted by National Institute of Ecology, and facilitated by the IUCN SSC Conservation Planning Specialist Group (CPSG).

The workshop began with a series of presentations including an introduction to CPSG and the Species Conservation Planning workshop process, a presentation to clarify the current state of knowledge of the Korean Gold-spotted pond frog, and a report on the Population Viability Analysis process and results. Participants then worked collaboratively to agree what successful conservation of the Korean Gold-spotted pond frog could look like in 2050 (see **BOX 1**). This vision for the future served as a guide for the development of the rest of the species conservation action plan.

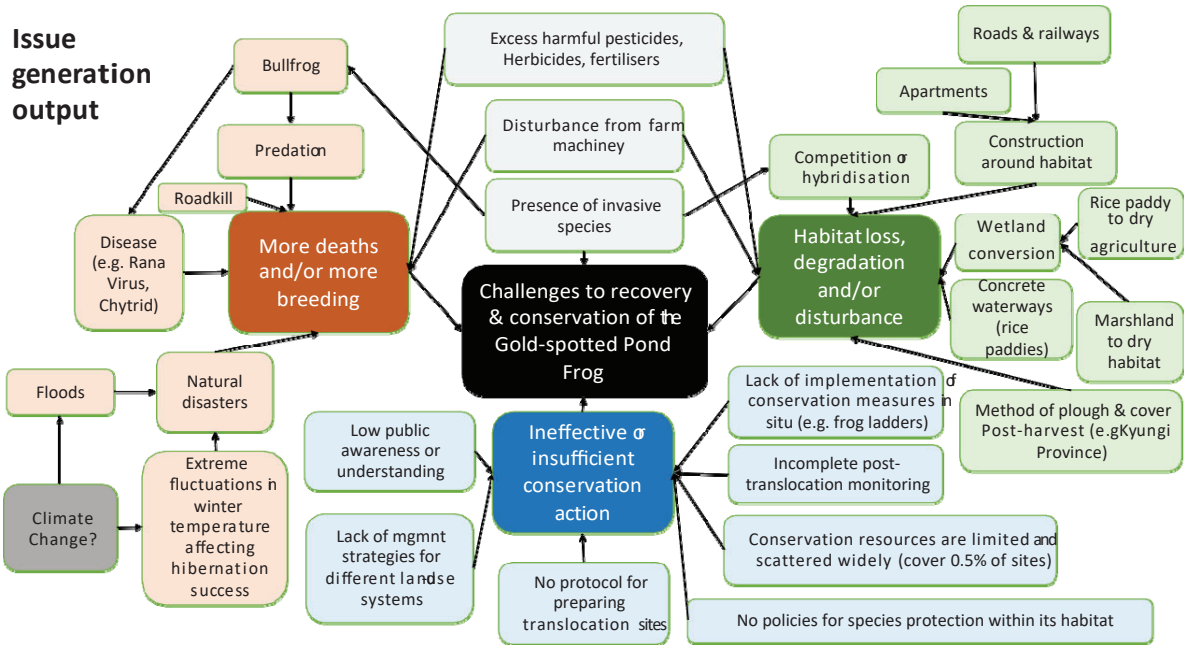
BOX 1. Vision for Korean Gold-spotted pond frog

(Korean) 금개구리 대부분의 서식지는 법 및 제도 하에 보호받고, 서식지 주변에 살고 있는 주민의 인식은 교육 등을 통해 동요와 인형이 만들어질 정도로 크게 높아져서 이제는 도시뿐만 아니라 농촌지역 거주민조차도 금개구리 서식지를 조성하기를 원하고 있다. 농촌 거주민은 친환경농업인증제도가 도입된 이후로 금개구리 서식지를 고려한 농업을 통해 수익을 창출한다. 또한 북한과의 공동 연구 및 서식지 보호를 통해 한반도 금개구리 개체군은 완전히 회복되어 멸종위기종 등급에서 해제되었다.

(English) The majority of habitats of the gold-spotted pond frog are protected by laws and regulations. Due to increased awareness through education outreach, even rural residents, as well as urban residents, are now eager to create habitats for the frog around their residential areas. This level of awareness is such that dolls and toys are being made to promote the cause. Furthermore, rural residents have been considering the frog habitats in their agriculture, which has allowed them to generate income, especially since the introduction of the eco-friendly farming certification system. Consequently, the population of the Korean gold-spotted pond frog in South Korea has fully recovered, leading to its removal from the list of endangered species. Additionally, through joint research and habitat protection with North Korea, habitats of the frog in North Korea are fully protected.

Next, workshop participants described the challenges to the Korean Gold-spotted pond frog's recovery and conservation. On days two through four, participants identified clear goals for addressing these challenges and recommend agreed-upon actions to achieve the goals. Discussions were supported by population simulation models that helped to quantify the relative risks of known threats to Korean Gold-spotted pond frog and the relative benefits of proposed conservation strategies (See page 9 for the complete PVA report).

CHALLENGES TO RECOVERY & CONSERVATION OF THE GOLD-SPOTTED POND FROG



Challenges to successful recovery and conservation of Korean Gold-spotted pond frog were condensed into six themes:

1. Spatial planning
2. Frog-friendly farming
3. Managing invasive species
4. Disease monitoring and management
5. Managing translocation mortality
6. Enabling Conditions
    - Raising public awareness
    - Enforcing conservation policies
    - Increasing intra-government cooperation
    - Increasing funding

Within each theme, participants worked to describe each challenge, including a description of its causes and impacts, the facts and assumptions around it, and existing data gaps that need to be filled (see working group notes, page 23). Then, goals for addressing these challenges and prioritized.

GOALS TO ADDRESS THE ISSUES FACING KOREAN GOLD-SPOTTED FROG CONSERVATION AND RECOVERY

The following goals were identified to address the issues and then prioritized by all participants on the basis of importance, urgency and feasibility.

No.	GOAL	Imp	Urg	Feas	Tot
1.	**Spatial planning**				
1.1	Consider wildlife when the national land use plan is set: - Urban areas: purchase rice fields & convert to wetland park - Rural areas: establish ten eco-villages with organic farming created	11	10	10	31
2.	**Frog-friendly Farming**				
2.2	Promote & enable frog-friendly irrigation methods including: - a study of frog death rates in concrete irrigation ditches - the impact on this of escape facilities (e.g. frog ladders) - where farmers agree, convert concrete ditches to dirt ditches. Otherwise install escape facilities demonstrated to be effective.	5	10	7	22
2.3	Promote and enable GSP Frog-friendly farming practices: - undertake a study to establish the impact of pesticides on GSP Frogs - develop & disseminate pesticides that are less harmful to GSP Frogs [Promote Integrated Pest Management?] - develop & disseminate information on farming methods that can co-exist with the GSP Frog - collaborate with farmers to apply GSP Frog-friendly farming practices.	7	5	5	17
3.	**Managing Invasive Species**				
3.1	Reduce the population of Bullfrogs in GSP Frog habitat (including by changing the habitat to be more favourable to GSP Frogs and less favourable to Bullfrogs)	1	5	5	11
4.	**Disease monitoring & management**				
4.1	Manage disease effectively including: - continuous disease monitoring - when breeding for reintroduction, make sure to manage healthy individuals and prevent disease	0	6	7	13
5.	**Managing translocation mortality**	8	12	6	26
5.1	Increase post-translocation survival rate				
5.2	Minimise translocations occurring due to development				
6.	**Enabling conditions**				
6.1	Increase public awareness of this species and the ecosystem benefits it provides to ecosystems	11	3	11	25
6.2	Reinforce conservation policies	9	6	2	17
6.3	Strengthen cooperation between government agencies	9	6	2	17
6.4.	Expand the budgets for conservation and conservation-directed research	8	6	4	18

The Korean Gold-spotted frog conservation and recovery goals, in priority order, are:

1. **Frog-friendly Farming (39)**
    a. Promote & enable frog-friendly irrigation methods *(22)*
    b. Promote and enable GSP Frog-friendly farming practices *(17)*
2. **Spatial planning (31)**
3. **Managing translocation mortality (26)**
4. **Increase public awareness of this species and the benefits that it provides to ecosystems (25)**
5. Expand the budgets for conservation and conservation-directed research (18)
6. Reinforce conservation policies (17)

7. Strengthen cooperation between government agencies (17)
8. Disease monitoring & management (13)
9. Managing Invasive Species (11)

ACTIONS TO ACHIEVE TOP PRIORITY GOALS FOR KOREAN GOLD-SPOTTED POND FROG CONSERVATION AND RECOVERY

The Korean Gold-spotted frog conservation and recovery goals, in priority order, are:

1. **Frog-friendly Farming (39)**
   - *a.* Promote & enable frog-friendly irrigation methods *(22)*
     - Provide space within the habitat to avoid drought or flooding.
     - Replace concrete waterways with earthen waterways
     - Research and develop escape routes at waterways and expanding installation of them
   - *b.* Promote and enable GSP Frog-friendly farming practices *(17)*
     - Develop and disseminate farming methods that can coexist with GSPFs
     - Develop and distribute pesticides that are less harmful to GSPFs
     - Cooperate with farmers to apply GSPF friendly farming methods
2. **Spatial planning (31)**
   a. Purchase a golden frog habitat in the city area to create a wetland ecological park
   b. Create 10 eco-tourism villages using eco-friendly agriculture
3. **Managing translocation mortality (26)**
   a. Improve survival rate after translocation
   b. Reduce translocation by development
4. **Increase public awareness of this species and the benefits that it provides to ecosystems (25)**
   a. Improve public awareness by education and public relations
   b. Identify ecosystem service and benefit from the species
5. **Other actions (not belonging to any of the top 4 goals)**
   a. Expand conservation budget for the species, *Expanding research budget for ecology of the species*
   b. Reinforce conservation policies for the species
   c. Provide space within the habitat to avoid drought or flooding
   d. Conduct continuous disease monitoring
   e. Ensure connectivity with neighboring populations
   f. Increase the carrying capacity of isolated small habitats
   g. Change the habitat of GSPFs to an environment favorable to the habitat of GSPFs but unfavorable to the habitat of bullfrogs
   h. Reduce the population of bullfrogs within the golden spotted pond frog (GSPF) habitat

Detailed working group notes, including indicators of success, timelines, and responsible parties for these recommended actions, can be found beginning on page 23.

DRAFT: PRELIMINARY POPULATION VIABILITY ANALYSIS FOR THE GOLD-SPOTTED POND FROG, *PELOPHYLAX CHOSENICA*

Compiled by Caroline Lees (IUCN SSC CPSG) in preparation for a conservation planning workshop to be held in South Korea in 2023. The information and insights used to build this report were provided by a team of experts from the National Institute of Ecology (NIE) comprising Dr Seokwan Cheong, Dr Jung-hyun Lee, and Moonhyun Shin.

INTRODUCTION

[Extract from the IUCN Red List Assessment (IUCN SSC Amphibian Specialist Group, 2021)].

The species is found in the agricultural lowlands between the Yellow Sea and the Taebaek Range on the west coast of the Korean Peninsula (see Figure 1.). It is found in some natural wetlands, but mostly in ditches and small ponds between and around rice paddies, as the natural habitat of the species is close to being totally modified. Though formerly more widespread, the species' distribution is now limited to several isolated populations along the western side of Korea, to elevations of 300m. It is categorised as Vulnerable by the IUCN based on a suspected decline of >30% over less than 3 generations (18 years) between 2008-2016, resulting from habitat loss and degradation from agriculture, pollution and urbanisation (see below). In South Korea it has just been moved from Endangered Level II, to Endangered Level I (i.e. a higher level of risk).

Adults have a very narrow home range of less than 1 ha (Sung et al. 2007). It breeds, by larval development, from May to June in wetlands and rice paddies. Its summer non-breeding habitat is mostly agricultural areas or lowland wetlands, and it usually hibernates on the edge of hills and low mountains within 40 m of the breeding habitat (Park et al. 2009, Ra et al. 2010). The generation length of this species is six years according to the IUCN Red List record, though the modelling results below suggest it is closer to 3.5 years.

Figure 1. Distribution map with example of a metapopulation of the Gold-spotted Pond Frog (ex. Incheon Ganghwa-gun). Ref: Developing standard rearing and reintroduction protocols of Golden frog, *Rana chosenica* an IUCN Vulnerable species. 2009 (ver. KOR)

BACKGROUND TO THE CONSERVATION PROJECT

The IUCN SSC Conservation Planning Specialist Group (CPSG) has been invited to work with South Korean experts and stakeholders, to help to plan a future for this species. To support planning, a Population Viability Analysis workshop was held in July 2022, facilitated by CPSG and attended by planning collaborators. This DRAFT document is an output of that workshop and will be used to inform discussions at the larger planning workshop to be held in 2023. That workshop will focus on all South Korean populations, of which there is an estimated 89 with an estimated average population size of 252 (Dr. Cheong, pers. comm.). North Korean populations will not be included, nor any populations in China where it may also occur.

Threats and potential threats to the species were described by the PVA team as follows:

- Habitat loss. 70-80% of these frogs live in rice paddies, the rest are found in lakes, rivers and streams. Rice cultivation has a long history in South Korea and until relatively recently there was a constant drive for rice paddy expansion. However, over the past 30 years there has been a decreasing trend in this form of agriculture and farmers increasingly favour dry crops. It is not known to what extent rice paddies were originally wetlands (i.e. whether the frogs may once have had a smaller distribution which expanded with the rice paddies).
- Development. Rice paddies may also be replaced with apartment developments and other infrastructure. When this happens, frogs are translocated to other sites.
- Predation. Many other species eat this frog, including birds, snakes, and bullfrogs (which are introduced).
- Small and highly fragmented populations. Though some populations of this species are very large, others are very small and isolated. These may be at risk to small population effects (inbreeding, loss of gene diversity, demographic and environmental stochasticity).
- Agricultural pesticides. Though no specific data are available for this species, agricultural pesticides are expected to have a damaging effect on populations. It is assumed that the biggest impact will be on eggs and tadpoles because they are anchored to the rice paddies, whereas the adults can move to and from them so may be less exposed. However, the breeding season for these frogs (that is, when the adults are most likely to be in the rice fields) is May to July, and this coincides with the main period of pesticide use, so adults may also be at significant risk. The susceptibility of this species to pesticides, and the relative susceptibility of different life stages, is not known.

