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Understanding human dimensions of Siamese Crocodile reintroduction in Kaeng Krachan National Park, Thailand

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Abstract

Siamese Crocodiles (*Crocodylus siamensis*) are critically endangered, with populations in only four countries, including Thailand. Despite existing reintroduction know-how, human cohabitants in crocodile habitats hinder their conservation efforts. We surveyed 208 respondents from five villages in Kaeng Krachan National Park (KKNP) to understand human dimensions toward Siamese crocodile reintroduction and conservation. While respondents generally had positive attitudes towards the crocodiles, fear of attacks by farm-bred crocodiles remained a major obstacle. A soft release of farm-bred crocodiles was deemed acceptable, though concerns about potential human-crocodile interactions persisted. By aligning these findings with IUCN SSC guidelines on human-wildlife conflict and coexistence, we emphasize the importance of addressing all levels of potential human-crocodile conflicts (HCC) in KKNP. Essential actions include building trust, creating benefits, practicing good governance, integrating traditional knowledge into reintroduction planning, resolving existing conflicts through community-led solutions, and devising a political ecology of crocodile conservation for acceptable strategies for managing HCC. To support sustainable crocodile reintroduction in KKNP, we recommend engaging unemployed males, fishermen, or temporary employers as citizen scientists, transparently communicating the reintroduction process to stakeholders, and implementing conservation education campaigns. Long-term socio-ecological monitoring is vital for sound decision-making, managing conflicts, and measuring reintroduction success.

Keywords: Acceptance, Human-crocodile conflict, Kaeng Krachan National Park, Siamese crocodile, Value orientation

Introduction

The Siamese crocodile (*Crocodylus siamensis*) plays a role of great ecological and economic significance, with its distribution and habitat limited to Southeast Asian countries. In the past, the Siamese crocodile was abundant, but its current population has declined significantly, with an estimated minimum number of 40 individuals (WCS-Thailand, 2023) due to various threatening factors such as habitat destruction, illegal fishing, and poaching (Bezuijen et al., 2012; Platt et al., 2019). In Thailand, the population of the Siamese crocodile has drastically declined and is nearly extinct in the wild due to habitat degradation and habitat loss from human activities, such as poaching for sale (Kanwatanakid-Savini et al., 2012; Ratanakorn et al., 2021) and hunting driven by fear (ONEP, 2017; Cavalier et al., 2021). For this reason, the population of Siamese crocodiles in Thailand has declined to critically endangered (ONEP, 2017), mirroring a similar trend observed globally (Bezuijen et al., 2012). The incident report on the human-crocodile conflict in Thailand has occurred mostly from the fear of humans accidental release of a farm-bred crocodiles during floods, with very few cases of human injury. The fear of humans toward crocodiles has become a major obstacle to the reintroduction of this species (DNP, 2021), as evidenced by local resistance to crocodile reintroduction in Yod Dome Wildlife Sanctuary (Khumseemuang et al., 2019).

The declining wild populations of Siamese crocodiles globally and in Thailand have led to restrictions on the export of crocodile products from Thailand due to its status in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora or CITES (Division of Wild Fauna and Flora Protection, 2022). Products from numerous crocodile farms in Thailand are not permitted for export to the United States and some European countries, therefore, Thailand has incurred significant economic losses (International Trade Centre, 2014). Therefore, the only solution is to downgrade the Siamese crocodiles to Appendix II of the CITES so that the Siamese crocodiles are allowed for international trade and to restore the endangered population by selecting purebred crocodiles using genetic technology and then reintroducing them to the wild and enabling controlled trade to prevent excessive use. Human-crocodile conflicts (HCCs) that could threaten the species survival (Division of Wild Fauna and Flora Protection, 2013) must be managed, thereby contributing to the sustainable conservation of Siamese crocodiles and economic development of Thailand (Phinnil, 2011; Daltry et al., 2016).

However, the reintroduction of the Siamese crocodile in Thailand has faced significant challenges

in relation to human dimensions. Siamese crocodiles feature as characters in literature, folklore, legends, and arts in Thailand, showcasing the intertwining of crocodiles with Thai life since ancient times. Examples of these characters imbued with meaning of coexistence with fear of Siamese crocodiles include a record of Thai people living alongside crocodiles during the reign of King Narai, a story of a crocodile doctor subduing a great crocodile named Chalawan, a proverb derived from the tale of an ungrateful crocodile symbolizing treachery or obstacles, murals depicting crocodiles in water scenes on the window panels of temples, crocodile flags representing a temple receiving Kathina robes, a Thai musical instrument called the "jakhe," and even place names or constellations reflect this connection (Thai Studies CU, 2018). This portrayal underscores the instinctive ferocity associated with crocodiles in Thai cultures (Chanhiran, 2008), contributing to negative attitudes towards them. Importantly, negative attitudes toward crocodiles have contributed to a lower public tolerance towards crocodiles (Cavalier et al., 2021; Das and Jana, 2018) and affected the acceptance of crocodile reintroduction in some Thai protected areas, including Yod Dome Wildlife Sanctuary (Khumseemuang et al., 2019) and Huai Samong in Thap Lan and Pang Sida National Parks.

Kaeng Krachan National Park (KKNP) is one of the eight Thai protected areas that still harbors a population of at least four Siamese crocodiles (Chanpradub et al., 2023) and is listed as the first priority for the Siamese crocodile reintroduction initiative (WCS-Thailand, 2023). Kanwatanakid-Savini et al. (2012) reported a coexistence between Siamese crocodiles and local people in KKNP. However, a later report by Deekaew et al. (2018) revealed that local people in the two villages who live at the heart of KKNP and are very close to the current crocodile habitats disagreed with all methods for Siamese crocodile reintroduction (wild egg collection for artificial incubation and releasing of farm-bred crocodiles to their natural habitats for reintroduction). Therefore, a study of social psychology concepts relevant to human dimensions of Siamese crocodiles is prominent in planning to manage potential HCCs after reintroduction and to garner sustainable pathways for a long-term conservation to benefit the country.

In response to this, we designed our research based on two social psychology theories and two models recommended by the IUCN SSC guidelines on human-wildlife conflict and coexistence (hereafter IUCN SSC guidelines: IUCN, 2023) as shown in figure 1. Using the Cognitive Hierarchy Theory (Vaske and Donnelly, 1999) and the Theory of Planned Behavior (Ajzen 1991), we studied wildlife value orientation (WVO), attitudes toward Siamese crocodiles, and the behavioral intention to participate in their conservation as behavioral intentions and attitudes vary

according to individual values (Manfredo et al., 2021; Homer and Kahle, 1998). Following the Wildlife Tolerance Model (Kansky et al., 2016) and Hazard-Acceptance Model (Bruskotter and Wilson, 2014), we explored risk perceptions and acceptance of reintroducing farm-bred Siamese crocodiles in KKNP, examining factors influencing acceptance of the three reintroduction methods. Finally, we aligned our results with the IUCN SSC guidelines to identify essential tasks or activities required in preparing for managing potential HCC following the reintroduction. Our findings provide insights into the human dimensions of restoring the Siamese crocodile population and offer guidance for managing potential HCCs as a result of the reintroduction initiative of Siamese crocodiles in KKNP.

