Comparative Analysis of Time Series Changes in Abundance and Rarity of Amphibians in Central South Korea

Yongwon Mo[1] and Ho Gul Kim[2]

1) Yeungnam Univ., South Korea, 2) Cheongju Univ., South Korea

Contact : csmo12@yu.ac.kr, webzin12@gmail.com

National Institute for Environmental Studies,Japan

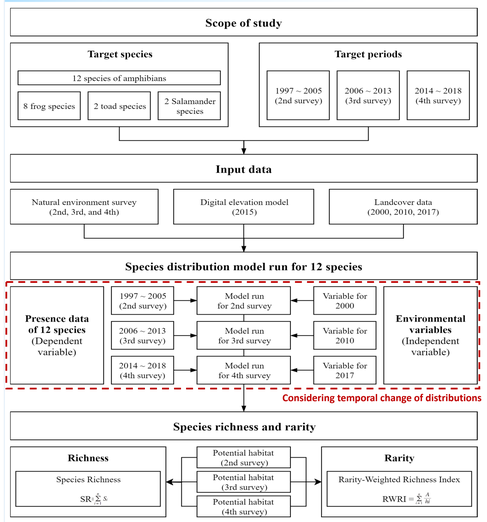
Main Conclusions

- Regions with high amphibian abundance have been declined in central South Korea.
- Amphibian abundance was higher in the west, and rarity was higher in the east.
- It is also necessary to check the effects of elevation, urbanization, and climate change on the abundance and rarity of amphibians.

Objectives

- Amphibian populations are declining at a much faster rate than other vertebrates worldwide (Hof et al., 2011). About 40% of them are listed as threatened by the IUCN(IUCN, 2021).
- Among the various species living in South Korea, amphibians have an important biological position and have high conservation value (Do et al., 2017). Amphibians are a taxon whose habitat is susceptible to destruction by development. In South Korea, habitats are being destroyed due to the decrease in mountain area due to the development (Jung et al., 2019). In addition, there is a problem that road kills are concentrated during the breeding season of amphibians due to roads developed on the hillside (Song et al., 2009).
- We aimed to analyze changes in species abundance based on potential habitats in a time series for 20 years and for 9 species of amphibians in the central region of South Korea. Finally, we tried to identify how the differences in development characteristics by local governments in the central region affect the species abundance and rarity of amphibians.

Research Flow



Study site

Methods

➢ Target species and Environmental variables

- Total 12 species, Frogs : 6 species (1 threatened, 1 endemic), Toads : 2 species, Salamander : 1 species
- As environmental variables, total 10 variables were used. They can categorized by physical character and proximity from nature and human interference.

Variable	Abbreviation	Type	Reference
Elevation	elevation	Continuous	(Chettri & Acharya, 2020; Rodriguez et al., 2005)
Slope	slope	Continuous	(Mims et al., 2015; Sánchez-Montes et al., 2018)
Aspect	aspect	Continuous	(Adams & Bury, 2002; Crosswhite, 1999; Franklin et al., 2009)
Stream order of watershed	watershed	Continuous	(Riley et al., 2005; Stevens et al., 2007; Welsh Jr & Lind, 2002)
Distance from forest	forest	Continuous	(Skelly et al., 2002; Welsh Jr, 1990)
Distance from residential area	resi	Continuous	(Burbrink et al., 1998; Glista et al., 2008)
Distance from river	river	Continuous	(Moraes et al., 2016; Xiaodong et al., 2005)
Distance from road	road	Continuous	(Gibbs & Shriver, 2005; Mazerolle et al., 2005)
Distance from paddy	paddy	Continuous	(Hegde & Krishnamurthy, 2014; Tsuji et al., 2011)
Distance from wetland	wetland	Continuous	(Babbitt, 2005; Pechmann et al., 1989; Rittenhouse & Semlitsch, 2007)

➢ Species Distribution Models(SDMs)

- R package Biomod2 was used to drive the SDMs. The selected 8 models (GLM, GBM, CTA, ANN, FDA, RF, MAXENT) were applied to 12 target species to analyze the habitat suitable for each species, and an ensemble technique was applied to synthesize the results of the 8 models to derive a habitat with high reliability.
- As ensemble techniques, 6 methods were used. 1) Mean of probabilities (PM), 2&3) Confidence interval for the probability of the mean (PCI upper, and PCI low) , 4) Median of probabilities (PME), 5) Models committee averaging (CA), and 6) The weighted mean of probabilities (PMW) (Thuiller et al., 2016)