Of these threats, predation is considered a "normal" component of mortality that cannot be mitigated in a wild population and must instead be accommodated. Removal of the introduced bullfrog is also not considered an option. In addition, Dr Lee provided the following description of threats, categorised using the IUCN Red List Threats Classification Scheme (2007):

Table 1. Threats to Gold-spotted Pond Frogs classified and quantified using the IUCN Threats Classification Scheme (provided by Dr Lee)

Level 1	Level 2	Specifics	Intensity(1-5)
1.Residential and commercial development	1.1 housing and urban areas	Habitat destruction	5
	1.2 commercial and industrial areas	Habitat destruction	5
2. Agriculture and aquaculture	2.1 annual and perennial nontimber Crops	Using agricultural pesticides and fertilizers, falling into a concrete waterway	4
4. Transportation and service corridors	4.1 roads and railroads	Habitat fragmentation and destruction, road kill	3

Level 1	Level 2	Specifics	Intensity(1-5)
8. Invasive and other problematic species and genes	8.1 invasive non-native/alien species	Bullfrog, Chytrid fungus	3
9. Pollution	9.1 household sewage and urban waste water	Polluted by domestic sewage	1
	9.3 agricultural and forestry effluents	Polluted by agricultural water	1
11. Climate change and severe weather	11.2 droughts	droughts	2

An *ex situ* population exists and has been used to breed frogs for release. The first release happened recently (in June 2022). Data are available for this *ex situ* effort (e.g. on the number of wild caught founders, the size of the captive population that was built from these individuals and the number of individuals released). No post-release monitoring data are available yet. Those involved in this *ex situ* effort will be part of the planning workshop.

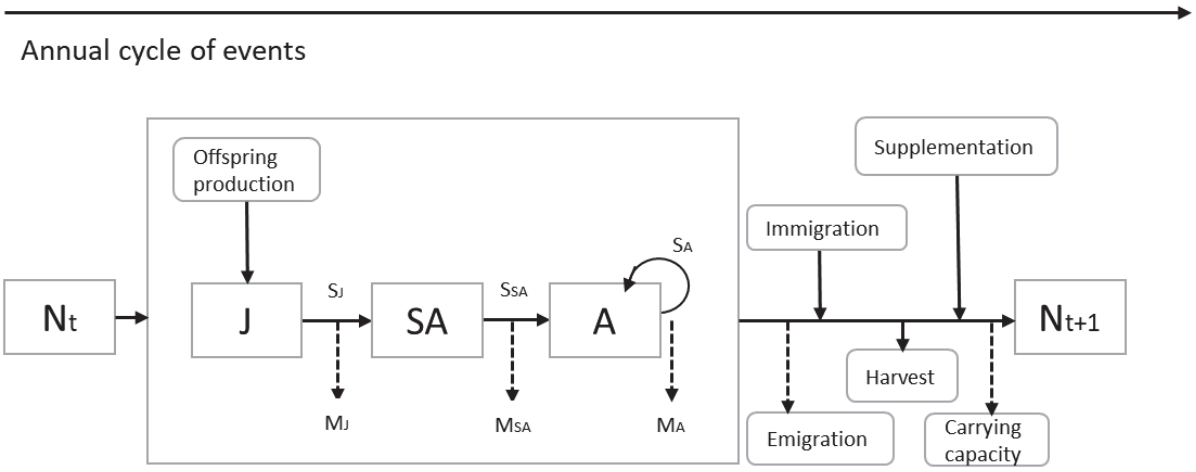
Though captive breeding for release is currently being tested, as there remain so many (and some still very large) wild populations, the emphasis for conservation planning will be on wild-wild translocations rather than captive-wild ones. However, the data and experiences gained from captive breeding are likely to be helpful.

VORTEX MODELS

Computer modelling can be a valuable tool for quantitatively assessing risk of decline and extinction of wildlife populations, both free ranging and managed. Complex and interacting factors that influence population persistence and health can be explored, including natural and anthropogenic causes. Models can also be used to assess the relative impact of alternative management strategies, to help identify the most effective conservation actions for a population or species, and to identify research needs.

The software used in these analyses is the simulation program VORTEX. VORTEX is a Monte Carlo simulation of the effects of deterministic forces as well as demographic, environmental, and genetic stochastic events, on small wild or captive populations. VORTEX models population dynamics as discrete, sequential events that occur according to defined probabilities. The program begins by either creating individuals to form the starting population, or by importing individuals from a studbook database. It then steps through life cycle events (e.g., births, deaths, dispersal, catastrophic events), for each individual and typically on an annual basis. Events such as breeding success, brood size, sex at birth, and survival are determined based upon designated probabilities that incorporate both demographic stochasticity and annual environmental variation. Consequently, each run (iteration) of the model gives a different result. By running the model hundreds of times, it is possible to examine the probable outcome and range of possibilities. For a more detailed explanation of VORTEX and its use in population viability analysis, see Lacy (1993, 2000) and Miller and Lacy (2005).

Figure 2. Diagram showing the series of events making up a typical annual cycle or timestep in VORTEX, that result in a simulated change in population abundance from Nt to Nt+1. The enclosed section of the diagram begins with the production of juveniles (J) followed by their transition through Subadult (SA) and Adult (A) life-stages. Mortality is imposed on each age-class cohort (Mx), the severity of which is determined by age-specific survival rates (Sx). On the right of the diagram, processes above the timeline act to increase abundance, while those beneath act to decrease it. The aggregate effect of these demographic processes results in a new population abundance at the end of the timestep.



PVA MODEL DEVELOPMENT AND QUESTIONS

A Population Viability Analysis for this species was published previously (Cheong et al 2009). This work used VORTEX models to explore questions including:

- the sensitivity of the models built to parameter uncertainty or variation;
- population extinction risks;
- the number of release animals and rates of supplementation needed to establish new wild populations.

This work is well-documented and no attempt is made to duplicate it here. However, since 2009 additional data have been gathered and additional questions are of interest. Specifically:

- what is the Minimum Viable Population size (MVP) for a wild population?
- which of the remaining populations are likely to be viable (based on their estimated population size)?

The modelling process for this project, which included work before, during and after the PVA workshop, included the following process steps:

1) Building and testing baseline models of a representative wild population.
2) Anticipating potential planning questions and building examples of models that can be used to explore those questions during the 2023 planning workshop.
3) Illustrating and interpreting the outputs of these sample models.

Draft model parameter values were taken from Cheong et al 2009 and from additional materials supplied by Dr Lee. During the July 2022 PVA workshop, participants:

- Reviewed and agreed parameters for the *in situ* baseline model.
- Estimated plausible ranges of values for uncertain parameters.
- Agreed preliminary questions to be pursued using the models.

These were then taken away and worked on further to develop the outputs contained in the following pages.

Wild Baseline Models

The Wild Baseline model is designed to represent a single, healthy population of the Gold-spotted Pond Frog under benign conditions, that is, with no major catastrophes, no climate-related shifts and no human-mediated alteration of habitats or environmental conditions. All models use an annual cycle of events, the modelling timeframe is 50 years, and each model run includes 500 iterations unless otherwise specified. Parameters and values included in the baseline models are shown in Table 7.

With the model values described in Table 7, deterministic projections (i.e., without stochastic influences on reproduction and mortality rates) show a wild population that grows at deterministic instantaneous rate of det-r=0.64. Generation time (T) is approximately 3.93 years for females and 3.16 years for males (mean for both = 3.54 years). Stable age structure for this modelled population is described in Figure 3 and illustrates the high mortality rate in the 0-1 age-class (90%) as well as the impact of the sex-ratio bias towards males resulting from elevated mortality assigned to the early adult age-classes, and the longer maturation time and slightly shorter lifespan of females. Note that this age-structure includes the egg stage.

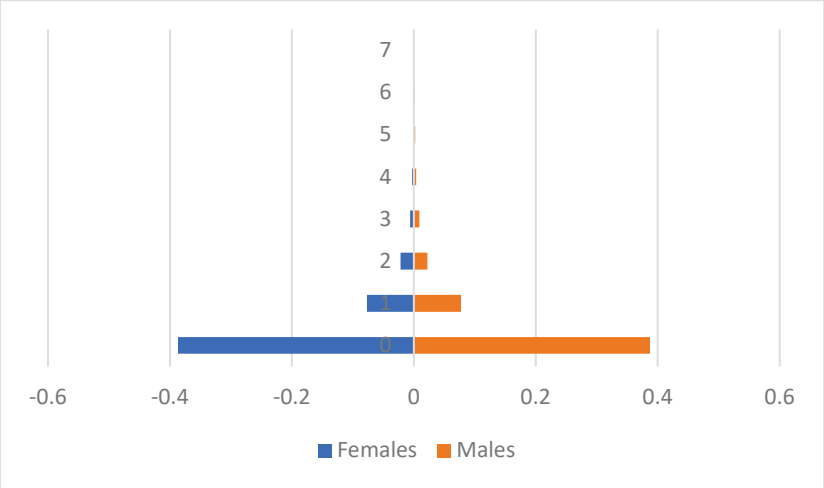


Figure 3. Age-pyramid portraying a stable-age structure for the Gold-spotted Pond Frog, calculated using Wild Baseline input values. Proportions of males and females are shown on the X-axis; the upper limits of the age-classes (in years) are shown on the Y-axis.

With stochastic elements included, instantaneous growth rate is reduced and there is high variability across iterations (stoc-r=0.56 ± 0.3). Risk of extinction over the 50-year period is zero (PE=0.00) for the starting population size and carrying capacity used (Ni=K=200). Gene Diversity at 50 years sits at GD=0.78 (78%), below internationally recommended thresholds of 90 – 95%. See Figure 4 for an illustration of Wild Baseline model trajectories and Tables 1 and 2 for a comparison of deterministic and stochastic results.

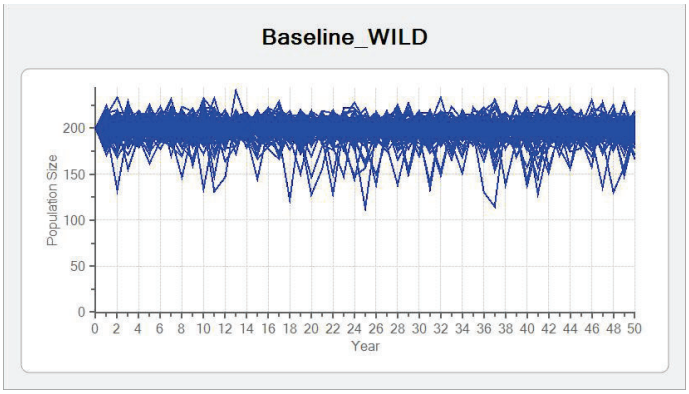


Figure 4. Examples of Wild Baseline model trajectories over 50 years, for the Gold-spotted Pond Frog.

Tables 2 & 3. Summary of deterministic and stochastic results for the Wild Baseline model.

2. Deterministic rates	
Instantaneous growth rate (r)	0.6411
Lambda (λ)	1.8986
Generational growth (Ro)	12.3991
Generation time (T)	3.54

3. Stochastic rates	
Instantaneous growth rate (r)	0.5609 ± 0.3277
Gene Diversity (GD) at 50 yrs	0.7782
Extinction Risk (PE)	0.000
N-Extant	198.25 ± 10.44

As shown above, the model grows strongly, potentially generating huge generational increases in population size in the absence of severe catastrophes and ongoing pressure from human-mediated risk factors. Note though that there are many uncertain parameters in this model, in particular the age-specific mortality rates which are expected to be influential determinants of population performance. This can be discussed further at the planning workshop. Note that the introduction of stochastic elements to the models (including inbreeding depression, environmental variation, and demographic stochasticity) both depresses average growth and introduces high levels of population fluctuation compared to the deterministic models.

WILD MODEL SENSITIVITY TESTS

As the Wild Baseline model described above was largely based on the parameters described in Cheong et al (2009), no attempt has been made to repeat the sensitivity tests described in this publication. We assume that the new model will be sensitive to the same set of parameters and the results from Cheong are displayed below. For further information see Cheong et al (2009).

Figure 5. Table from Cheong et al (2009) showing the inputs and results of sensitivity testing of a baseline

Parameter	Value	Growth rate	Extinction rate	Population size
Mortality rate	47%	0.181	0.704	61.49
	52%	0.161	0.729	60.86
	57%	0.139	0.794	57.83
	62%*	0.113	0.811	51.99
	67%	0.063	0.881	48.68
Metamorphosis rate	1%	−0.222	0.998	23.00
	6%*	0.113	0.811	51.99
	11%	0.254	0.709	62.36
	16%	0.314	0.721	63.40
	21%	0.403	0.645	64.02
Carrying capacity	60	0.120	0.866	40.28
	80	0.109	0.861	47.58
	100*	0.113	0.811	51.99
	120	0.118	0.762	60.59
	140	0.104	0.749	60.99
Reproductive rate	66%	0.079	0.858	50.15
	71%	0.084	0.835	52.27
	76%*	0.113	0.811	51.99
	81%	0.133	0.779	54.68
	86%	0.154	0.768	57.19

*, values used to obtain a baseline simulation model

As shown in Figure 5 above from Cheong et al (2009), for the ranges of values tested, model performance is particularly susceptible to metamorphosis rates, and to the percentage of females breeding. Carrying capacity is less influential.

WILD MODEL SCENARIOS

Building from the Wild Baseline, models were constructed to provide preliminary answers to questions posed during the PVA workshop. The results of these analyses are described below.

Question 1: What is the Minimum Viable Population Size (MVP)? Where MVP is defined as the smallest size of population that can persist for 100 years, with an extinction risk of <1% and with >90% gene diversity retained?

Models were built to evaluate the performance of different populations that varied only in their population size. Starting size (Ni) and carrying capacity (K) were set to the same value and were varied from Ni=K=10 to Ni=K=1250 at varied increments. The timeframe was set to 100 years. In addition, a generic catastrophe was added to the models based on Reed et al (2003) who analysed multiple longitudinal datasets for vertebrate populations and calculated the average likelihood of severe declines. The catastrophe added here has a 14% chance of occurrence each generation, and causes a 50% drop in survival across age-classes, in the year of occurrence. The results of these tests are shown below:

Table 4. Results of Minimum Viable Population Size tests for population sizes (and carrying capacities) ranging from 10 – 1250, where MVP is defined as <1% extinction risk over 100 years and retention of >90% gene diversity. Orange shading: meets neither criteria; Yellow shading: meets extinction risk but not gene diversity retention criteria; Green shading: meets both criteria.