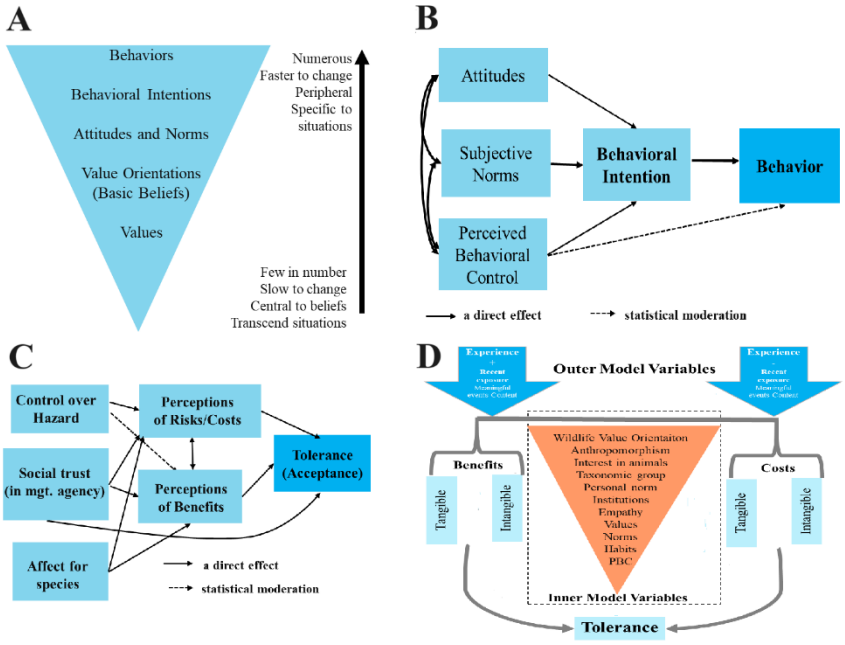

Figure 1. Social psychological theories and models suggest understanding tolerance and behavior regarding human-wildlife conflict. These are (A) the Cognitive Hierarchy Theory (Vaske and Donnelly, 1999), (B) the Theory of Planned Behavior (Ajzen, 1991), (C) the Hazard-Acceptance Model (Bruskotter and Wilson, 2014), and (D) Wildlife Tolerance Model (Kansky et al., 2016).

Material and methods

Study areas

The study areas were targeted at local villages along the Phetchaburi River or near the Kaeng Krachan Reservoir in three subdistricts of Kaeng Krachan, Song Phi Nong, and Huay Mae Priang, all located in Kaeng Krachan District, Phetchaburi Province. This included five villages: Pong Luek and Bang Kloy villages in Huay Mae Priang Subdistrict (upstream), Tha Linglom in Song

Phi Nong Subdistrict (midstream), and Tha Ruea and Phu Khem in Kaeng Krachan Subdistrict (downstream), as depicted in figure 2.

The questionnaire was conducted between June 21-23, September 8-10, and September 20-23, 2023, targeting local residents in those five villages. All research participants were informed about the research purpose, with their permission obtained before the administration of the questionnaire-based survey and assured that their data would be analyzed anonymously. Convenience sampling was utilized and proportionately to the population across the three subdistricts. This sampling technique was chosen due to logistical challenges, as over 50% of households are located along the Petchaburi River and the reservoir with only access by boats during the daytime. Therefore, researchers approached any respondents willing to take part the questionnaire survey (Newing et al., 2011).Statements of anecdotal evidence being told during and after the questionnaire survey by respondents were recorded.

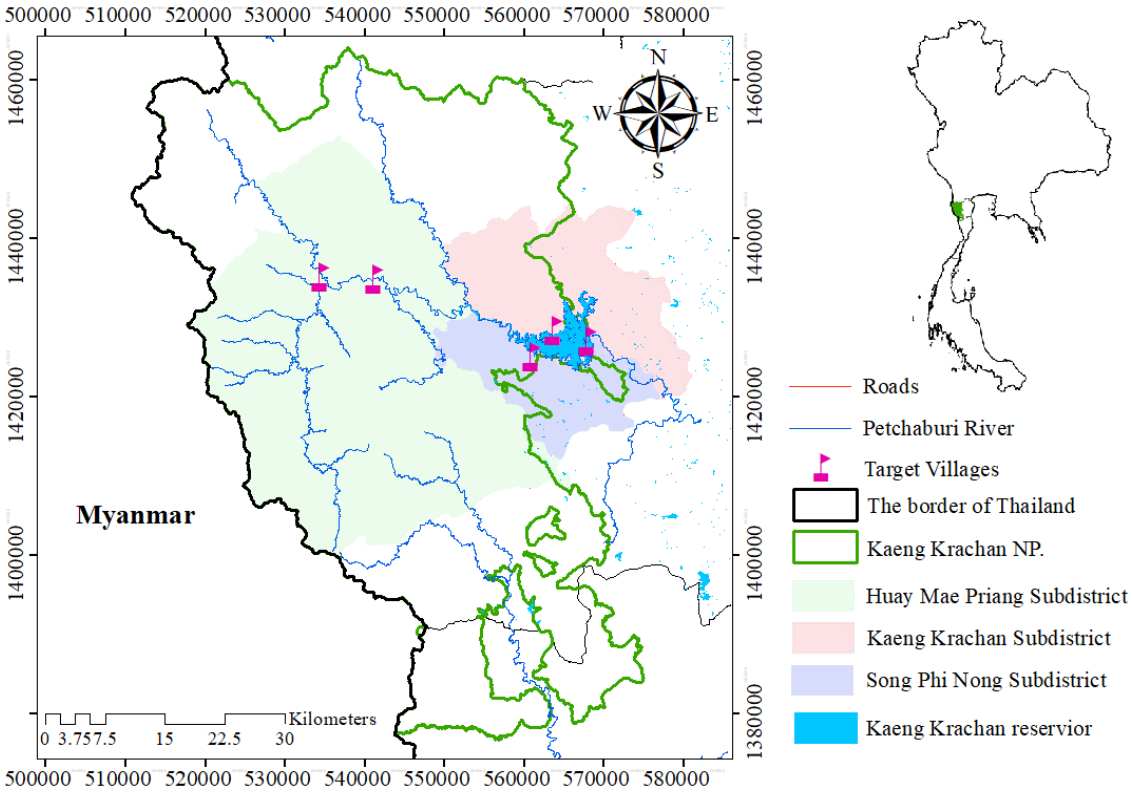

Figure 2. The location of the target villages in the 3 subdistricts situated within KKNP and surrounding Kaeng Krachan Reservoir, where reports of Siamese crocodile sightings have been documented.

A total of 208 individuals were surveyed, resulting in an 80% response rate and comprising 6.66% of the target population, as reported by the Department of Provincial Administration (2023). The

questionnaire was comprised of five sections. Section 1 focused on the general information of respondents. Sections 2 and 3 were designed based on the Cognitive Hierarchy Theory (Vaske and Donnelly, 1999) to measure the value orientation toward Siamese crocodiles, the attitudes toward these crocodiles and their conservation, and behavioral intentions to participate in conservation efforts. Sections 4 and 5 were designed in accordance with the Hazard-Acceptance Model (Bruskotter and Wilson 2014) in order to understand the level of acceptance toward methods for reintroduction of Siamese crocodiles and the risk perception of the crocodiles' reintroduction. Sections 2 through 5 were designed using a five-Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Data analysis

Value orientation

According to Manfredo et al. (2021), we categorized the WVO into 4 groups: (1) Utilitarian, valued for human benefit; (2) Mutualist, seen as dependent on humans in the ecosystem; (3) Pluralist, valued for co-existence with human in the ecosystem; and (4) Distanced, not valued or considered in wildlife thought and interest.