➢ Species richness and rarity

- We constructed species distribution models for all target species and habitat suitability maps with probability values ranging from 0-1 were prepared. “Maximum training sensitivity plus specificity” in which the sum of sensitivity (prediction rate of occurrence region) and specificity (prediction rate of non-occurrence region) was maximized to transform this into binary data with 0 (non-appearance) and 1 (appearance) values were used as reference (Hu and Jiang, 2011; Tronstad and Andersen, 2011; Heibl and Renner, 2012; Jeon et al. 2014). The species richness map was analyzed by overlapping the habitats suitable for each species, where the results were 0 and 1.
- Species abundance has a limit in that it can be affected by the distribution of species having a wide habitat area. Therefore, in this study, rarity was analyzed to overcome the limitations of species abundance. Rarity was analyzed using the Rarity-Weighted Richness Index (RWRI) index, after calculating the number of areas in which the target species appeared in each grid (the grid in which the target species was found), and adding them together (Bruce et al. 2000). In other words, the rarity has a higher value as more rare species with a narrow habitat range appear.

$$SR = \sum_{i=1}^{n} S_i$$

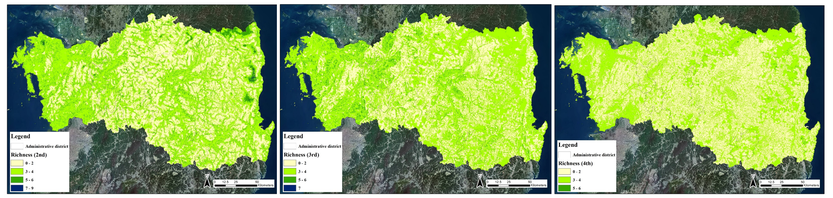
SR = Species Richness
N = total number of species in the grid
S_i = The grid in which each species was appeared (grating with a value of 1)

$$RWRI = \sum_{i-1}^{n} \frac{A}{hi}$$

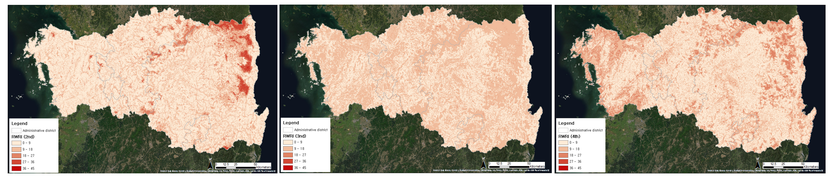
h_i = the number of grids in which species I was appeared
n = the total number of species found in the study area
A = the total number of grids in the study area

Results

- **Temporal changes of SR**

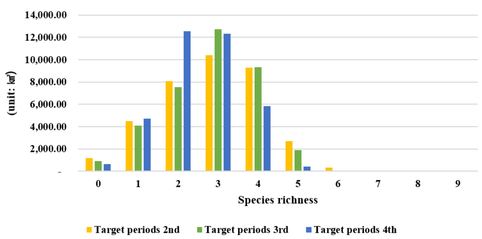


- **Temporal changes of RWRI**



- **The occupancy change of SR by time series**

  - Over time, the regions with species richness of 4 to 6 tended to decrease, while regions with species richness 1-3 showed the same or increased results.
  - Spatially, high species abundance was observed in the western region, which have a generally low elevation and flat topography, and the eastern region of the mountain range in the east.



- In terms of rarity, we identified that the region around the mountain range has a higher rarity than other regions. In other words, more rare amphibians inhabit in this area.

Discussions

- There would be more factors that threaten biodiversity in areas with low abundance of amphibians with relatively low status in the ecosystem. Threats that negatively affect amphibians include destruction of natural vegetation, road construction, traffic volume, buildings, and tourists. In addition, since land use patterns vary according to elevation, major threat factors may appear differently depending on elevation.
- A spatial comparison of the abundance and rarity of amphibians and important factors such as urbanization progress and climate change could confirm these impacts.
- This study can be used as basic data for establishing a land development plan considering the conservation of amphibians in South Korea. It can be used to analyze the habitat suitability of amphibians and establish a conservation plan in some countries with a similar climate and environment to that of South Korea.