Ni=K	stoch-r	SD(r)	PE	N-all	SD(N-all)	GeneDiv	meanTE
10	0.376	0.994	1.000	0.000	0.000	0.000	10.600
20	0.263	0.717	0.828	2.870	6.510	0.035	37.800
30	0.288	0.596	0.316	17.660	13.260	0.105	49.700
40	0.320	0.536	0.104	31.890	12.970	0.144	47.800
50	0.354	0.498	0.036	44.310	12.360	0.231	57.000
60	0.381	0.469	0.014	55.510	11.020	0.298	77.700
70	0.399	0.452	0.004	66.100	10.650	0.356	78.000
80	0.412	0.431	0.002	77.190	10.370	0.365	84.000
90	0.430	0.416	0.000	87.540	9.380	0.404	0.000
100	0.438	0.405	0.000	94.790	13.210	0.443	0.000
250	0.513	0.322	0.000	245.450	21.230	0.677	0.000
500	0.551	0.286	0.000	494.650	29.660	0.808	0.000
750	0.565	0.271	0.000	746.360	17.010	0.866	0.000
1000	0.577	0.260	0.000	988.470	64.210	0.888	0.000
1250	0.578	0.255	0.000	1243.590	27.590	0.911	0.000

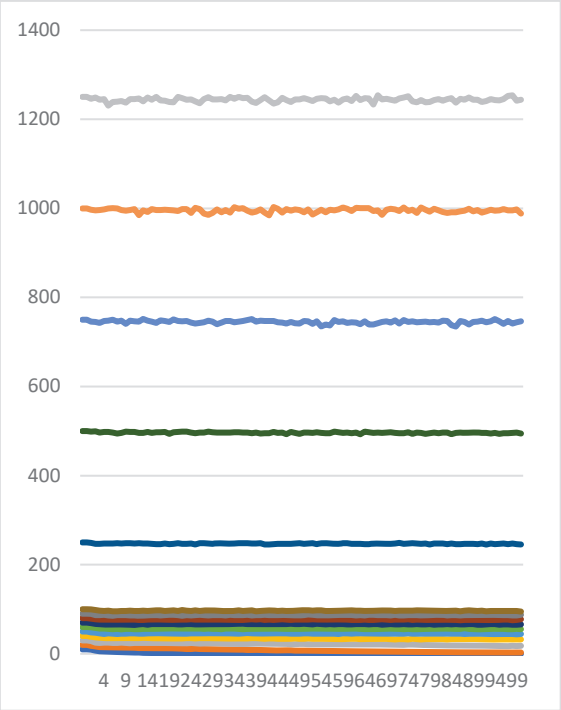


Figure 6a. MVP Tests: graph of average N across all iterations over 100 years, for Ni=K ranging from 10-1250.

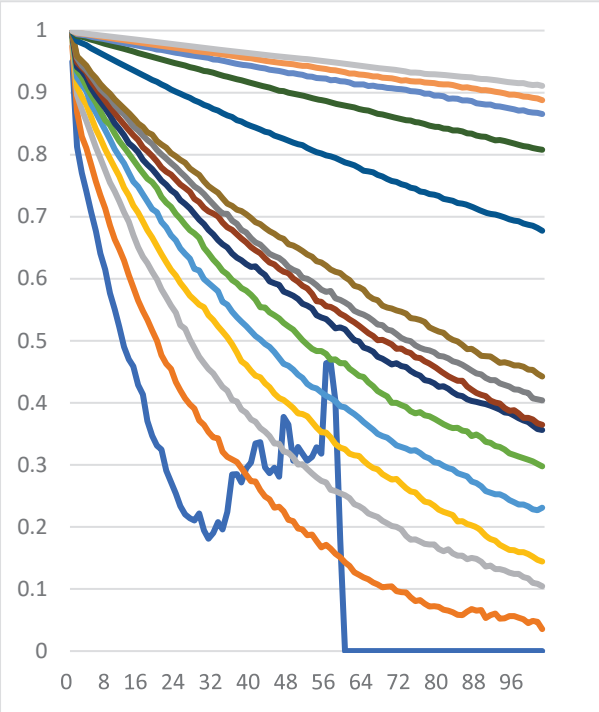


Figure 6b. MVP Tests: graph of average GD across all iterations over 100 years, for Ni=K ranging from 10-1250.

- For the conditions specified in these models, only populations with 1250 individuals or more meet the MVP criteria set (<1% extinction risk over 100 years and >90% gene diversity retained).
- Populations of 70 or more meet the extinction risk criterion but do not retain the required amount of gene diversity.
- Populations of fewer than 70 meet neither criterion and all populations with only 10 individuals go extinct over the 100-year period modelled.
- MVPs in this analysis may be optimistic as only one, generic catastrophe is included in the models and growth rates are relatively high compared to other rates found in the literature (e.g. Cheong et al. 2009). On the other hand, breeding females lay only 90 eggs (on average) each season in these models, whereas 600-1000 is possible. Exploring this further will require additional expert input at the planning workshop.

Question 2. What is the impact on release population viability, of using different life-stages for release?

When establishing or re-establishing wild populations using translocated or captive-bred individuals, the size, number, age-structure and sex-ratio of release cohorts is an important consideration. Mortality can be high in the early life-stages (eggs, tadpoles) and lower in the later sub-adult or adult life-stages. However, releasing older age-classes (by raising them in captivity or collecting them from wild sites) can be more difficult or expensive. Therefore, trade-offs may need to be made between releasing large numbers of very young individuals/eggs (of which most may be expected to die) and releasing smaller numbers of older individuals (which may be expected to survive for longer). This dilemma is further compounded if individuals introduced to the wild (from captivity or from a different location) are less fit for life in that new environment than individuals that have grown up there. In absence of data confirming or quantifying these effects, some of these trade-offs can be explored using models.

Models were built to compare the difference between releasing 100 eggs, versus 100 tadpoles, versus 100 metamorphs (defined here as post-tadpole but less than 1-year-old) versus100 sub-adults (1-2 years old for males, 1-3 years-old for females), versus 100 adult frogs, into an area able to accommodate 1250 individuals. The model is structured so that the egg, tadpole and metamorph life-stage, are included within a single mortality value for the 0-1 year time period. Therefore, releases of eggs, tadpoles and metamorphs are all modelled as releases of 1-2 year-old sub-adults, with the number of individuals reduced according to how many are expected to have died during the previous life-stages. Sub-adult releases are modelled as releases of individuals aged 1 (males) and aged 1 or 2 (50% allocated to each) of females. Adult releases are modelled as individuals aged 2 years (males or 3 years (females). The results are shown in Table 5.

Table 5. Results of tests to examine the changes in Wild population performance when founded on either 100 eggs, 100 tadpoles, 100 metamorphs, 100 sub-adults or 100 adults.

Scenario	stoch-r	SD(r)	PE	N-all	SD(N-all)	GeneDiv	SD(GD)	nAlleles	SD(nA)
100 Eggs	0.5382	0.3638	0	1241.69	53.11	0.856	0.0469	12.72	3.33
100 Tadpoles	0.5430	0.3523	0	1239.09	71.38	0.855	0.0449	13.11	3.16
100 Metamorphs	0.5517	0.3567	0	1247.06	25.6	0.8728	0.0403	15.2	2.94
100 Sub-adults	0.5734	0.3202	0	1245.2	44.7	0.9021	0.0242	18.97	2.65
100 Adults	0.5931	0.3301	0	1247.94	32.96	0.9063	0.0228	20.73	2.38

- In these models, founding a new population with 100 individuals of any life stage results in a population that grows strongly to carrying capacity, with zero likelihood of extinction (PE=0.00).
- Better genetic outcomes are achieved by releasing sub-adults and adults (GD at 100 years > 0.90) as less gene diversity is lost through early life-stage mortality.
- Note that the effect described by the models is relevant to situations where all of the individuals released, regardless of life-stage, are of equal genetic value (e.g. are all unrelated founders). In reality this situation is unlikely. Individuals translocated within a single egg mass are expected to be closely related, whereas translocated adults may be less so, which could further increase the value of releasing adults. On the other hand, many more eggs (and from different egg masses) may be able to be captured and translocated compared to adults, which could reduce the effect.
- These trade-offs can be further explored during the conservation planning workshop, where the models can be reconfigured to describe hypothetical or real scenarios of interest to the workshop participants.

Question 3. In a group of isolated frog populations, can genetic diversity be improved by translocating frogs between populations?

In these models, a metapopulation of frogs includes four populations each of N=200. The following scenarios are modelled:

1) **Isolation.** No inter-site movements
2) **3-year round robin.** Movement of 5% of each population to one other population every 3 years, in a round-robin cycle.
3) **5-year round robin.** Movement of 5% of each population to one other population every 5 years, in a round-robin cycle.
4) **3-year distributed.** Distribution of 5% of each population across the other three populations, every 3 years.

5) **5-year distributed.** Distribution of 5% of each population across the other three populations, every 3 years.

The results of these models are displayed below.

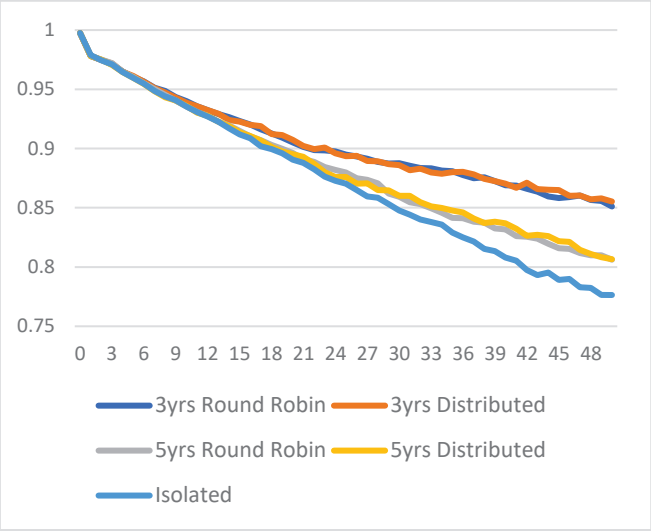


Figure 6. Shows mean gene diversity (GD) over time, in one sub-population of N=200 sited within a larger metapopulation comprising three other populations of the same size, showing no inter-site connectivity (isolated) and four variations of inter-site translocations/dispersal, which are either at 3- or 5-year intervals and which follow either a round robin or a multi-site dispersal strategy.

Table 6. Results of tests to explore how translocation/dispersal within a metapopulation changes gene diversity retention within sub-populations. Four strategies are considered, including one with no inter-site movement (Isolated).

Scenario	stoch-r	SD(r)	PE	N-all	SD(N-all)	GeneDiv
3 yrs Round Robin	0.6109	0.2016	0	797.01	20.95	0.9398
3 yrs Distributed	0.6113	0.1985	0	794.33	23.86	0.9391
5 yrs Round Robin	0.5981	0.1948	0	794	22.97	0.9427
5 yrs Distributed	0.5969	0.1966	0	792.86	24.42	0.9435
Isolated	0.5921	0.1992	0	792.26	24.98	0.9435

- As shown in Figure 6, and Table 6. above, inter-site translocations or dispersal can improve gene diversity outcomes within a metapopulation. Over the 50-year period, considerably less gene diversity is retained when populations are isolated from each other and most gene diversity is retained at the higher translocation frequency of every 3 years or roughly once per generation. The choice of translocation strategy in this instance made no discernible difference.
- Models can be used to explore this further during the planning workshop, for example by varying the relative sizes of sub-populations and the rates of inter-site transfers, to emulate likely configurations in the wild.

Table 7. VORTEX parameters and values used to construct a Wild Baseline Model for the Gold-spotted Pond Frog.

In the table below, values are assembled from the 2009 PVA (Cheong et al 2009), modified with additional data and insights from the PVA Team.

VORTEX Parameter	Wild Base Model Value	Justification
Period modelled	50 years	Used in 2009 – may change pending further PHVA discussions
Inbreeding depression severity (entered as lethal equivalents)	6.29	Vortex Default (wild pops). Species-specific response to inbreeding accumulation unknown.
Percent due to recessive alleles	50%	Vortex Default.
EV correlation between reproduction and survival	None	Not specified in 2009 paper – check with Dr. Cheong
Breeding system	Polygynous	Confirmed. Males can breed with multiple females in a breeding season; females with only one male.
Age of first offspring (females & males)	3/2	From Cheong et al. 2007. 36 months for females, 24 months for males.
Maximum age of reproduction (females and males)	7 years	From Cheong et al. 2007.
Maximum lifespan	7	From Cheong et al. 2007. Only 0.7% of individuals remaining after 7 years (84 months).
Maximum number of broods per year	1	Species is seasonal, 1 season per year. Multiple broods can be produced in a season. We consider the fate of one of these in the baseline (see below).
Maximum number of progeny per brood	90+/-30	Kim et al. 2002, Lee 2004. From the PVA Team: in one season females can lay 600-1000 eggs, spread over multiple broods, each averaging 90 eggs each +/-30. In the baseline model we consider the fate of just one brood to enable simulations of genetic outcomes which take longer when numbers are larger.
Sex-ratio at birth in % males*	50%	No evidence of a biased sex-ratio at birth. Paper cites 83% males in the breeding population (4.88:1). Data for other frog species also indicate a male bias in adult sex-ratio and this typically sits between 3:1 and 20:1 for frogs (from Dr Lee).
% adult females breeding (S.D)	76%	Lee 2004.
Distribution of offspring number:		
Normal	90 +/-30	Figures are from 2009 representing one clutch (of several laid during the breeding season). New models will include total across clutches laid of 600-1000.
Female & Male mortality rates		
Age 0 to 1	62.5%	Lee 2004.
Age 1 to 2	45%	Lee 2004.
Age 2 to 3 (females)	45%	
Age 2 + (males)	20+(-10*(A>2))+(30*(A>4))+(30*(A>5))+(20*(A>6))	Not specified in the 2009 paper. Only 0.7% of individuals remain after 7 years (84 months). This information, and information on operational sex-ratio from Dr Lee (4.88:1 in favour of males) were used to construct baseline age-specific survival values for adult frogs that leave few females living to 6yrs, few males living to 7yrs, and provide an adult sex-ratio skew of approximately 3.43:1 at stable-age structure.
Age 3+ (females)	10+(40*(A>4))+(30*(A>5))+(20*(A>6))	

VORTEX Parameter	Wild Base Model Value	Justification
% Males in breeding pool	100%	Lee 2004. Females will be a limited resource because of the sex-ratio skew. Therefore, though 100% of males are available for breeding in the model, fewer will have the opportunity to breed (in the baseline only approx.. 50%). It is likely that older males are more successful at gaining mating opportunities than younger males though there is no known evidence for this at present (Dr Lee).
Initial population size	200	2009 release cohort size – varied as needed.
Carrying capacity	200	2009 carrying capacity – varied as needed.