Statistical analysis

Data analysis was conducted using the R 4.2.3 program (R Core Team. 2023). We reported frequency, percentage (%), mean, and standard deviation (sd), to elucidate respondents' backgrounds related to gender, age range, the highest level of education , and the primary occupation [mean and sd?] of the respondent. Additionally, the mean and sd of the five-Likert scale on attitudes towards Siamese crocodiles, behavioral intentions to participate in conservation efforts, acceptance of methods for reintroduction of Siamese crocodiles and the risk perception of crocodiles' reintroduction. A mean score of less than three indicated a negative attitude, low agreement, low tolerance, or a low-risk perception.

The study utilized inferential statistics with a significance level of $\alpha = 0.05$. One-way ANOVA and independent t-tests compared attitudes toward crocodiles, behavioral intentions for conservation, acceptance of farm-bred crocodile reintroduction methods, and perceived risk among respondents across different subdistricts, genders, age ranges, education levels, and primary occupations. A chi-square test analyzed differences in Siamese crocodile value orientations across these same demographic variables.

Additionally, ordinal linear regression was used to examine factors influencing the acceptance of reintroduction methods, measured on a 5-point Likert scale from strongly unacceptable to strongly acceptable, as ordinal dependent variables. The independent variables for this statistical analysis included gender, age range, highest education background, occupation, attitudes toward crocodiles, conservation intentions, acceptance of conservation activities, and risk perceptions of Siamese crocodile reintroduction in KKNP. These factors were examined using the MASS package (Venables and Ripley, 2002). Variables derived from factor analysis were used to reduce the number of variables before analysis, and the acceptability level was adjusted from 5 levels to 3: acceptable (3), neutral (2), and unacceptable (1) for ease of interpretation.

Analyzing statements of anecdotal evidence

We analyzed anecdotal evidence collected during the questionnaire survey to illustrate human perspectives on issues related to HCCs. To ensure the reliability of these data, we considered consistently repeated stories with clear and specific details about the same issues. We linked these anecdotes and research results from the questionnaire with IUCN SSC guidelines on human-wildlife conflict and coexistence to identify tasks or activities needed to prepare for potential HCCs after reintroduction promptly.

Results

Characteristics of the respondents

Out of 208 samples, Kaeng Krachan Subdistrict contributed the highest proportion at 42.79%, followed by Huay Mae Priang at 35.10% and Song Phi Nong at 22.12%. The male respondents accounted for 53.85%, slightly more than females (46.15%), with an average age of 46.56 ± 16.61 years old (median = 46). Generation X comprised the largest group at 36.54%, followed by Generation Y (27.88%), baby boomers and older generations (22.60%), and Generation Z (12.98%). Respondents whose highest level of educational attainment was primary school provided the greatest number of responses (40.38%), followed by secondary school (32.69%), respondents without formal education (21.15%), and those with university education (5.78%). The majority of respondents worked in agriculture (31.73%), followed by temporary laborers (23.56%), organizational staff (11.54%), unemployed individuals (10.1%), fishermen (9.62%), business owners (8.65%), and housewives (4.81%).

Human Dimensions Based on Cognitive Hierarchy Theory

Value orientation to Siamese crocodiles

Among the respondents, 86.54% valued the Siamese crocodile as mutualist, followed by pluralist (7.21%) and distanced (2.88%). Variations in all four value orientations were not significantly associated with genders (χ^2 = 3.99, p = 0.26), age ranges (χ^2 = 12.83, p = 0.17), their highest education levels (χ^2 = 4.52, p = 0.87), and primary occupations (χ^2 = 14.48, p = 0.70), except for subdistricts (χ^2 = 16.59, p = 0.01), as depicted in figure 3.

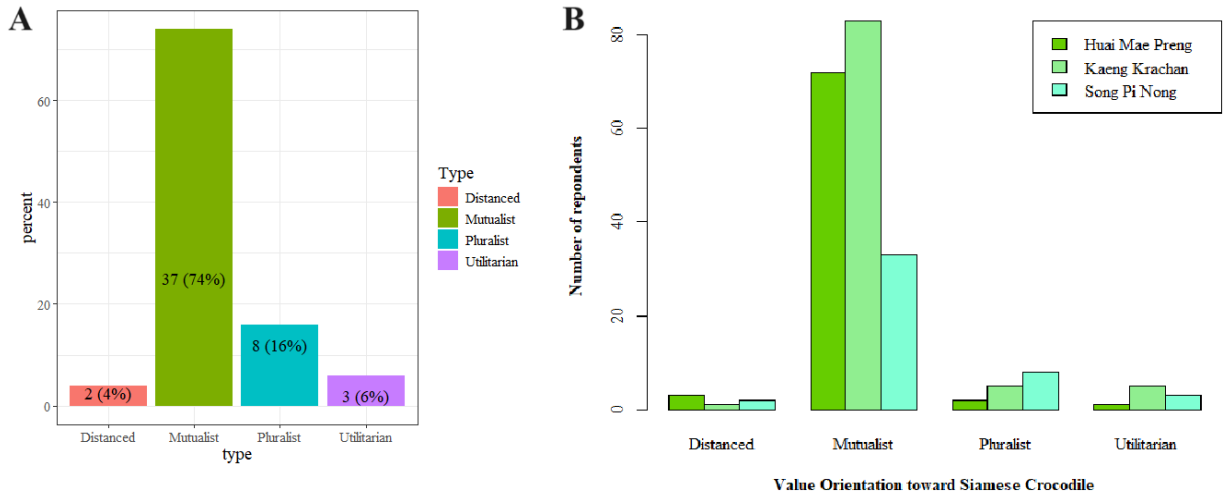

Figure 3. Frequency of value orientation to Siamese crocodiles (A) and comparison of the differences between subdistricts (B).

Attitudes toward Siamese crocodiles

Overall attitudes towards the Siamese crocodile were positive (79.43%; mean±sd = 3.70 ± 0.74), particularly the perceptions that Siamese crocodiles would not be competing with humans for aquatic animals as food and would pose no harm to people in the community. The attitudes towards Siamese crocodiles across all six attitudinal contents significantly differed ($F = 48.24$, $p < 2\times10^{-16}$), as depicted in figure 4.

Furthermore, the attitudes toward the Siamese crocodiles were significantly different between respondents residing in different subdistricts, especially between Song Phi Nong and Huay Mae Priang Subdistricts (p = 0.02), different age groups as Generation Z and X (p < 0.01), and different occupations as organizational staff and housewives (p < 0.01) but not for respondents with different levels of education and gender as shown in figure 5.

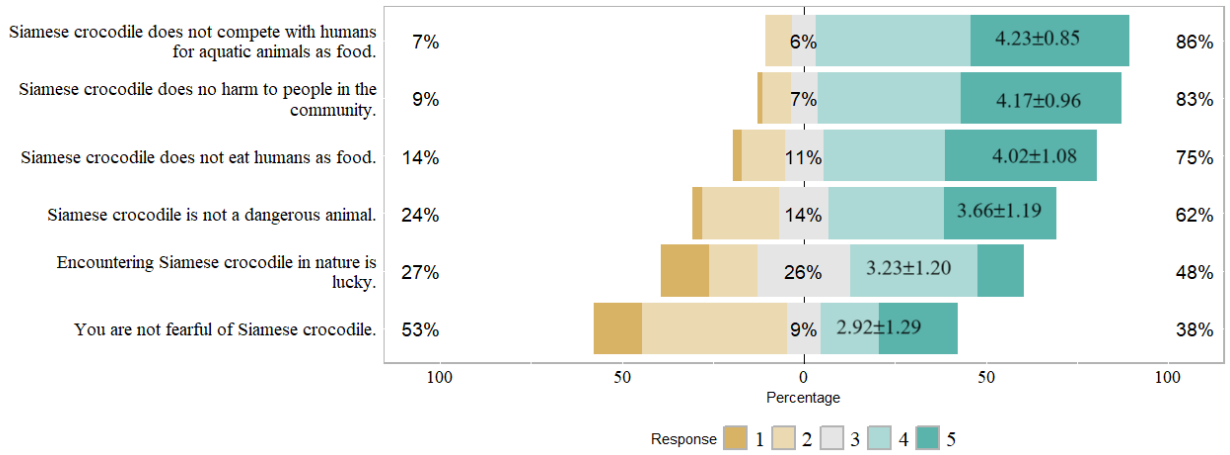

Figure 4. Attitudes toward Siamese crocodiles based on mean scores and frequency ratings on a five-point Likert scale, where 1 = strongly disagree and 5 = strongly agree.