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APPENDIX I. PVA PARTICIPANTS

No.	Affiliation	Title	Name	Note
1	National Institute of Ecology (NIE)	Division director	CHEONG, Seokwan	Division of Restoration Strategy
2	National Institute of Ecology (NIE)	Team leader	LEE, Jeeong-hyun	Research Planning Team
3	National Institute of Ecology (NIE)	Associate researcher	SHIN, Moonhyun	

WORKING GROUP NOTES:

GOLD-SPOTTED POND FROG ISSUE STATEMENTS

Group title: Direct Threats
Group members:
Facilitator: Jang, Younghae
Flip chart writer: Park, Ji-Ho
Time keeper: Yoon, Young-Jun
Recorder: Cheong, Seokwan
Reporter: Park, Min-Woo

Issue Name:	Influence of invasive species 침입종에 의한 영향
Description:	If bullfrogs from North America share a habitat with GSP frog, GSP frog will hardly survive in the long term because of predation and competition 북미산 황소개구리가 금개구리와 서식지를 공유할시 포식, 경쟁 등에 의해 전 발생단계에서 문제가 생김
Impact:	Bullfrogs eat GSP frogs and their tadpole and GSP frogs are insufficiently competitive to live with bull frogs 포식으로 인해 성체와 아성체의 생존률이 감소하고 유생과 성체가 경쟁에서 밀려 도태
Causes:	GSP frogs and Bullfrogs prefer very similar niche and habitat and since bullfrogs have relatively high mobility, they can easily move to habitats of GSP frogs 금개구리와 황소개구리의 서식지 특성이 유사하고 황소개구리의 이동성이 커서 금개구리 서식지로 쉽게 유입됨
What do we know?	- GSP frogs are insufficiently competitive to live with bull frogs 황소개구리와의 경쟁에서 밀림 - Bull frogs eat GSP frogs 황소개구리가 금개구리를 포식한다 - They are sympatric species 황소개구리와 금개구리는 동소종임
What do we assume?	- Influence on tadpoles 유생이 영향을 받는다는 점
What more do we need to know?	- Data on movement of individuals between metapopulations of two species 두 종의 메타개체군간 개체 이동에 관한 자료
STATEMENT	Bullfrogs eat GSP frogs and their tadpole and GSP frogs are insufficiently competitive to live with bull frogs

Extra note on the issue
<Description>
황소개구리와 미국가재가 문제가 될 듯 하다.
<Impact>

황소개구리가 잡아먹어서 개체군 크기에 유의미하게 영향을 미친다고 추측됨. 미국가재도 공격성이 강하며, 양서류 개체군을 감소시킨다는 외국 사례가 있음. 황소개구리가 포식성이 커서 특히 성체, 갓 변태한 유생이 영향.
황소개구리에게 먹이원을 빼앗겨서 금개구리는 영향을 받음.
황소개구리 알은 4000-2만, 금개구리는 200개, 경쟁에서 밀릴듯함.
<Cause>
황소개구리는 수로를 따라 유입이 됨. 특히 홍수 등에 의해. 이동성도 큼. 번식력도 큼. 건조 내성이 뛰어남. 추측됨.

<discussion notes>
두웅습지에서 황소개구리를 제거했을 때 성체 생존율이 올라갔다는 연구결과가 있음.
또한 유생수는 감소하였으나 성체는 많아졌음. 다만 알에 대한 증거는 없으므로 전 발생단계라 볼 수는 없음.
또다른 연구에서 황소개구리가 많을 경우 금개구리 개체수가 확실히 적어진다는 연구 결과가 있음.
다른 종에 관한 연구에서 황소개구리와의 경쟁에 의해 생존에 영향을 준다는 결과가 있음.
황소개구리는 유속이 느린 하천 둠벙 등 다양한 습지에 살고 있으며 건조에도 강하고 기후 변동에도 내성이 강함. 따라서 금개구리와 황소개구리의 서식지 특성이 유사하다 할 수 있음.
황소개구리의 이동성은 1년에 1km 264.4m2, 금개구리는 서식범위가 직경 713m2 정도.
금개구리는 한 지역에서 재발견되는 확율이 높아 한 지역을 고집한다는 연구결과가 있음.
캘리포니아의 어떤 종의 경우 황소개구리에 의해 유생이 경쟁에서 밀린다는 결과가 있음.
벨기에의 경우 사람에 의해 비의도적으로 퍼진 사례가 보고된 바 있음.
두웅습지의 경우 어느날 갑자기 황소개구리가 나타났을 때 금개구리가 줄었다는 관찰이 있음.
이를 보았을 때 유생이 경쟁에서 밀리는 것은 사실, 이동성이 낮은 것은 추측

Facts & Evidence	Assumptions & Justification	Key information Gaps
- 황소개구리와의 경쟁에서 밀림 - 황소개구리가 금개구리를 포식한다 -황소개구리와 금개구리는 동소종임	- 유생이 영향을 받는다는 점	- 두 종의 메타개체군간 개체 이동에 관한 자료

Issue Name:	Small and isolated population 고립된 작은 개체군 문제
Description:	Small populations are isolated due to habitat fragmentation, which poses a great threat to population survival. 서식지 파편화 등으로 작은 개체군이 고립되어 개체군 생존에 위협이 큼
Impact:	Due to predation, the survival rate of adults and subadults decreases, and larvae and adults are pushed out of competition and culled. 포식으로 인해 성체와 아성체의 생존률이 감소하고 유생과 성체가 경쟁에서 밀려 도태
Causes:	Lack of connectivity after habitat fragmentation by roads, construction, and etc. 도로, 건설 등에 의한 서식지 파편화 이후 연결성의 부재(부족)
What do we know?	- Isolation due to habitat fragmentation, reduced genetic diversity and reduced population survival 서식지 파편화에 의한 고립과 유전적 다양성 저하와 개체군 생존율 감소 - Effect by predation 포식에 의한 영향

What do we assume?	- Effects of genetic diversity on the survival rate of GSP frogs 유전적 다양성이 금개구리 생존율에 미치는 영향 - population dynamic due to Lack of connectivity after habitat fragmentation 서식지 파편화 이후 연결성이 부족하여 개체군에 영향을 주는 것
What more do we need to know?	- Road kill impact 로드킬에 의한 영향
STATEMENT	A paragraph that combines this information simply and clearly, that will be understood by someone not at the workshop.

Extra note on the issue

<Impact>

한정된 유전자 풀만 가지고 번식, 근친교배, 근교약세, 취약해 짐. 번식률 사망률 감소 가능. 외부 스트레스 환경에 취약할 것임. 포식, 로드킬 등 우연한 사건에 의해 개체군 전체가 영향 받을 가능성이 큼.

<Cause>

수계의 단절, 개발에 의한 서식지 파편화, 연결통로(Corridor)를 마련해야 하나 그것도 없음. 연결성이 훼손됨.
이동성이 작은 생태적 특징도 원인.

<discussion notes>

일반적인 생물학적 사실임.

다만 로드킬의 경우 이동성이 작으므로 가능성은 있으나 확실하지는 않음.

Facts & Evidence	Assumptions & Justification	Key information Gaps
- 서식지 파편화에 의한 고립과 유전적 다양성 저하와 개체군 생존율 감소 - 포식에 의한 영향	- 유전적 다양성이 금개구리 생존율에 미치는 영향 - 서식지 파편화 이후 연결성이 부족하여 개체군에 영향을 주는 것	- 로드킬에 의한 영향

Issue Name:	Disease
Description:	A situation where the survival of the population is impossible due to mass death of larvae or adults due to diseases such as chytrid or ranavirus Chytrid나 ranavirus 등 질병에 의해 유생이나 성체가 대량폐사하여 개체군 존속이 불가한 상황
Impact:	So far, there are no cases in the wild, only some cases in the process of artificial breeding, but it can be fatal when new diseases are introduced from abroad. 현재까지 복원을 위한 증식 과정에서의 사례를 제외하고 야생상태에서 사례는 없으나 해외에서 새로운 질병 유입시 치명적일 수 있음
Causes:	좁은 서식지 면적과 높은 밀도. 해외에서 식용, 애완 목적으로 유입된 양서류의 탈출이나 유기
What do we know?	- Mass mortality due to Ranavirus 라나바이러스에 의한 대량폐사 - The impact of disease is large in a small area 좁은 지역에서 질병의 영향이 크다는 점
What do we assume?	- Escape of imported species, introduction of diseases due to abandonment 수입종의 탈출,

	유기에 따른 질병 유입
What more do we need to know?	- Specific studies on the effects of diseases 질병에 의한 영향에 관한 구체적 연구 - Susceptibility to chytrid 카이트리드에 대한 감수성
STATEMENT	A paragraph that combines this information simply and clearly, that will be understood by someone not at the workshop.

Extra note on the issue

<Description>
항아리곰팡이병이 전세계 영향. 하지만 국내에서는 사례는 없음
라나바이러스도 청개구리 등 3종을 이용해 실험했을 때도 집단폐사는 없었음. 사육시에는 발견된바 있음
<Impact>
만약에 서식지가 좁다면 영향을 줄 수도 있을 듯함.
사육상태는 밀도가 높고 하니깐 발생이 될 수 있는 듯.
현재까지는 잘 모르겠음. 가능성은 있음.
<Cause>

해외 유입이 된다면 원인 : 개체 수입, 탈출, 유기, 특히 야생개체 수입시 질병을 갖고 있을 경우가 많음. 야생개체, 사육개체 구별하여 수입 관리, 화이트리스트 관리. 자연적 전파도 가능
<discussion notes>
개체군 존속이 불가한 상황이란 과도한 표현임. 개체군에 영향을 준다 정도가 적절.
산개구리 집단폐사체를 검시하였을 때 라나바이러스가 발견된 사례는 있음. 하지만 직접적인 사인인지는 알 수 없음.
해외의 경우 카이트리드에 의해 고유 양서류가 대량폐사한 사례는 있음.
해외 유입시 치명적인 것은 가정임.
사육 개체군의 경우 대량폐사한 사례가 있으므로 사실이라 할 수 있음.
개체군이 사용하는 서식범위는 3,700m2라는 조사 결과가 있음.
적정 밀도에 관해서는 자료가 없음. 따라서 좁은 서식지 면적과 밀도는 추측의 영역임.

Facts & Evidence	Assumptions & Justification	Key information Gaps
- 라나바이러스에 의한 대량폐사 - 좁은 지역에서 질병의 영향이 크다는 점	- 수입종의 탈출, 유기에 따른 질병 유입	- 질병에 의한 영향에 관한 구체적 연구 - 카이트리드에 대한 감수성

Issue Name:	Chemicals such as pesticides 농약 등 화학물질
Description:	Over-application of pesticides causes stunting of individual development or occasional mortality of adults and larvae 과다 살포된 농약에 의해 개체 발달에 장애를 유발하거나 가끔 성체와 유생 폐사
Impact:	Affects the development of organisms such as larvae. Herbicide use reduces food

	sources and hiding places 유생 등 개체 발달에 영향. 제초제 사용으로 먹이원 및 은신처 감소
Causes:	Insufficient education and supervision, such as disposal methods when using pesticides, widespread impact due to drone use, and no buffer between farmland and habitat 농약 사용시 폐기 방법 등 교육, 감독 미비하며, 드론 사용으로 인한 광범위 영향, 농지와 서식지 사이에 버퍼가 없음
What do we know?	- 농약이 폐사를 유발 Pesticides cause mortality - 제초제 사용에 의한 피도 감소, 살충제 사용에 의한 먹이생물 감소 Reduction of coverage by using herbicides, reduction of prey by using pesticides
What do we assume?	- Pesticide use has long-term effects 농약 사용이 장기적으로 영향을 미침 - GSP frog occurrence disorder caused by pesticide use 농약 사용에 의한 금개구리 발생 장애
What more do we need to know?	- The effect of the concentration of pesticides used in the field on the survival and occurrence of individuals 실제 현장에서 사용하는 농약의 농도가 개체 생존과 발생등에 미치는 영향
STATEMENT	A paragraph that combines this information simply and clearly, that will be understood by someone not at the workshop.

Extra note on the issue

<Impact>
규정에 어긋난 농약사용(희석율, 사용장소, 잘못된 폐기방법 등). 발달에 장애가 됨. 장기적 노출이 문제. 번식률 감소, 폐사율 증가. 제초제를 사용하여 식물이 죽으니 피복도(은신처) 감소, 먹이 감소의 영향. 직접적 폐사의 원인이 되기도 함.
<Cause>
사용자에 대한 교육 및 관리감독 부족, 드론 사용에 의한 무차별 살포. 서식지와 농지의 인접. 향후 대상특이적 농약을 개발해야 할 듯
<discussion notes>
최근 농약에 의해 직접적인 피해를 본다는 증거는 사실 없음. 개체 단위는 가능하나 개체군 수준에서는 판단하기 곤란함. 농약 사용에 의한 먹이원 감소는 연구결과가 있음. 먹이가 되는 파리, 벌목의 곤충의 감소를 유발함. 은신처가 되는 식물의 피도 감소가 개체군 생존에 악영향을 준다는 연구 결과도 있음. 직접적, 단기적인 영향이라기 보다는 간접적, 장기적 영향일 듯함. 유생 등의 개체 발달 영향에 대해서는 더 찾아보기로.

Facts & Evidence	Assumptions & Justification	Key information Gaps
- 농약이 폐사를 유발 - 제초제 사용에 의한 피도감소, 살충제 사용에 의한 먹이생물 감소	- 농약 사용이 장기적으로 영향을 미침 - 농약 사용에 의한 금개구리 발생 장애	- 실제 현장에서 사용하는 농약의 농도가 개체 생존과 발생등에 미치는 영향

Issue Name:	Natural disasters 자연재해
Description:	Population wiped out or collectively killed by floods, droughts, etc. 홍수, 가뭄 등에 의해 개체군이 쓸려가거나 집단 폐사함
Impact:	During floods, population deaths increase and dispersal to nearby areas, and during droughts, survival rates decrease due to reduced genetic diversity as population survival decreases 홍수 시에는 개체군 폐사 증가 및 인근으로 분산이 되며 가뭄 시에는 개체군 생존이 감소함에 따라 유전자 다양성이 저하되어 생존률 감소
Causes:	Anthropogenic interventions such as climate change and groundwater development 기후변화와 지하수 개발 등 인위적 개입
What do we know?	- Drought-induced population size decline 가뭄에 의한 개체군 크기 감소 - Drying by groundwater development 지하수 개발에 의한 건조
What do we assume?	
What more do we need to know?	- Comparison of the effects of climate (precipitation, etc.) changes on the golden frog population 금개구리 개체군의 기후(강수량 등) 변화에 의한 영향 비교 - Effects of drying due to groundwater development on gold frogs 지하수 개발에 의한 건조가 금개구리에 미치는 영향
STATEMENT	A paragraph that combines this information simply and clearly, that will be understood by someone not at the workshop.

Extra note on the issue

<Description>
홍수와 가뭄에 의해 영향을 받는다.
<Impact>
전 발달단계에서 사망률이 올라간다. 개체군이 파편화된다.
파편화되면 유전적 문제, 지역적 질병발생으로 인해 몰살. 개체군이 작으므로.
홍수에 의해서 긍정적 부정적 영향을 모두 받을 수 있다.
<Cause>
지구온난화, 인위적인 개발. 직선형 수로가 쉽게 마르게 하는 원인. 농약 사용 및 지하수 개발에 의한 고갈, 건조화
<discussion notes>
자연재해 관련해서는 사례를 더 찾아봐야 하나 추정인 듯. 홍수 후 개체수가 감소한 다른 종의 사례가 있음. 다른 종에서는 물이 가물어 알이 죽어 버린 사례는 있음.

Facts & Evidence	Assumptions & Justification	Key information Gaps
- 가뭄은 개체군 크기를 감소시킴 - 지하수 개발에 의한 건조		- 금개구리 개체군의 기후(강수량 등) 변화에 의한 영향 비교 - 지하수 개발에 의한 건조가 금개구리에 미치는 영향

Group title: *Ineffective of insufficient conservation action*
Group members: Sujeong Cho, Donggul Woo, Hyun Kim, Youngmin Kim, Young-gun Kim, Ha-en Gye, Hye-rim Kwon, Moonhyun Shin

Issue Name:	Lack of public awareness, 대중인식 부족
Description:	금개구리에 대한 무관심이나 보전에 관한 인식 부족 Indifference to the species and lack of awareness for conservation
Impact:	보전활동을 위한 원동력(지지) 부족 Lack of driving force for conservation activities
Causes:	Hard to distinguish from similar species 개구리 종을 구분하기도 어려움, Negative cognition like nasty or scared 징그럽다 또는 무섭다와 같은 부정적 인식, Lack of education for the species 금개구리 관련 교육 부족 Hard to give imperativeness for budget and conservation for the species 금개구리 보전에 대한 관심과 예산 투자에 대한 당위성 부여가 쉽지 않음
What do we know?	Hard to distinguish from similar species Lack of education Hard to find good reasons to get budget for conservation
What do we assume?	Negative cognition for amphibian species
What more do we need to know?	Survey result for public awareness of the species
STATEMENT	Since the public is not interested in the conservation for the species, it is hard to improve the conservation status for the species
GOAL 1:	Improving public awareness by education and public relation
GOAL 2:	Identifying ecosystem service and benefit from the species

Issue Name:	Lack of conservation policies 보전정책 부족
Description:	Lack of conservation policies like designating protected area 보호지역, 새의 먹이주기 등 금개구리를 대상으론 하는 보전 정책 부재
Impact:	Habitat decrease due to lack of management for the habitat 서식지 관리부재로 서식지 감소
Causes:	- Lack of collaboration between government agencies 중앙관계 부처(환경부, 농림축산식품부) 간의 협업이 필요하지만 이를 조율하는 것이 어려움 - Hard to designate as a protected area since they are mostly private agricultural land 주 서식지가 농경지(논)이다 보니 보호지역으로 설정하기가 어려움 - Low Effectiveness of punishment and crackdown for illegal catching 불법 포획 등에 대한 단속과 처벌 실효성 낮음
What do we know?	Hard to expect cooperation between government agency (Ministry of Environment, Ministry of Agriculture, and Korea Rural Community Corporation) 중앙 관계부처 간의 협업 어려움 Hard to designate as a protected area 서식지를 보호지역으로 설정하기 어려움 Low effectiveness for preventing illegal catching 불법 포획 등에 대한 처벌 실효성 낮음
What do we assume?	보전할 수 있는 정책으로 개발할 만한 사안들은 있을 것임

	There must be some effective candidates for conservation policies
What more do we need to know?	
STATEMENT	
GOAL 1:	*Reinforcing conservation policies for the species*
GOAL 2:	*Strengthening cooperation between government agencies*

Issue Name:	Lack of information for migration monitoring and survival rate 이주사업에 대한 모니터링을 통한 효과 분석 부족
Description:	After translocation to alternative habitat, monitoring is conducted, but lack of evaluation for migration and survival rate
Impact:	Translocation is not quite successful so far, but developer just translocate them as a solution to remove the species in the target area 이주 후 개체군 대부분이 감소와 절멸, 이주가 개발사업의 면죄부 역할
Causes:	Translocation is abused to remove the species in the development target area 개발의 필요에 따라 현지내 보존을 피하는 방법으로 악용됨, Lack of evaluation data for monitoring results 이주사업 후 사업효과가 부족한 것으로 보이지만 평가자료 역시 부족, Lack of manpower and system to manage 현실적으로 관리를 위한 인력과 시스템 부족, No management plan after the monitoring (normally 3 years) 모니터링 기간(3년) 이후에 관리될 방안 부재 Companies don't like to share monitoring and translocation methods since they think that is their business secret 대체서식지 모니터링 및 이주방법에 대한 공유 및 협업에 소극적임
What do we know?	Lack of evaluation data for monitoring results Lack of manpower and system to manage No management plan after the monitoring (normally 3 years)
What do we assume?	Translocation is abused to remove the species in the development target area Companies conducting migration for the species don't like to share monitoring and translocation methods since they think that is their business secret
What more do we need to know?	이주사업에 대한 모니터링을 통한 효과 자료 Monitoring research on the translocation effectiveness
STATEMENT	
GOAL 1:	*improving survival rate after translocation*
GOAL 2:	*Reducing translocation by development*

Issue Name:	Lack of budget for conservation 보전을 위한 예산 부족
Description:	Insufficient budget for conservation of the species 보전을 위한 불충분한 예산
Impact:	Conservation actions has low effectiveness due to lack of budget 보전에 필요한 예산 부족으로 보호 활동에 실효적 보전성과 낮음
Causes:	Hard to persuade decision makers and publics to ask conservation budget Many people don't sympathize with using more budget for the species
What do we know?	
What do we assume?	Small budget for conservation of the species 금개구리 보전 사업에 대한 예산이 적음 Hard to get more budget for the species since hard to give clear reasons 예산 개발 시스템 부재 및 예산 반영 어려움

What more do we need to know?	Research on estimate for conservation budget to effectively conserve the species 보전에 필요한 사업과 소요 예산의 추정 자료
STATEMENT	
GOAL 1:	Expanding conservation budget for the species
GOAL 2:	*Expanding research budget for ecology of the species* ``

Group title: HABITAT

Group members: 김수경, 김선령, 김민한, 이진홍, 천지연, 민완기, 박상인

Explanation:

Issue Name:	Land use change due to development of paddy habitat 논서식지 개발로 인한 용도변경
Description:	Paddy fields are disappearing due to the construction of fields, greenhouses, and apartments. 논이 밭, 비닐하우스, 아파트 건설등으로 사라지고 있다.
Impact:	Population decline and loss Density increases due to habitat fragmentation reduced food source movement restrictions 개체군 감소 및 소실 서식지 파편화로 인한 밀집도 상승 먹이원 감소 이동 제한
Causes:	low economic feasibility urban expansion Decrease in small-scale agriculture and emergence of large-scale farm owners due to aging agricultural population 논의 낮은 경제성 도시팽창 농업인구 고령화로 인한 소규모 농업 감소 및 대규모 농장주의 등장
What do we know?	Population decline and loss Density increases due to habitat fragmentation reduced food source 개체군 감소 및 소실 서식지 파편화로 인한 밀집도 상승 먹이원 감소 Paddy area decreased from 966 ha in `12 to 780 ha in 2021 (2021 cropland area survey results, Statistics Korea) Aging of the agricultural population Increased from 65.5% of those aged 60 or older in 2012 to 77.3% in 2021 (Main response policies and future tasks according to changes in the population structure of farm households in 2022, National Assembly Legislation Research Service) Compared to 2009 in 36 existing habitats, the population decreased in all 5 areas, and habitats in 2 areas were completely reclaimed and not found, 5 areas planned for development (Ra et al., 2016) Compared to 2017, the habitat decreased by 20% only in the Chungnam region in 2021 (Hankyoreh, 2021) 논 면적이 `12년 966 ha 에서 '21년 780ha 로 감소 (2021년 경지면적 조사 결과, 통계청) 농업 인구 연령의 고령화 '12년 60세 이상 65.5% 에서 '21년도 77.3% 로 증가 (2022년 농가 인구구조 변화에 따른 주요 대응정책과 향후과제, 국회입법조사처)

	기존 36개 서식지 지점2009년에 비해서 5개 지역에서 모두 개체수 감소하였으며, 2지역은 서식지가 아예 매립되어 발견되지 않음, 개발 예정 5지역임(라 등, 2016) 2017년에 비해여 2021년 충남지역에 한해서 서식지가 20%감소하였음 (한겨레, 2021)
What do we assume?	limited mobility '이동 제한
What more do we need to know?	Does the change from paddy to wetland lead to an increase in the population and proportion of golden frog habitats? 논의 습지로의 변화로 인해 금개구리 서식지 비율 및 개체수의 증가를 가져오는가?
STATEMENT	

Issue Name:	Transition and Landing of Natural Wetlands 자연습지의 천이 및 육역화
Description:	Due to the construction of dams and the direct strengthening of rivers, wetlands are becoming land areas 댐 건설및 하천의 직강화등으로 인해 습지의 육역화가 진행된다.
Impact:	Habitat decline and loss reduced food source movement restrictions Increased presence of predators (estimated) 서식지의 감소 및 소실 먹이원 감소 이동 제한 포식자 출현 증가(추정)
Causes:	Securing agricultural harvest and disaster prevention weather change Natural Landscaping in the Downstream of the Dam Changes in hydraulic sluice due to urbanization and development Loss of wetlands due to development of water-friendly spaces (bicycle roads, installation of sports facilities, etc.) 농수확보 및 재해예방 기후변화 댐하류의 자연육역화 도시화 및 개발로 인한 수리수문 변화 친수공간(자전거 도로, 운동시설 설치 등) 개발로 인한 습지 소실
What do we know?	Habitat decline and loss reduced food source movement restrictions 서식지의 감소 및 소실 먹이원 감소 이동 제한 Naeseongcheon stream has accelerated due to the construction of Yeongju Dam (Newstapa, 2017) Acceleration of wetland area in river through river maintenance and embankment installation (Ahn Hong-gyu, 2020, A study on wetland restoration measures to prevent river landfill) 영주댐 건설로 내성천 육화가속 (뉴스타파, 2017) 하천 정비와 제방설치로 하천내 습지면적 육역화 가속 (안홍규, 2020, 하천 육역화방지를 위한 습지복원방안에 관한 연구)

What do we assume?	Estimated population decline due to increased presence of predators 포식자 출현 증가로 인한 개체수 감소 추정
What more do we need to know?	
STATEMENT	

Issue Name:	Disturbance by agricultural machinery 농기계에 의한 교란
Description:	Habitat environment disturbance due to agricultural mechanization 농업의 기계화로 인한 서식환경 교란
Impact:	Disruption of spawning grounds due to the use of rice transplanters Hibernating ground disturbance due to tractor use 이앙기 사용으로 인한 산란지 교란 트랙터 사용으로 인한 동면지 교란
Causes:	Decrease in small-scale farming due to aging agricultural population the rise of large-scale agriculture to increase agricultural efficiency 농업인구 고령화로 인한 소규모 농업 감소 대규모 농업의 증가 농업 효율성 증대를 위해
What do we know?	98.6% mechanization rate of paddy farming in 2020 (Korea Rural Newspaper, 2022) The supply ratio of large tractors was 0% in 1990, but increased to 61.9% in 2020, and the supply ratio of large combines increased from 0% in 1990 to 86.2% in 2020 (9th Basic Plan for Agricultural Mechanization Ministry of Agriculture, Food and Rural Affairs, 2022) 2020년 논농사의 기계화율 98.6% (한국농어민신문, 2022) 대형 트랙터 공급 비율이 90년 0%였으나 2020년 61.9%로 증가, 대형 콤바인 공급 비율은 90년 0%에서 2020년 86.2%로 증가 (9차 농업기계화 기본계획 농림축산식품부, 2022)
What do we assume?	
What more do we need to know?	
STATEMENT	

Issue Name:	Construction of concrete waterways in rice fields 논 내의 콘크리트 수로 건설
Description:	Increasing concrete replacement for earth canal 흙 농수로의 콘크리트화
Impact:	habitat loss movement restrictions 서식지 소실 이동제한
Causes:	Modernization of traditional agriculture, changes in agricultural methods Stable securing and efficient management of agricultural water Farm road securing construction for agricultural machinery use 전통농업의 현대화, 농업방식의 변화 농수의 안정적인 확보 및 효율적 관리 농기계사용을 위한 농로 확보 공사

What do we know?	Farming surrounded by concrete has become a graveyard for frogs (Hankyoreh, 2022) There is no escape route maintenance, and the ratio of escape routes in agricultural waterways is 1% (Jeonbuk Ilbo, 2022) 콘크리트로 둘러진 농사로, 개구리들의 무덤 됐다 (한겨레, 2022) 탈출로 정비 전무하며, 농수로 내 탈출구 비율 1% (전북일보, 2022)
What do we assume?	
What more do we need to know?	Find the rate of increase in agricultural waterways in the Rural Community Corporation 농어촌공사에서 농수로 증가율 찾기
STATEMENT	

Issue Name:	Spraying pesticides and chemical fertilizers 살충제 및 화학비료 살포
Description:	Direct and indirect damage from exposure to chemicals 화학물질 노출에 의한 직간접적 피해
Impact:	Tadpole behavior changes and development inhibition Individual mortality due to pesticides reduced food source 올챙이 행동변화 및 발달 저해 살충제로 인한 개체 사망 먹이원 감소
Causes:	Increase agricultural yield and efficiency Increase Agricultural Profits Lack of support for eco-friendly agriculture Agricultural technology development (drone spraying) 농업 생산량 및 효율성 증대 농업 수익 증대 친환경농업 지원 부족 농업기술 발달(드론 살포)
What do we know?	As of 2019, fertilizer consumption was 268kg/ha, the highest among OECD countries. Australia: 67.6kg/ha (Korea Rural Economic Institute, 2019) 0.17~6.8mg/kg of organic nitrogen-based pesticides were detected in major amphibians in Korea (bullfrog, black frog) (Odeung, 2002, accumulation of organic nitrogen-based pesticides in amphibians and fish living in major river basins in Korea) Inhibition of growth and development of tadpoles by chemical substances (Hyomin Ahn, 2013, Inhibition of development and formation of dorsal mesoderm by heavy metals in Korean shaman frog embryos) Pesticide disaster prevention using agricultural drones helps to resolve labor shortages and improve agricultural productivity. Agricultural drones are more efficient due to the aging population in rural areas and the closeness between residential areas and farmland (Chung and Jo, 2022, A study on pesticide control efficiency using agricultural unmanned aerial vehicles) In 2010, the exclusion of eco-friendly certification for low pesticide farming resulted in obstacles to organic (non-pesticide) farming conversion. In the past, it could have been a stepping stone to move from low-pesticide to non-pesticide, but it was difficult to switch to pesticide-free farming at once, so farmers gave up organic farming (Hankyoreh 21, 2023.01, rice farming on 'half of arable land', can it be converted to organic farming?) 2019년 기준 비료 사용량이 OECD 국가중 제일 높은 268kg/ha 사용 호주는 67.6kg/ha (한국농촌경제연구원, 2019) 우리나라 주요 양서류(황소개구리, 참개구리) 체내 유기질소계 농약류가 0.17~6.8mg/kg 검출 (오 등, 2002, 우리나라 주요 하천유역에 서식하는 양서류 및 어류의 유기질소계