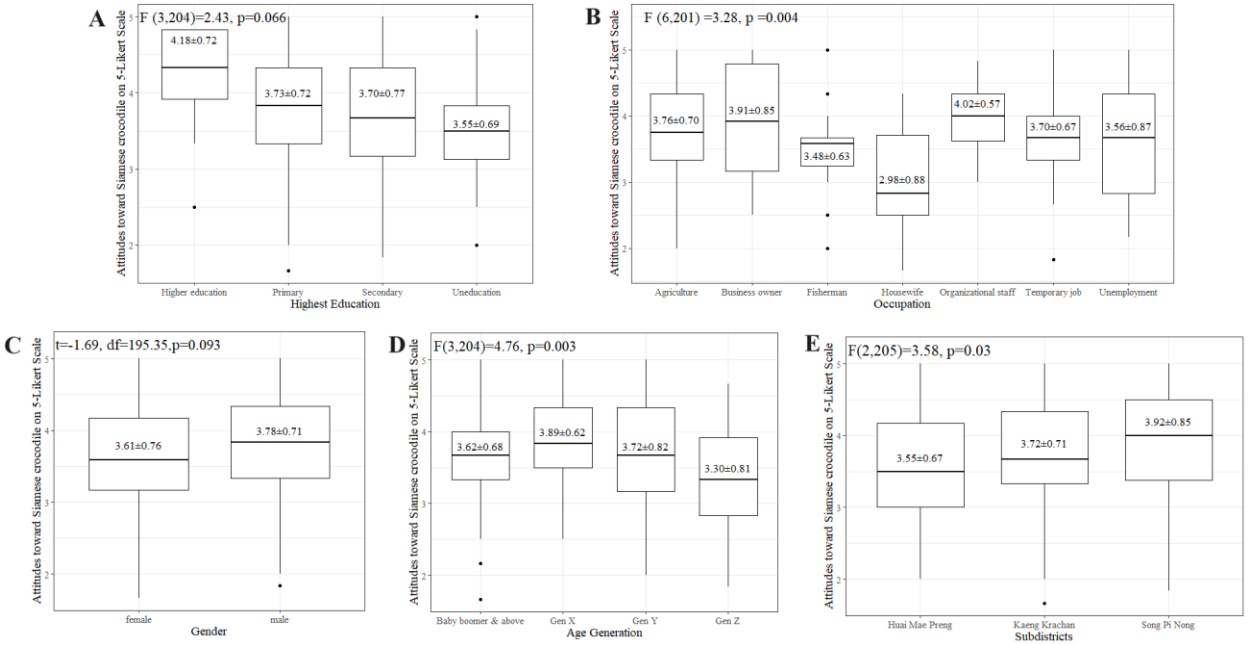

Figure 5. Comparison of attitudes towards Siamese crocodiles in accordance with the highest level of education attained (A), occupations (B), gender (C), age ranges (D), and subdistricts (E).

Attitudes toward the conservation of Siamese crocodiles

The respondents exhibited positive attitudes toward the conservation of Siamese crocodiles (85.65 %, 4.05 ± 0.81), particularly the conservation of Siamese crocodiles in their natural habitats instead of in captivity, as depicted in figure 6.

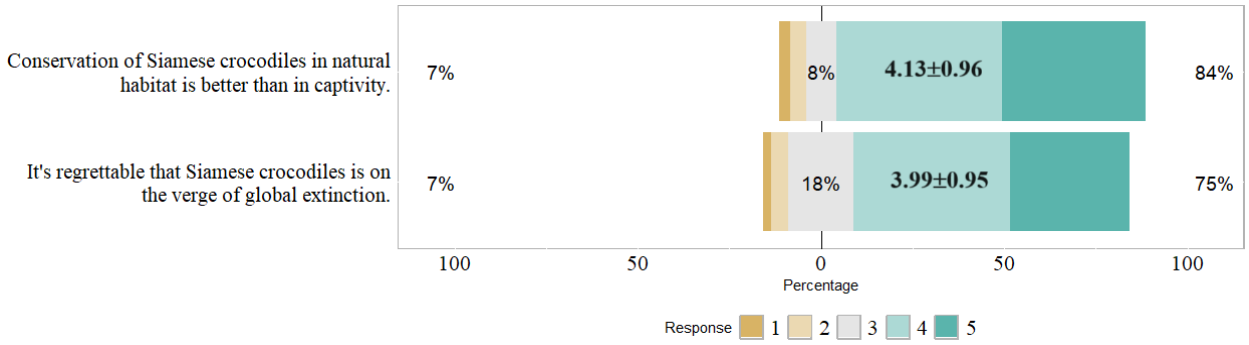

Figure 6. Attitudes toward the conservation of Siamese crocodiles based on mean scores and frequency ratings on a five-point Likert scale, where 1 = strongly disagree and 5 = strongly agree.

Respondents with different backgrounds on levels of education, occupations, gender, and age generations held insignificantly different attitudes toward the conservation of Siamese crocodiles. Only the factor of residency in different subdistricts revealed significantly different attitudes toward the conservation of Siamese crocodiles (F = 3.26, p = 0.04), particularly in Song Phi Nong Subdistrict located downstream and Huay Mae Priang located upstream of Phetchaburi (p = 0.03), as illustrated in figure 7.

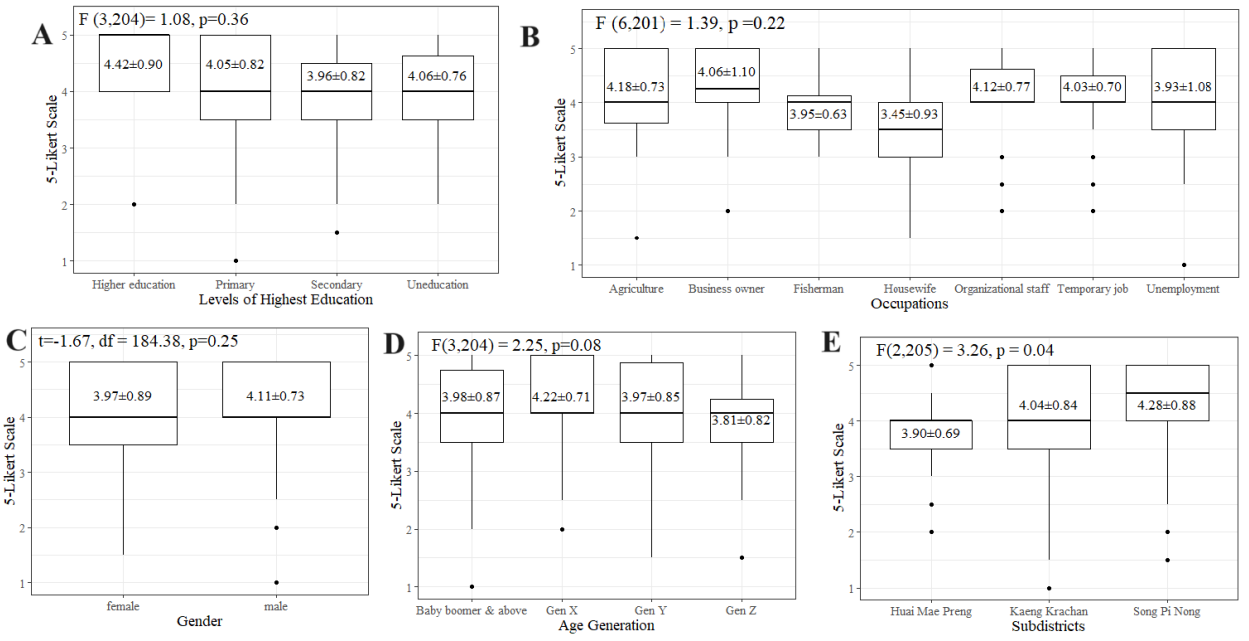

Figure 7. Comparison of attitudes towards the conservation of Siamese crocodiles by the highest level of attainted education (A), occupations (B), gender (C), age ranges (D), and subdistricts (E).

Behavioral intentions to participate in the conservation of Siamese crocodiles

The top three conservation activities that garnered the highest behavioral intentions to participate were as follows: conservation education activities at schools (83%: 4.04±0.92); conservation campaigns in villages around KKNP reservoir (79%: 3.92±1.01); communication channels for reporting the presence of crocodiles (78%: 3.89±0.99). The behavioral intention of all eight efforts was significantly different ($F_{7,1736} = 17.69$, $p < 0.01$), as shown in figure 8.

Significant differences in behavioral intentions to participate in Siamese crocodile conservation activities were found across subdistricts, except for elevating the Siamese crocodile as one of the identities of Phetchaburi Province ($p > 0.05$). Differences in benefit sharing from Siamese crocodile farms to communities coexisting with crocodiles were observed among respondents with different primary occupations ($F_{6,201} = 2.34$, $p = 0.03$), particularly between organizational staff and fishermen ($p = 0.03$). Furthermore, there was a greater inclination among males compared to females to report the presence of Siamese crocodiles ($t = 2.52$, $df = 177.38$, $p = 0.01$).

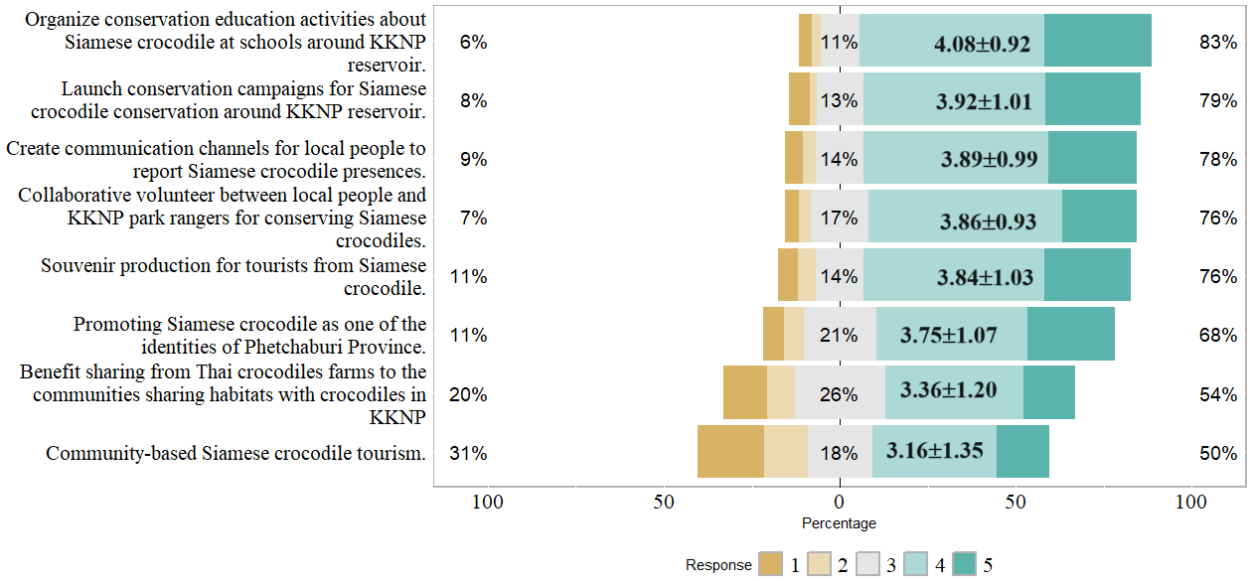

Figure 8 Behavioral intentions to participate in eight conservation efforts for Siamese crocodiles in Kaeng Krachan National Park, based on mean scores and frequency ratings on a five-point Likert scale, where 1 = strongly disagree and 5 = strongly agree.

Overall behavioral intentions to participate in conservation efforts on Siamese crocodiles were not significantly different among respondents with varying backgrounds of educational level, occupation, gender, or age. Only respondents living in different subdistricts ($F_{2,203} = 4.43$, $p = 0.01$), particularly Song Pi Nong and Huai Mae Preng districts, showed a difference in behavioral intention to take part in Siamese crocodile conservation efforts ($p = 0.02$) as shown in figure 9.

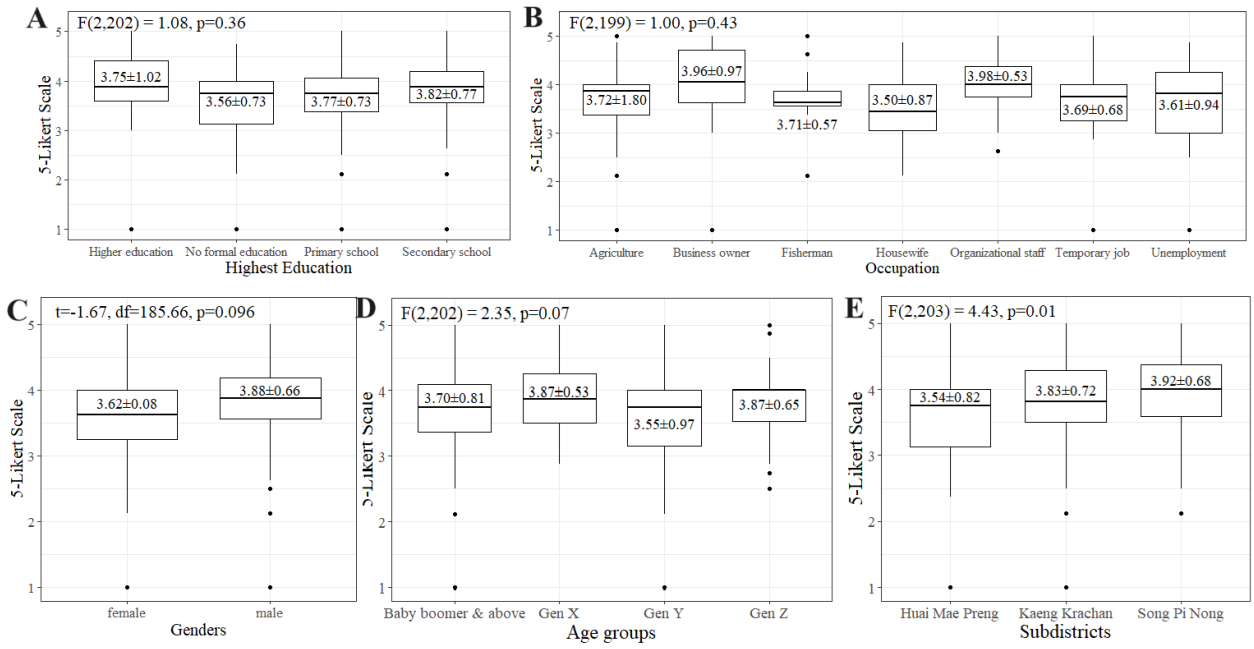

Figure 9. Comparison of behavioral intentions to participate in conservation efforts of Siamese crocodiles by the highest level of education (A), occupation (B), gender(C), age range (D), and subdistrict (E).