	농약류 축적) 화학물질로 인한 올챙이 성장 및 발달 저해 (안효민, 2013, 한국산 무당개구리 배아에서 중금속에 의한 발생 및 등쪽 중배엽 형성 저해) 농업용 드론을 활용한 농약 방재는 일손 부족을 해소하고, 농업 생산성 향상에 도움이 됨. 농업용 드론은 농촌지역 인구고령화와 주거지역과 농경지 사이의 밀접성으로 인해 보다 효율적임 (정과 조, 2022, 농업용 무인항공기를 활용한 농약방제 효율성 방에 관한 연구) 2010년 저농약 농법의 친환경 인증 제외로 인해 유기농(무농약) 농업 전환의 걸림돌 발생. 이전에는 저농약에서 무농약으로 넘어갈 디딤돌이 될 수 있었으나 한번에 무농약 농법으로의 전환이 힘들어 농민들의 유기농업을 포기하게 됨 (한겨레21, 2023.01, '경작지 절반' 쌀 농사, 유기농 전환할 수 있을까?)
What do we assume?	Estimation of tadpole behavioral changes and growth inhibition due to chemical stress 화학적 스트레스로 인한 올챙이 행동변화 및 성장저해 추정
What more do we need to know?	Changes in Agricultural Revenue 농업 수익의 변화
STATEMENT	

GOALS TO ADDRESS ISSUES FACING THE GOLD-SPOTTED POND FROG

No.	GOAL	Imp	Urg	Feas	Tot
1.	**Spatial planning**				
1.1	Consider wildlife when the national land use plan is set: - rban areas: purchase rice fields & convert to wetland park - rural areas: establish ten eco-villages with organic farming created	11	10	10	31
12	Increase the carrying capacity of small, isolated frog habitats & ensure connectivity with neighbouring populations.	3	2	3	8
1.3	Provide space within habitats to avoid drought or flooding.	1	0	4	5
2.	**Frog-friendly Farming**				
2.2	Promote & enable frog-friendly irrigation methods including: - a study of frog death rates in concrete irrigation ditches - the impact on this of escape facilities (e.g. frog ladders) - where farmers agree, convert concrete ditches to dirt ditches. Otherwise install escape facilities demonstrated to be effective.	5	10	7	22
2.3	Promote and enable GSP Frog-friendly farming practices: - undertake a study to establish the impact of pesticides on Gold-spotted Pond Frogs - develop & disseminate pesticides that are less harmful to GSP Frogs [Promote Integrated Pest Management?] - develop & disseminate information on farming methods that can co-exist with the GSP Frog - collaborate with farmers to apply GSPF-friendly farming practices.	7	5	5	17
2.4	Through research, gather data on the impact of modern farm machinery on frog hibernation and breeding. Use this to develop guidelines to minimise disturbance	0	0	0	0
3.	**Managing Invasive Species**				
3.1	Reduce the population of Bullfrogs in GSPF habitat (including by changing the habitat to be more favourable to GSPFs and less favourable to Bullfrogs)	1	5	5	11
4.	**Disease monitoring & management**				
4.1	Manage disease effectively including: - continuous disease monitoring - when breeding for reintroduction, make sure to manage healthy individuals and prevent disease	0	6	7	13
5.	**Managing translocation mortality**	8	12	6	26
5.1	Increase post-translocation survival rate				
5.2	Minimise translocations occurring due to development				
6.	**Enabling conditions**				
6.1	Increase public awareness of this species and the benefits that it provides to ecosystems	11	3	11	25
6.2	Reinforce conservation policies	9	6	2	17
6.3	Strengthen cooperation between government agencies	9	6	2	17
6.4.	Expand the budgets for conservation and conservation-directed research	8	6	4	18

ACTIONS TO ACHIEVE GOALS FOR KOREAN GOLD-SPOTTED POND FROG CONSERVATION AND RECOVERY

Group Name: Direct Threats
Group Members: Jang, Hyung-gyu / Cheong, Seokwan / Lee, Jung-hyun / Son, Sang-ho

GOAL 1: 금개구리 서식지 내에 황소개구리의 개체수를 줄인다.(Reduce the population of bullfrogs within the golden spotted pond frog(GSPF) habitat.)

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	Bullfrog extermination activities are carried out in 100 major golden frog habitats 주요 금개구리 서식지 100개소에서 황소개구리 퇴치 활동을 한다.	0% bullfrog discovery rate 황소개구리 발견율 0%	State, local government, people 국가, 지자체, 국민	Selected 100 bullfrog eradication targets 황소개구리 퇴치 대상지 100개소 선정	Bullfrog eradication in 30 locations and improvement in elimination methods 황소개구리 퇴치 30개소 실시 및 퇴치방법 개선	Completion of bullfrog eradication in 70 places and summary of eradication results 황소개구리 퇴치 70개소 완료 및 퇴치 성과 정리

GOAL 2: 금개구리 서식지 형태를 금개구리 서식에는 유리하나 황소개구리 서식에 불리한 환경으로 바꾼다.(Change the habitat of GSPFs to an environment favorable to the habitat of GSPFs but unfavorable to the habitat of bullfrogs.)

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	Identification of optimal habitat conditions for golden frogs 금개구리 최적 서식 환경 조건 규명	Finding out optimal habitat conditions 최적 서식 조건 도출	researchers, people 연구자, 국민	Preparation of methods for detecting suitability of gold frog habitat and major environmental factors 금개구리 서식지 적합성 및 주요 환경 요인 검출 방법 마련	Figuring out of optimal habitat conditions for gold frogs and results of major environmental factors 금개구리 최적 서식 조건 및 주요 환경 요인 결과 도출	
2	Adjust the water depth to an appropriate level for GSP frog habitat 물 깊이를 금개구리 서식에 적절한 정도로	50% reduced bullfrog discovery rate 황소개구리 발견율 50%	local governments, citizens, Land owner, researcher 지자체, 국민,	Pilot application of microhabitat environmental factor control for optimal	After applying the optimal habitat conditions for GSP frogs, check and	Establishment of optimum habitat conditions for GSP and maintenance

	조절한다	감소	서식지 소유자, 연구자	habitat conditions for GSP frogs 금개구리 최적 서식 조건을 위한 미소서식지 환경 요인 조절 시범 적용	monitor the population of golden frogs and bullfrogs 금개구리 최적 서식 조건 적용 후, 금개구리와 황소개구리 개체 수 확인 및 모니터링	of continuous environment, monitoring of bull frog population, determination of optimum habitat conditions for golden frogs 금개구리 최적 서식 조건 확정 및 지속적인 환경 유지, 황소개구리 개체 수 모니터링, 금개구리 최적 서식 조건 확정
3	Remove water from the bullfrog's hibernating area (reservoir, pond, etc.) 겨울철 황소개구리 동면장소(저수지, 연못 등) 물을 제거한다.	50% reduced bullfrog discovery rate 황소개구리 발견율 50% 감소	local governments, citizens, Land owner, researcher 지자체, 국민, 서식지 소유자, 연구자	Confirmation of bullfrog hibernation site and selection of application point 황소개구리 동면장소에 대한 확인과 적용 지점 선정	Derivation of research results on water removal methods (time, drainage, etc.), pilot application of water removal work, and analysis of bullfrog elimination rate 물 제거 방법(시기, 배수량 등)에 대한 연구 결과 도출, 물 제거 작업 시범 적용과 황소개구리 퇴치율 분석	Expansion and application of bullfrog hibernation sites nationwide, final analysis of elimination success rate 전국 황소개구리 동면장소 확대 및 적용, 퇴치 성공률 최종 분석

GOAL 3: 고립된 작은 서식지의 수용 능력을 높인다.(Increase the carrying capacity of isolated small habitats.)

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	dentification of optimal habitat conditions for GSP frogs 금개구리 최적 서식 환경 조건 규명	Finding out optimal habitat conditions 최적 서식 조건 도출	researchers, people 연구자, 국민	Establishment of research methods to identify the suitability of golden frog habitat and major environmental factors 금개구리 서식지 적합성 및 주요 환경 요인 규명 연구방법 마련	Identification of GSP frog habitat suitability and major environmental factors 금개구리 서식지 적합성 및 주요 환경 요인 규명	
2	Increase the coverage of herbaceous species in the habitat 서식지내 초본류의 피도를 높인다	100% increase in GSP frog density in 30 representative habitats 대표 서식지 30개소 금개구리 밀도 100% 증가	local governments, citizens, Land owner, researcher 지자체, 국민, 서식지 소유자, 연구자	Selection of target areas for increased coverage of herbaceous species within the GSP frog habitat and preparation of application methods 금개구리 서식지 내 초본류 피도 상향 대상지 선정과 적용 방법 마련	Transplanting herbaceous species in the golden frog habitat and monitoring the increase in the population of golden frogs 금개구리 서식지 내 초본류 이식과 금개구리 개체 수 증가 여부 모니터링	Transplanting herbaceous species within the golden frog habitat and analyzing the results of the increase in the population of golden frogs, preparing a plan to expand the target area in the future Analysis of the results of the increase in the number of golden frogs due to the maintenance of stable water levels in the golden frog habitat, and preparation of a plan to expand the target area in the future

						금개구리 서식지 내 초본류 이식과 금개구리 개체 수 증가 여부 결과 분석, 향후 적용 대상지 확대 계획 마련
3	Stable maintenance of water level favored by golden frogs 금개구리가 선호하는 수위를 안정적으로 유지	100% increase in golden frog density in 30 representative habitats 대표 서식지 30개소 금개구리 밀도 100% 증가	local governments, citizens, Land owner, researcher 지자체, 서식지소유자, 연구자	Selection of a site for stable water level maintenance in the gold frog habitat and preparation of application method 금개구리 서식지 내 안정적 수위 유지 대상지 선정과 적용 방법 마련	Maintaining a stable water level in the golden frog habitat and monitoring the increase in the golden frog population 금개구리 서식지 내 안정적 수위 유지와 금개구리 개체 수 증가 여부 모니터링	Analysis of the results of the increase in the number of golden frogs due to the maintenance of stable water levels in the golden frog habitat, and preparation of a plan to expand the target area in the future 금개구리 서식지 내 안정적 수위 유지에 따른 금개구리 개체 수 증가 여부 결과 분석, 향후 적용 대상지 확대 계획 마련

GOAL 4: 인접 개체군과의 연결성을 확보한다.(Ensure connectivity with neighboring populations.)

No.	**Action description**	**Success Indicators**	**LEAD** (Collaborators)	**0-1 year**	**1-5 years**	**5-10 years**
1	Design and installation of waterways that do not hinder the movement of	30% expansion of eco-friendly waterways	State, researcher 국가, 지자체	Design of a waterway that allows	Selecting a target for pilot	Installation of an eco-friendly

	golden frogs 금개구리 이동에 방해가 되지 않는 수로의 설계와 설치	nationwide 전국 수로 친환경 수로 30% 확대		movement of golden frogs 금개구리 이동이 가능한 수로 설계	application of eco-friendly waterways, monitoring results after pilot application, and improving eco-friendly waterway design 친환경 수로 시범 적용 대상지 선정과 시범적용 후, 결과 모니터링, 친환경 수로 설계 개선	waterway in the golden frog habitat and monitoring of results 금개구리 서식지 내 친환경 수로 설치와 결과 모니터링
2	Stepping stones between populations Establishment of meta-populations 개체군 간 징검다리 메타 개체군 조성	10 places over 10 years 10년간 10개소	State, local government, researcher State, researcher 국가, 지자체, 연구자	Selection of new meta-population creation target and re-introduction population selection 신규 메타 개체군 조성 대상지 선정 및 재도입 개체군 선정	Test installation in 3 new meta populations, monitoring whether gold frog population is maintained, and continuous population strengthening 신규 메타 개체군 3개서 시범설치와 금개구리 개체군 유지 여부 모니터링, 지속적인 개체군 강화	Establishment of new meta-populations in 7 locations across the country, monitoring of populations in 10 locations, final analysis of meta-population adaptation and stability confirmation 전국 7개소 신규 메타 개체군 조성 및 총 10개소 개체군 모니터링, 메타 개체군 적응 및 안정성 확인 최종 결과 분석

GOAL 5: 지속적으로 질병 모니터링을 실시한다.(Conduct continuous disease monitoring.)

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	Establishment of gold frog disease monitoring plan 금개구리 질병 모니터링 계획 수립	Prepare a 10-year plan 10년단위 계획 마련	State, researcher 국가, 연구자	Identification of various diseases related to golden frogs such as chytrid and ranavirus, selection of targets for monitoring golden frog diseases, and preparation of major plans 항아리곰팡이병, 라나바이러스 등 금개구리 관련 각종 질병 확인, 금개구리 질병 모니터링 대상지 선정 및 주요 계획 마련		
2	Gold frog disease monitoring 금개구리 질병 모니터링 실시	Publication of annual report 연간 보고서 발간	State, researcher 국가, 연구자	Publication of an annual report on the results of monitoring various diseases related to gold frogs such chytrid and ranavirus 항아리곰팡이병, 라나바이러스 등 금개구리 관련 각종 질병 모니터링 결과 연간보고서 발간		

GOAL 6: 복원을 위한 사육할 경우 건강한 개체 관리와 방역에 만전을 기한다.(When breeding for reintroduction, make sure to manage healthy individuals and prevent disease.)