Human Dimensions Based on Hazard-Acceptance Model

The acceptance of reintroduction methods for farm-bred Siamese crocodiles

The respondents predominantly accepted the reintroduction method involving wild-collected eggs for artificial incubation before reintroduction, followed by the soft release of farm-bred Siamese crocodiles. The hard release of farm-bred Siamese crocodiles was deemed unacceptable. This resulted in a significant difference in acceptance levels among the three reintroduction methods of Siamese crocodiles ($F_{2,651}$ = 49.72, $p < 0.01$). The technique involving wild-collected eggs for artificial incubation was more accepted than both hard release ($p < 0.01$) and soft release ($p < 0.01$), while soft release was more accepted than hard release ($p < 0.01$: see figure 10).

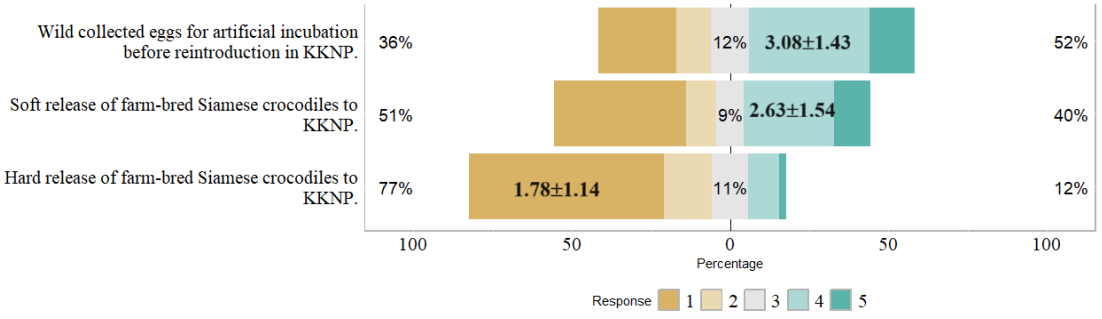

Figure 10. Acceptance of the three reintroduction methods for Siamese crocodiles, based on mean scores and frequency ratings on a five-point Likert scale, where 1 = strongly disagree and 5 = strongly agree.

Risk perception on farm-bred Siamese crocodile reintroduction

The overall risk perceptions toward the crocodile reintroduction were moderate (3.26±1.03). Respondents were primarily concerned about the risk of human injury from the reintroduced farm-bred Siamese crocodiles, followed by the risk of the crocodiles having low adaptation to the natural environment and their inability to search for natural foods. The least perceived risk was that humans might harm or kill the reintroduced farm-bred Siamese crocodiles due to fear. All risk perceptions regarding the reintroduction of farm-bred Siamese crocodiles were significantly different ($F_{3,868} = 8.45$, $p < 0.01$), as shown in figure 11.

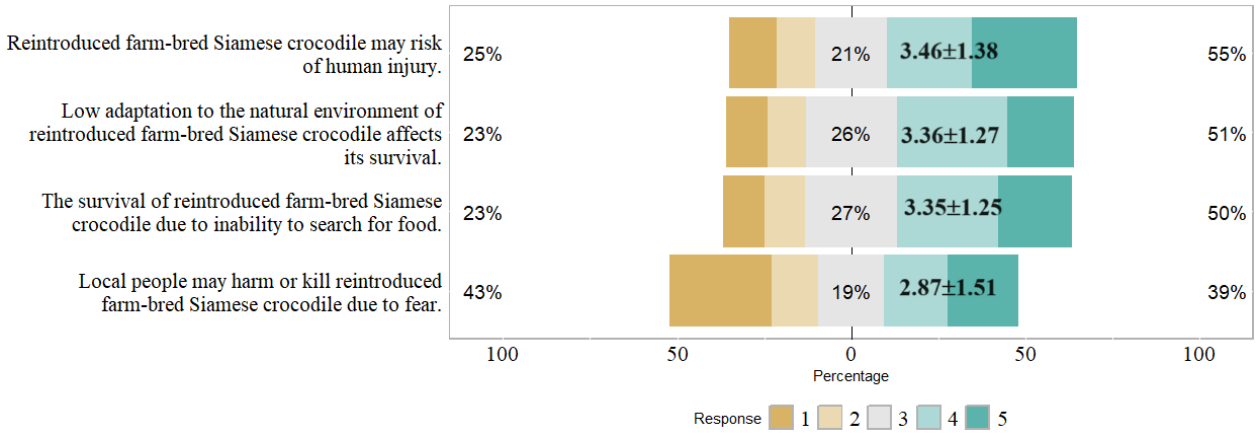

Figure 11. Risk perception of Siamese crocodile reintroduction in KKNP, based on mean scores and frequency ratings on a five-point Likert scale, where 1 = strongly disagree and 5 = strongly agree.

Our study revealed differences in risk perception among respondents from different subdistricts ($F_{2, 205} = 4.60$, $p = 0.01$), especially those living in Kaeng Krachan-Huai Mae Preng, by gender ($t = 2.64$, $p < 0.01$), and having different occupations ($F_{6,201} = 2.89$, $p = 0.01$), especially between unemployed respondents and fishermen ($p = 0.049$) and housewives ($p = 0.01$: figure 12).

Focusing on the risk perception of reintroduced farm-bred Siamese crocodiles on human safety, significant differences appeared among respondents with different occupations ($F_{6,201} = 4.31$, $p < 0.01$), especially fishermen and organizational staff ($p = 0.02$), unemployed respondents ($p < 0.01$), and temporary workers ($p < 0.01$) and between unemployed respondents and agriculturalists ($p = 0.04$). Respondents living in different subdistricts also had significant differences of perceived risks ($F_{6,205} = 6.41$, $p < 0.01$), especially in Huai Mae Preng and Kaeng Krachan ($p < 0.01$) and Song Pi Nong ($p = 0.01$).

On the other hand, the perceived risk of locals harming or killing reintroduced farm-bred crocodiles due to fear varied by subdistricts ($F_{2,205} = 3.23$, $p = 0.04$), especially between Kaeng

Krachan and Huay Mae Priang (p = 0.04), by age range ($F_{4,204}$ = 2.98, p = 0.02), particularly between Generation Z and Baby Boomers (p = 0.049), and by gender (t = 2.18, p = 0.03).

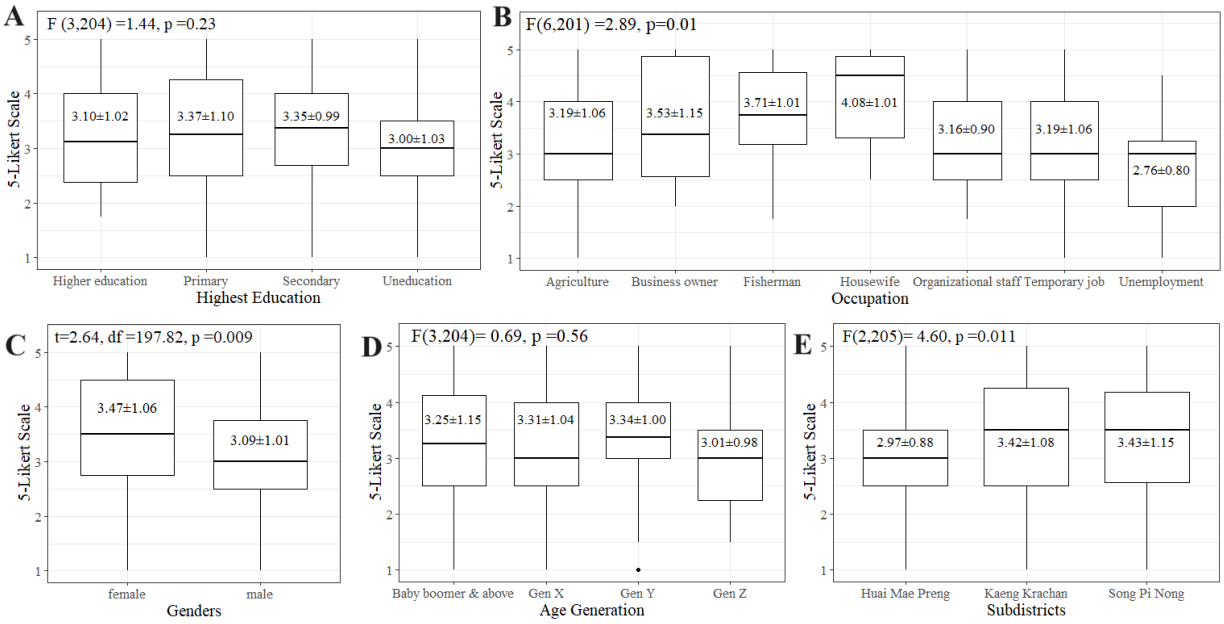

Figure 12. Comparison of risk perceptions toward the reintroduction of Siamese crocodiles by the highest level of education (A), occupation (B), gender (C), age range (D), and subdistrict (E).

Factors affecting the acceptance of reintroduction methods of Siamese crocodiles

The factors affecting the acceptance of each reintroduction method were different. The hard release was accepted by male respondents with lower education levels. This group feared Siamese crocodiles and perceived them as ferocious but supported conservation communication and perceived the risk to human safety from reintroduced Siamese crocodiles. Respondents who accepted the soft release were influenced by their value orientation on Siamese crocodiles as pluralists, the acceptance of community communication on crocodile conservation, and perceived risk of the reintroduced Siamese crocodiles in two aspects of human safety and of crocodile adaptation and survival in the new environment. Finally, factors affecting respondents' acceptance toward the collection of crocodile eggs for artificial incubation before reintroduction were associated with the males who were aware of either human safety or competing for food with humans from the crocodiles but supporting Siamese crocodile conservation through both community communication and community development from crocodile farms and trade. The results on factors affecting the preferential reintroduction methods are shown in Table 1.

Preparedness for human-crocodile conflict after reintroduction

By aligning the above-mentioned results to the IUCN five principles of IUCN SSC guidelines: (1) do no harm, (2) understand issues and context, (3) work together, (4) integrate science and policy, and (5) enable sustainable pathways, we summarized the contribution our insights in preparing for and offered further activities to be integrated into the plan for managing potential human-crocodile conflicts after reintroduction as shown in Table 2.

Table 1 Analysis using ordinal regression of factors affecting the acceptance for each reintroduction method of farm-bred Siamese crocodiles in Kaeng Krachan National Park

Parameters	Hard release				Soft release				Egg collection for incubation			
	Est	**SE**	**t**	**P**	**Est**	**SE**	**t**	**P**	**Est**	**SE**	**t**	**P**
Acceptance level: 1|2	*18.65*	*0.23*	*80.66*	*0.00*	*0.09*	*0.16*	*0.56*	*0.68*	*-0.26*	*0.22*	*-1.19*	*0.23*
Acceptance level: 2|3	*19.62*	*0.29*	*67.73*	*0.00*	*0.60*	*0.17*	*3.52*	*0.00*	*0.39*	*0.22*	*1.78*	*0.07*
Gender: (female as reference)												
Male	0.85	0.36	2.33	0.02	-	-	-	-	1.10	0.31	3.58	0.00
Highest Level of Education (undergraduate /vocational studies as a reference)												
Primary education	17.30	0.23	75.37	0.00	-	-	-	-	-	-	-	-
Secondary education	15.91	0.33	48.31	0.00	-	-	-	-	-	-	-	-
No education	17.50	0.27	65.24	0.00	-	-	-	-	-	-	-	-
Value orientation as pluralist					*2.14*	*0.77*	*2.79*	*0.01*				
Attitude toward Siamese crocodiles												
Siamese crocodiles are ferocious and feared by local people	0.53	0.23	2.32	0.02	-	-	-	-	-	-	-	-
Siamese crocodiles neither harm nor compete for food with humans	-	-	-	-	-	-	-	-	-0.47	0.21	-2.24	0.025
Aceeptability toward measures for Siamese crocodile conservation												
Community communication for Siamese crocodile conservation	0.83	0.29	2.99	0.003	1.00	0.22	4.49	0.00	0.97	0.19	5.11	0.00
Community development using benefits from crocodile farms	-	-	-	-	-	-	-	-	0.61	0.18	3.45	0.001
Risk perception of crocodile reintroduction												
Risk to human safety	-0.64	0.24	-2.70	0.007	-0.81	0.22	-3.78	0.00	-	-	-	-
Risk of inability to adapt and survive of reintroduced Siamese crocodiles	-	-	-	-	-0.44	0.17	-2.57	0.01	-	-	-	-
Residual Deviance, AIC	259.24, 277.24				318.37, 330.37				342.786, 354.79			

Table2 Alignment of research findings that support managing potential human-crocodile conflicts in Kaeng Krachan National Park based on IUCN SSC guidelines on human-wildlife conflict and coexistence (IUCN, 2023)

Principles	Guiding principles to practices	Supporting researches/ outreaches/activities	Suggested further activities
1. Do no harm	1.1) Follow the precautionary principle by understanding the levels of conflict over wildlife	This study identified 3 levels of HCCs: Dispute = fear of crocodiles; Underlying = local people were unsatisfied with crocodile egg collections in 2016. Deep-rooted = releasing farm-bred crocodiles perceived as disrespectful [to??]	1. Conduct an interview with local experts about traditional ecological knowledge and other beliefs associated with Siamese crocodiles 2. Convene a meeting to reconcile and resolve existing underlying and deep-rooted conflicts.
	1.2) Follow ethical guidance 1.3) Assess the risk of unintended consequences 1.4) Consider historical context, environmental justice, and case uniqueness.	-	3. Host a workshop to plan interventions and establish legitimacy for managing human-crocodile conflicts, including unintended outcomes involving all stakeholders, particularly local residents who interact daily with crocodiles in their habitats.
2. Understand issues and context	2.1) Seek to understand ecological and spatial drivers	Researches by Plat et al. (2002), Kanwatanakid-Savini et al. (2012), Lapbenjakul et al. (2017), Chanpradub et al. (2023), Ariyaraphong et al. (2023) address this question.	4. Ecological research on the reintroduction of 4.1 breeding habitats and suitable release sites. 4.2 whole genome of the farm-bred crocodiles. 4.3 crocodile behaviors before, during, and after reintroduction as a long-term monitoring program to prompt local people in understanding crocodile behaviors.
	2.2) Understand socio-economic and political drivers of potential HCCs: (1) Recognize the complexity of human-wildlife conflicts. (2) Evaluate the political and governance context.	This study, Deekaew et al. (2018) reported: (1) Complex and multi-layered potential HCCs in KKNP, involving fear despite no crocodile attack records and anecdotes of crocodiles saving humans from drowning. (2) Insights into social contexts and drivers such as attitudes, perceived risk, WVO, and acceptance of reintroduction.	More social science research is needed on: 5.1 Potential impacts of farm-bred crocodile reintroduction from local perspectives. 5.2 Traditional ecological knowledge and perceived benefits (tangible and intangible) from crocodile conservation. 5.3 Political and governance contexts of Siamese crocodile reintroduction.
3. Work together	3.1) Identify and involve all relevant stakeholders in planning for interventions	DNP, WCS, universities, crocodile farms, and KKNP stakeholders, excluding local residents, participated in a workshop on	6. All stakeholders, especially local people who share habitats with crocodiles in daily life must be included in designing the HCC interventions.