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	Preparation of object management and quarantine manuals and inspection of actual conditions 개체 관리 및 방역 매뉴얼 마련 및 실태점검	연간 보고서 발간	State, local government, researcher 국가, 지자체, 연구자	Preparation of individual management and quarantine manuals, preparation	Object management, quarantine and emergency response system	

				of emergency response system 개체 관리 및 방역 매뉴얼 마련, 비상 대응 체계 마련	application status inspection, annual report publication 개체 관리, 방역 및 비상 대응체계 적용 실태 점검, 연간 보고서 발간	

GOAL 7: 금개구리와 공존이 가능한 농법 개발하여 보급한다.(Develop and disseminate farming methods that can coexist with GSPFs.)

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	Development and improvement of coexistent farming methods 공존 가능한 농법 개발 및 개선	arming method development completed, annual report published 농법 개발 완료, 연간 보고서 발간	State, local government, researchers, farmers 국가, 지자체, 연구자, 농민	Development of farming methods that can coexist with golden frogs and rice paddy farming 금개구리와 논농사 공존이 가능한 농법 개발	Pilot application and improvement of coexistence farming methods 공존 가능 농법 시범 적용과 개선	Publication of annual reports such as verification of the effectiveness of coexistence farming methods, preparation of plans for expansion to other regions 공존 가능 농법 효과성 검증 등 연간 보고서 발간, 타 지역 확대 방안 마련

GOAL 8: 금개구리에 해가 적은 농약을 개발하여 보급한다.(Develop and distribute pesticides that are less harmful to GSPFs.)

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	Development and improvement of pesticides with less harm 해가 적은 농약 개발 및 개선	Completion of pesticide development, publication of annual report 농약 개발 완료, 연간 보고서 발간	State, local government, researchers, farmers 국가, 지자체, 연구자, 농민	Development of pesticides that can coexist with golden frogs and paddy farming 금개구리와	Pilot application and improvement of coexistent pesticides 공존 가능 농약 시범	Publication of annual reports such as verification of coexistent pesticide effectiveness, preparation

				논농사 공존이 가능한 농약 개발	적용과 개선	of plans for expansion to other regions 공존 가능 농약 효과성 검증 등 연간 보고서 발간, 타 지역 확대 방안 마련

GOAL 9: 금개구리 친화적인 농법을 적용할 수 있도록 농민과 협력한다.(Cooperate with farmers to apply GSPF friendly farming methods.)

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	Establishment and operation of cooperative organizations 협력 기구 마련 및 운영	Operation of 10 regional consultative bodies 지역협의체10개 운영	Farmer, Researcher 농민, 연구자	Discovery of local consultative body for farmers in golden frog habitat 금개구리 서식지내 농민 대상 지역협의체 발굴	Formation of a local consultative body for farmers in the Golden Frog Habitat 금개구리 서식지내 농민 대상 지역협의체 구성	Operate a regional consultative group for farmers in the golden frog habitat and prepare plans for expansion to other regions 금개구리 서식지내 농민 대상 지역협의체 운영 및 타 지역 확대 방안 마련
2	Education and technology transfer for agricultural application 농법 적용을 위한 교육 및 기술 이전	Application of agricultural methods to all regions of the habitat 서식지 전지역 농법 적용	Local governments, researchers, farmers 지자체, 연구자, 농민	Preparation of agricultural training and technology transfer plan for farmers in golden frog habitat 금개구리 서식지내 농민 대상 농법 교육 및 기술 이전 계획	Farming education and technology transfer to farmers in the gold frog habitat 금개구리 서식지내 농민 대상 농법 교육 및 기술 전수	Develop plans for expansion across all regions 전 지역 확대 방안 마련

				마련		
3	Application situation monitoring and improvement 적용상황 모니터링 및 개선	Publication of annual report 연간 보고서 발간	researcher, farmer 연구자, 농민	Publication of monitoring annual report 모니터링 연간 보고서 발간		

GOAL 10: 서식지 내에 가뭄이나 홍수를 피할 수 있는 공간을 마련한다.(Provide space within the habitat to avoid drought or flooding.)

No.	**Action description**	**Success Indicators**	**LEAD** (Collaborators)	**0-1 year**	**1-5 years**	**5-10 years**
1	Proper shelter composition research 적정 피난처 조성 연구	Establishing Shelter Standards 피난처 기준 마련	researcher, farmer 연구자, 농민	Appropriate Shelter Suitability Analysis 적정 피난처 적합성 여부 분석	Proper shelter creation research and standard establishment 적정 피난처 조성 연구 및 기준 마련	
2	Shelter installation and performance improvements 피난처 설치 및 성능 개선	100 installations per year 연간 100개소 설치	State, local government, researchers, farmers 국가, 지자체, 연구자, 농민	Selected 100 priority sites for shelter installation 피난처 설치 우선 예정지 100개소 선정	Prepared 30 places per year and measures to improve installation performance 연 30개소 및 설치 성능 개선방안 마련	Completion of 70 installations per year and preparation of plans for expansion to other regions 연 70개소 설치 완료 및 타 지역 확대 방안 마련

Group Name:
Group Members:

GOAL 1: 콘크리트 수로를 흙수로로 교체한다 (Replacing concrete waterways with earthen waterways)

No.	**Action description**	**Success Indicators**	**LEAD** (Collaborators)	**0-1 year**	**1-5 years**	**5-10 years**
1	A Detailed Investigation of Amphibian Damage in Concrete Waterways Research area: Gocheon-eup, Gimpo-si and 2 other places	One research report 연구실적 보고서 1편	National Institute of Ecology (research institutes and	1 year survey 1년 조사	Results announcement and promotion Indicator	

	콘크리트 수로내에 양서류 피해에 대한 세부조사 연구조사 지역: 김포시 고천읍외 2곳		civic groups) 국립생태원 (연구기관 및 시민단체)		check 결과발표 및 홍보 지표점검	
2	Forming a consultative body involving residents to apply ecosystem service payment system in a pilot area and replace it with soil water Target area: Gocheon-eup, Gimpo-si and 2 other places 주민과 포함된 협의체를 결성하여 시범적인 지역에서 생태계 서비스 지불제를 적용 흙수로 교체 대상지역: 김포시 고천읍외 2곳	Extension of earth canal replacement (m) Gold Frog Population Growth Rate 흙수로 교체 연장(M) 금개구리 개체수 증가율	Korea Amphibian Reptile Conservation Network 한국 양서 파충류 보전 네트워크	council organization 협의체 조직	Pilot area operation and evaluation (1 location) 시범지역 운영 및 평가(1곳)	Application area operation and evaluation (2 locations) 적용지역 운영 및 평가(2곳)
3	Incorporate soil canal replacement incentives into ecosystem service payments to ensure compliance with GBF biodiversity. GBF생물다양성을 부합하도록 생태계 서비스 지불제에 흙수로 교체 인센티브를 포함한다.	Incentive included 인센티브 포함 유. 무	National Institute of Ecology 국립생태원	planning 계획수립	pilot operation 시범운영	evaluation 평가

GOAL 2: 탈출시설을 연구 개발하여 설치 확대한다(Researching and developing escape routes at waterways and expanding installation of them)

No.	**Action description**	**Success Indicators**	**LEAD** (Collaborators)	**0-1 year**	**1-5 years**	**5-10 years**
1	A study on the effectiveness of escape facilities for amphibians Research area: Gocheon-eup, Gimpo-si and 2 other places 양서류 대상 탈출시설 효과 검증연구 연구조사 지역: 김포시 고천읍외 2곳	A research report 연구실적 보고서 1편	National Institute of Ecology (research institutes and civic groups) 국립생태원 (연구기관 및 시민단체)	1 year survey 1년 조사	Results announcement and promotion Indicator check 결과발표 및 홍보 지표점검	
2	Trial installation of 3 escape	Extension of	National Institute	1 place	2 places	

	facilities for amphibians 양서류 대상 탈출시설 3곳 시범 설치	escape facility installation waterway (m) 탈출시설 설치 수로 연장(M)	of Ecology (research institutes and civic groups) 국립생태원 (연구기관 및 시민단체)	1곳	2곳 지표점검	

GOAL 3: 도시 내 금개구리 서식지를 매입하여 습지 생태공원 조성한다 (Purchase a golden frog habitat in the city area to create a wetland ecological park)

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	Creation of Geumgaeguri Wetland Park example areas (3 locations) Target area: Yesan-gun, Gimpo-si, Sejong-si 금개구리 습지공원 사례지역 (3곳)조성 대상지역: 예산군, 김포시, 세종시	3 case areas 사례지역 3곳	Ministry of Environment and local government (Yesan-gun, Gimpo-si, Sejong-si) 환경부 및 지자체(예산군, 김포시, 세종시)	local governments and councils 지자체와 협의회의	land purchase 토지매입	composition and monitoring Indicator check 조성 및 모니터링 지표점검

GOAL 4: 농촌형: 10곳에 친환경 농업 활용 생태관광 마을 조성한다 (Creating 10 eco-tourism villages using eco-friendly agriculture)

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	Creation of 10 eco-friendly ecotourism villages Target area: 2 locations in 5 provinces 친환경 생태관광 마을 10곳 조성 대상지역: 5개도별 2곳 선정	Number of case areas 사례지역 개수	Ministry of Agriculture, Food and Rural Affairs (Ministry of Environment, each participating local government) 농림축산식품부 (환경부, 각 참여지자체)	National Competition 전국 공모사업	Basic plan and implementation design 기본계획 및 실시 설계	Operation and evaluation 운영 및 평가

Group Name: *Ineffective of insufficient conservation action*
Group Members: Sujeong Cho, Donggul Woo, Hyun Kim, Youngmin Kim, Young-gun Kim, Ha-en Gye, Hye-rim Kwon, Moonhyun Shin
GOAL 1: Improving public awareness by education and public relation (Issue 1)

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	NGOs create and manage participation activities and programs	Increasing number of participants, institutes and	Government agencies and NIE	Checking current status	Making consultative group and program,	Improve Management of programs and activities

		programs, satisfaction survey			Manage the programs and activities	
2	Ministry of Environment puts endangered species conservation in School text book	School Text book	Ministry of Education and NIE, NIBR	Checking current status (what's in the text book about endangered species)	making publicized	Adjusting text book
3	NIE produces media contents and goods	YouTube hits, increasing sales volumes	NGOs, related institutes	Securing budget	Producing contents and goods	Promotion

GOAL 2: Identifying ecosystem service and benefit from the species (Issue 2)

No.	**Action description**	**Success Indicators**	**LEAD** (Collaborators)	**0-1 year**	**1-5 years**	**5-10 years**
1	NIE researches on the benefit and ecosystem service about the species	Research report	Related institutes, NGOs	Making budget	Conducting the research	

GOAL 1: *Reinforcing conservation policies for the species (Issue 2)*

No.	**Action description**	**Success Indicators**	**LEAD** (Collaborators)	**0-1 year**	**1-5 years**	**5-10 years**
1	Ministry of Environment and NIE adjust and specify conservation plan for endangered species for amphibian species	New detailed plan for the species	Related institutes, scholar, NGOs,	Debating with stakeholders	Adjust the plan	

GOAL 2: *Strengthening cooperation between government agencies (Issue 2)*

No.	**Action description**	**Success Indicators**	**LEAD** (Collaborators)	**0-1 year**	**1-5 years**	**5-10 years**
1	MOE makes a committee with related government agencies	Committee	Ministry of Agriculture, Ministry of Land, Infrastructure and Transport	making publicized	Making committee	

GOAL 1: *improving survival rate after translocation (Issue 3)*

No.	**Action description**	**Success Indicators**	**LEAD** (Collaborators)	**0-1 year**	**1-5 years**	**5-10 years**
1	NIE researches on translocation survival rate	Research report	Related institutes and NGOs	Making budget	Conducting the research	
2	NIE makes translocation guideline based on the research results	Guideline	MOE, NGOs, developers			Making the guideline

GOAL 2: *Reducing translocation by development (Issue 3)*

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	MoE makes incentives (ex. floor area ratio) for developers who make preserved land in their target lands	Increasing preserved land in developing sites	Ministry of Land, Infrastructure and Transport, Developers	making publicized	Making incentives	
2	MoE improves awareness of conservation benefits to developers and gives information about the benefit (ESG management)	Increasing preserved land in developing sites	Ministry of Land, Infrastructure and Transport, Developers	making publicized	making publicized	Promotion and education (ESG)

GOAL 1: Expanding conservation budget for the species, *Expanding research budget for ecology of the species (Issue 5)*

No.	Action description	Success Indicators	LEAD (Collaborators)	0-1 year	1-5 years	5-10 years
1	NGOs makes publicized and facilitate ESG management	Increased budget	MoE, NIE, related institutes	making publicized	making publicized	Get more budget

APPENDIX I. PARTICIPANTS OF THE 2023 KOREAN GOLD-SPOTTED POND FROG SPECIES CONSERVATION ACTION PLANNING|PVA WORKSHOP

1.	Cho, Do Soon (조도순)	National Institute of Ecology (국립생태원)
2.	Kim han (김한)	Gyeongsang National University (국립경상대학교)
3.	Yeo, Yong-gu (여용구)	Seoul grand park (서울대공원)
4.	Kim, Hyun (김현)	Jeongeup City Hall (정읍시청)
5.	Son, Sang-Ho (손상호)	mulsari (NGO)
6.	Cho, Soojeong	NGO
7.	Min, Wan-ki	Individual participants
8.	Kim, Sukyung	Yesan Oriental Stork Park (예산황새공원)
9.	Park, Sanglim	Yesan Oriental Stork Park (예산황새공원)
10.	Lee, Kang Woon (이강운)	Holoce Ecosystem Conservation Research Institution
11.	Lee, Chong Ok (이종옥)	Holoce Ecosystem Conservation Research Institution
12.	Lee, Su-Yeon	Seoul National University (서울대학교)
13.	Min, Mi-Sook	Seoul National University (서울대학교)
14.	Park, Dae-Sik (박대식)	Kangwon National University (국립강원대학교)
15.	Park, Min-woo	Kangwon National University (국립강원대학교)
16.	Park, Ji-hoo	Kangwon National University (국립강원대학교)
17.	Kwon, Hyerim	Kangwon National University (국립강원대학교)
18.	Choi, Ji-hyun	Kangwon National University (국립강원대학교)
19.	Shin, Yoo-cheol	Kangwon National University (국립강원대학교)
20.	Lee, Jung-Hyun (이정현)	National Institute of Ecology (국립생태원)
21.	Choi, Ahreum (최아름)	National Institute of Ecology (국립생태원)
22.	Shin, Moonhyun (신문현)	National Institute of Ecology (국립생태원)
23.	Lee, Hakbong (이학봉)	National Institute of Ecology (국립생태원)
24.	Choi, Seung-woon (최승운)	National Institute of Ecology (국립생태원)
25.	Cheong, Seok Wan (정석환)	National Institute of Ecology (국립생태원)
26.	Woo, Donggul	National Institute of Ecology (국립생태원)
27.	Jang, Hyeong-Kyu	National Institute of Ecology (국립생태원)
28.	Yoon, Yuong-jun	National Institute of Ecology (국립생태원)
29.	Kim, sun-ryoung	National Institute of Ecology (국립생태원)
30.	Kim, Min Han	National Institute of Ecology (국립생태원)

31.	Lee, Jin-hong	National Institute of Ecology (국립생태원)
32.	Kwon, Kwanik	National Institute of Ecology (국립생태원)
33.	Lee, Je-min	National Institute of Ecology (국립생태원)
34.	Heo, jun-hang	National Institute of Ecology (국립생태원)
35.	Kim, Areum	National Institute of Ecology (국립생태원)
36.	Kim, Youngmin	National Institute of Ecology (국립생태원)
37.	Gye, Haeun	National Institute of Ecology (국립생태원)
38.	Jang, Younghae	National Institute of Ecology (국립생태원)
39.	Lees, Caroline	IUCN CPSG (IUCN 종보전계획수립 전문가 그룹)
40.	Nguyen, Dao	IUCN

APPENDIX II. WORKSHOP HANDBOOK

GOLD-SPOTTED POND FROG (*RANA CHOSENICA*) CONSERVATION PLANNING WORKSHOP (PHVA)

20-23 FEBRUARY 2023, SEOUL, SOUTH KOREA

WORKSHOP HANDBOOK

IUCN SSC Species Survival Commission

CONSERVATION PLANNING SPECIALIST GROUP
Changing the Future for Wildlife

*The IUCN SSC Conservation Planning Specialist Group's **One Plan Approach** supports the collaborative development of species conservation plans by diverse communities of stakeholders who are willing and able to act for the species.*

GOLD-SPOTTED POND FROG CONSERVATION PLANNING WORKSHOP (PHVA)

20-23 FEBRUARY 2023, SEOUL, SOUTH KOREA

WORKSHOP ROLES

WORKSHOP FACILITATORS:	Onnie Byers and Caroline Lees (IUCN SSC CPSG)
WORKING GROUP FACILITATORS:	Mr. Moonhyun Shin and Dr. Hak-bong Lee
TRANSLATORS:	National Institute of Ecology (NIE) (presentations to be written/given in English)
PVA MODELLER:	Caroline Lees (IUCN SSC CPSG)

DESCRIPTION OF PRIMARY ROLES

FACILITATOR	- sets time and tasks - facilitates plenary discussions - encourages equal participation - maintains focus on overall workshop theme - maintains the integrity of the workshop design
WORKING GROUP FACILITATORS	- support working groups to stay on task and on time - encourage equal participation - ensure reports are delivered at the end of each day
PARTICIPANTS:	- manage their own working group discussions - provide information, determine issues of concern - create the vision and propose goals and actions
TRANSLATORS	- provide support during plenary and in working groups - interpret for local context - translate written materials and slide content as needed
PVA MODELLER	- elicit participant input to the PVA models - run models in response to working group questions and present results, throughout the workshop - write a modelling report after the workshop
COMPUTER RECORDERS	- record plenary and working group discussions

IUCN SSC Species Survival Commission

CONSERVATION PLANNING SPECIALIST GROUP
Changing the Future for Wildlife

Working Agreement

Leave all personal and institutional agendas at the door to focus on the task at hand

All ideas are valid

Everything is recorded on flip charts

Everyone participates; no one dominates

Listen to each other

Treat each other with respect

Assume good will

Seek common ground

Personal differences and problems are acknowledged - not "worked"

Observe time frames

Complete a draft report by the end of the meeting

GOLD-SPOTTED POND FROG CONSERVATION PLANNING WORKSHOP (PHVA)

20-23 FEBRUARY 2023, SEOUL, SOUTH KOREA

OVERVIEW OF WORKING GROUP MECHANICS

1. Working groups will operate in either KOREAN or ENGLISH – the group can choose.

2. Report-back and other plenary sessions will be held in ENGLISH. Translation support will be provided.

3. The Facilitator will provide each Computer Recorder with a flash-drive containing an electronic template for recording ISSUE Statements, GOALS, ACTIONS and other NOTES.

4. Working groups will record ISSUE STATEMENTS, GOALS and ACTIONS in English or will translate them into English before the end of each day. Translation support will be provided.

5. Where possible, ISSUE STATEMENTS, GOALS and ACTIONS to be presented in PowerPoint or on flipcharts will be translated into English in advance of report-back sessions. Translation support will be provided.

6. Detailed NOTES can be recorded in the language chosen by the group.

7. The full record of the day's discussions will be handed to the Facilitator (on the flash-drives provided) at the end of each day. Flash-drives will be returned to each Computer Recorder at the start of the following day.

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OVERVIEW OF WORKING GROUP PROCESS

Together, participants will generate an inter-connected list of the "Issues" that need to be considered in moving forward with Gold-spotted Pond Frog conservation. Working groups will be formed and a subset of these "Issues" will be assigned to each.

TASK I. **Develop "Issue Statements":** for each Issue, write three sentences to describe: 1) what it is; 2) what impact it has on Gold-spotted Pond Frog conservation; and 3) why it occurs. Indicate any differences between Sites. Prioritise your Issues. Ideally there will be no more than 5. If you have more, consider grouping them. *This is not the time to develop solutions, actions or research directions; this will be done in later steps.*

TASK II. **Assemble information and identify gaps:** review each Issue Statement and agree: what is FACT, what is ASSUMPTION and what is an important DATA GAP. Amend statements to reflect this and add supporting information or references.

TASK III. **Set Goals in response to each Issue Statement.** Goals describe things we will try to achieve in order to remove or reduce the impact of a particular Issue. Make Goals site-specific where necessary. An Issue may require more than one Goal. *Goals will be prioritised by all workshop participants.*

TASK IV. **Recommend Action steps for each Goal**. Action steps are the things we need to do to achieve our Goals. For each Action step, document WHAT it is that will be done, WHO will do it, WHEN it will be done and HOW progress will be measured. Consider 1, 5 and 10-year timelines. These actions will form the main recommendations from the workshop.

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WORKING GROUPS: LEADERSHIP ROLES

Each small working group manages its own discussions, data gathering, time, and report production. Here are brief descriptions of the various roles to be played by different people in your group so that you can function effectively during the workshop. Leadership roles can be rotated; divide the work as you wish.

However, remember to assign these roles at the beginning of each working group session.

Discussion facilitator – Ensures that each person wanting to speak is heard within the time available. Keeps track of discussion using flip-charts. Keeps the group task front and centre at all times.

Flip chart Recorder – May be (but does not have to be) a person other than the discussion facilitator. Records ideas using brief phrases to provide group memory and a visible record of issues, ideas, and discussions. Checks with the person speaking that the phrase recorded is an accurate representation of their contribution.

Computer Recorder – Keeps track of group discussion using a computer. This should not simply be a recording of the flip chart points or detailed minutes of the session. Instead this should be an accurate and clear summary of the group's discussion, including any major viewpoints, information and decisions. It is important for the recorder to ask participants to briefly restate long ideas so that they can be accurately captured. **This computer record will be the basis of the report from the wider workshop.**

Timekeeper – Keeps the group aware of the time remaining for each working group session.

Reporter – Presents the working group report in plenary. It is particularly important that this role is assigned **at the beginning** of each session so that the person has enough time to prepare.

TASKS I: ISSUE STATEMENTS

Purpose: to focus the discussion by clearly describing and prioritising your group's ISSUES, and by identifying the underlying causes of those issues.

STEPS:

1. Assign roles for this session – INCLUDING THE PRESENTER! Record who is in the group.
2. Write the list of issues on a flip-chart.
3. Read them out in turn and check that everyone has the same understanding of each.
4. Add any issues you feel are missing (use brainstorming).
5. Cluster and consolidate issues under headings. Keep a list of the original 'brainstorm' items under each new heading.
6. For each issue, write 3 sentences that will explain, to someone not at the workshop:
    a. what the issue is;
    b. what causes it; and
    c. why it is a problem for the conservation of the Gold-spotted Pond Frog.
7. With reference to each issue, if there are differences between Sites, make sure these are described.
8. Try not to discuss "what needs to be done" – this comes later.
9. As a group, prioritise your issues according to their overall impact on Gold-spotted Pond Frog conservation.

THINGS TO CONSIDER:

- Is the issue stated objectively? (i.e. does not include implied solutions – **solutions come later**)
- Is the issue within the scope of the workshop and the people involved?
- Does everyone have the same understanding of the issue?
- Does the statement identify both the impact of the issue and its underlying causes or drivers – have you applied the **"5 WHYS"?**

ISSUE STATEMENT EXAMPLES:

A GOOD EXAMPLE:

Issue: Fire

a) Wild-fires burn through cockatoo habitat periodically.
b) Fires temporarily reduce the productivity of cockatoo food trees and as a result there is not enough food to support a growing population of birds.
c) Fire is a natural part of the ecology of cockatoo habitat but the frequency and intensity of fires is increasing due to the combined effects of introduced weeds (which burn more intensely than native vegetation), loss of traditional burning practices (which restricted the extent and intensity of fires) and climate change.

In the above statement it is clear **what** the problem is, **how** it affects the species and **why** it occurs. This is sufficient for an issue statement.

A POOR EXAMPLE:

Issue: Fire

We need to prevent fire in black cockatoo habitat so that the population can grow.

In the above statement the cause of fire is not clear, "issues" and "needs" are confused and solutions are implied – this one needs some more work.

TASK II: ASSEMBLE INFORMATION AND IDENTIFY GAPS

Purpose: to clarify, for each issue, what is FACT, what is ASSUMPTION and what are the key INFORMATION GAPS

STEPS:

1. Assign roles.
2. Taking each issue statement in turn, review the text carefully.
3. Discuss what is **KNOWN** about this issue (and how), what is **ASSUMED** (and why), and what more we **NEED TO KNOW**, before effective action can be taken.
4. Make sure that differences between Sites are considered, if appropriate.
5. Where necessary, edit the issue statements to make clear what is FACT and what is ASSUMPTION.
6. List KEY INFORMATION GAPS.
7. Record these discussions carefully, especially information relating to sources of evidence or justification.

INFORMATION ASSEMBLY EXAMPLE

Issue: Hybridisation

Description: *Emydura macquarii* is a common Australian native turtle **known** to have been introduced historically into the Bellinger River (Georges, et al., 2007; Georges, et al., 2011). *E. macquarii* are **known** to hybridise with the Endangered Bellinger River Snapping Turtle - BRST (Georges & Spencer, 2015).

Cause: In the past the two species occupied different areas in the river (Cann, et al., 2015) and hybridisation events are **assumed** to have been rare (Blamires & Spencer, 2013). Following a recent disease outbreak in BRST there is evidence that *E. macquarii* has become the dominant turtle species in the Bellinger River (Chessman, 2015).

Impact: It is **assumed** that the rate of hybridisation could increase under the current situation. It is **assumed** that an increase in the hybridisation rate will result in the BRST becoming rarer.

Key information gap: Is the rate of hybridisation increasing?

TASK III: GOALS

Purpose: to agree what we will try to achieve in order to reduce or remove the issues identified.

STEPS:

1. Assign roles.
2. Review the issue statements and information gaps.
3. Think about the different ways in which those issues could be addressed. Which are most likely to get done? Which do the people in this room have most influence over?
4. With this in mind, develop goals to address each issue. Where relevant, goals should be SITE-SPECIFIC.
5. There can be more than one goal for each issue.
6. Develop goals to fill each information gap *considered to be an obstacle* to Gold-spotted Pond Frog conservation.
7. If there is time, include an indication of how progress towards achieving each goal will be measured or evaluated.

GOAL EXAMPLE:

Issue Statement: Fire

a) Wild-fires burn through cockatoo habitat periodically.
b) Fires temporarily reduce the productivity of cockatoo food trees and as a result there is not enough food to support a growing population of birds.
c) Fire is a natural part of the ecology of cockatoo habitat but the frequency and intensity of fires is increasing due to the combined effects of introduced weeds (which burn more intensely than native vegetation), loss of traditional burning practices (which restricted the extent and intensity of fires) and climate change.

GOAL 1: Supplement food for black cockatoos after fires.

GOAL 2: Restore traditional burning around cockatoo feeding grounds.

TASK IV: ACTIONS (TO BE COMPLETED IN SITE-BASED GROUPS)

Purpose: to recommend action steps that will enable goals to be achieved.

STEPS:

1. Assign roles. Make a list of who is in the group.
2. Take each goal in turn and write it on a flip-chart.
3. Brainstorm actions that could be taken to achieve that goal. Think about which ones will have the most impact on Gold-spotted Pond Frog conservation and which are most achievable given the resources available.
4. Recommend one or more actions to achieve each goal.
5. Document details for each action:
    a. a description of WHAT the action is
    b. WHERE it needs to be done
    c. WHEN it should be done (consider 1, 5 and 10-year time-frames)
    d. WHO (which agency or agencies IN THIS ROOM) could lead it, and who the key collaborators could be.
    e. what INDICATORS or MEASURES will be used to track or demonstrate its completion?
6. Check each agreed action conforms to S.M.A.R.T. characteristics (see below).

THINGS TO CONSIDER:

Actions should conform to **S.M.A.R.T** characteristics:

- ***Specific*** – it must be clear what is to be done, by whom, where.
- ***Measurable*** – concrete outcomes or indicators are defined that allow progress to be assessed
- ***Attainable*** – can be accomplished under current conditions
- ***Relevant*** – helps solve the specific issue targeted (i.e. helps achieve one of the associated goals) and needs to be done
- ***Time-bound*** – is grounded in a realistic timeframe

EXAMPLE OF A COMPLETED ACTION STEP (MODIFIED FROM ORIGINAL)

Issue: Habitat Fragmentation

In Singapore, the habitat of Raffles' Banded Langur consists of small forest fragments. This is due to the creation of roads and the removal of forest in some areas to allow for other forms of land-use. As a result, the langur population persists only in small, isolated groups, each one susceptible to significant losses due to chance demographic events and inbreeding depression.

GOAL

Restore connectivity between isolated/fragmented groups of Raffles' Banded Langur in Singapore

ACTION 1.

Details: Identify sites in Singapore where there is a need for human-mediated movement (due to loss of connectivity, lack of canopy cover, obstructions, roads, water bodies etc.) and test the use of rope bridges in appropriate locations.

Responsibility: Raffles' Banded Langur Coordinator.

Timeline: permits and proposal by early 2017; construction of first rope bridge by mid-2017, monitoring till mid-2018

Collaborators: JGIS, MINDEF, Singapore NParks, WRS, and volunteers

Measures: camera trap photos of langurs using the bridges.