Table2 (Con't)

Principles	Guiding principles to practices	Supporting researches/ outreaches or activities at the current states	Suggested further activities
3. Work together	3.2) Work in multidisciplinary teams and across sectors	crocodile reintroduction in Thai protected areas (WCS-Thailand, 2023).	7. KKNP and WCS-Thailand should provide conservation education to all stakeholders to ensure a shared understandings of common goals of the Siamese crocodile reintroduction and create effective collaboration.
	3.3) Collaboratively develop a theory of change and action plans or strategies benefiting multidisciplinary teams across sectors.	WCS-Thailand provided conservation education to KKNP park rangers and local school students, emphasizing education without involving collaborative planning or community engagement for solutions.	8. Leading organizations (DNP) should seek to develop a theory of change and action plans for reintroduction along with all stakeholders. 9. Organize a workshop for local people to identify activities they can participate in.
	3.4) Design and manage solutions collaboratively. 3.5) Encourage and support community-led solutions	Apply Teampanpong et al. (2024) as a guideline to set up community-based Siamese conservation.	10. establish community-based Siamese crocodile conservation 11. Design long-term programs (campaign, education, communication) with communities.
	3.6) Transfer ownership of process and decisions	-	12. Explore a consensus on managing ownership of community-based Siamese crocodile conservation.
4. Integrate science and policy	4.1) Incorporating scientific insights into local, societal, and political perspectives into planning and actions.	This study and Deekaew et al. (2018) provided results to understand societal perspectives but did not cover political perspectives.	13. Conduct research on political ecology of Siamese crocodiles.
	4.2) Apply rigorous scientific methods for plannings: (1) Evaluate physical, ecological, natural patterns. (2) Identify conflict hotspots and problematic crocodiles. (3) Study crocodile demography and distribution.	Researches by Plat et al. (2002), Kanwatanakid-Savini et al. (2012), Lapbenjakul et al. (2017), Chanpradub et al. (2023), Ariyaraphong et al. (2023) provided science to understand wildlife ecology for making decisions on management.	14. Prepare, plan and predict resource utilization by the crocodiles across time and space and the behavior of the crocodiles after reintroduction. 15. Review literatures to set plans for capture, translocation, and/or lethal control of problematic crocodiles after reintroduction.
4. Integrate science and policy	(4) Planning across landscapes	-	16. using data from 1-5 in to devise landscape planning in human-crocodile conflict management

Table2 (Con't)

Principles	Guiding principles to practices	Supporting researches/ outreaches or activities at the current states	Suggested further activities
		-	and identify the primary sites for testing the model of human-coexistence with Siamese crocodiles
	(5) Avoid quick fixes; do not copy–paste solutions	The studies mentioned above provide site-specific information for making more appropriate planning/solutions to KKNP.	17. Conduct workshops with Phetchaburi River communities to discuss Siamese crocodile threats and conservation interventions post-reintroduction, aiming for minimal conflicts.
	4.3) Create opportunities for training and capacity building	WCS trained rangers in crocodile conservation and provided capacity-building for students, encompassing both scientific and social science research.	18. Identify essential trainings and build capacity of local people and park rangers on risk prevention measures.
	4.4) Adapt to local governance, political and policy contexts	-	19. Research local governance in Siamese crocodile conservation and reintroduction. 20. Analyze laws and policies supporting the management of HCCs. 21. Identify policy instruments-regulatory, legal, economic, financial, rights-based, norms, and social—to develop a comprehensive plan.
	4.5) Create a collective learning loop.	-	22*. Run community-based Siamese conservation
5. enable sustainable pathways	5.1) Nurture societal and cultural values of wildlife	WCS- Thailand conducted conservation eduacation with school students around KKNP reservoirs and Phetchaburi River.	23. Maintain annual education with school students. 24.Incorporate social marketing and behavior change theory when engaging with communities, wishing to create sustainable collaboration.
	5.2) Develop/nurture ongoing dialogue and build relationships	-	22*. Set up and run community-based Siamese conservation

Table2 (Con't)

Principles	Guiding principles to practices	Supporting researches/ outreaches or activities at the current states	Suggested further activities
5. enable sustainable pathways	5.3) Incorporate long-term ecological needs		25. Establish response teams to monitor ecological needs and anticipate emerging conflicts from reintroduced crocodiles.
	5.4) Anticipate and prevent emerging conflicts.	-	26. Incorporate evaluation plans for HCCs interventions.
	5.5) Minimize and redistribute costs burdens fairly	This research addressed some potential benefits from Siamese crocodiles.	27. Initiate program to deisgn compensation and insurance due to HCCs
	5.6) Create sustainable economic benefits from wildlife	-	28. Introduce economic incentives to minimize and redistribute costs of crocodile conservation from stakeholders' perspectives.

Discussion

Attitudes Toward Siamese Crocodiles and their Conservation

Our findings indicate that fear of Siamese crocodiles exists among respondents as a common sentiment among those living in crocodile habitats (Cavalier et al., 2021). This result aligns with Deekaew et al. (2018), who found that residents in Pong Luek and Bang Kloi villages within KKNP not only feared crocodiles but also held a deep respect and veneration for them. Similarly, fear of Siamese crocodiles has been reported in Cambodia (Daltry et al., 2004) and Laos (Plat et al., 2018). Despite their fear of Siamese crocodiles, respondents exhibited overall positive attitudes toward them (3.70±0.74) and their conservation as well as an interest in participating in various conservation activities. This is likely because Siamese crocodiles have inhabited the Phetchaburi River for generations without any reports of harm on people safety, particularly in Huay Mae Priang Subdistrict (Pong Luek and Bang Kloi villages), where these crocodiles are held in deep respect and veneration. We believed that storytelling about Siamese crocodiles helping drowning people from their ancestors further contribute to these positive attitudes. Similar stories about the relationship between humans and crocodiles have been reported in other local Thai communities (Thai Studies CU, 2018).

Our results indicate that the presence of Siamese crocodiles in KKNP does not adversely affect the perception of this species among fishermen. This could be attributed to the fact that they did not have negative encounters with Siamese crocodiles though they perceived a high risk from reintroduction of farm-bred crocodiles for human injury, but moderate risk that they may harm or kill reintroduced farm-bred Siamese crocodiles due to fear. Moreover, the deep respect and veneration towards Siamese crocodiles among local people underscore the importance of preventing their extinction and conserving them within KKNP. This finding aligns with the study by Neves and Giger (2022), which found that while crocodiles are often perceived as threatening and instilling fear, they are also deeply respected. This complexity in human-crocodile relationships in KKNP likely stems from cultural values and beliefs. These beliefs are relevant to findings on conservation of Siamese crocodiles in Cambodia (Daltry et al., 2004) and Laos (Plat et al., 2018). Therefore, our findings emphasize that human perceptions and attitudes depending not only on facts and personal experiences but also on cultural norms, expectations, and beliefs are crucial for addressing conflicts between humans and various wildlife species (Dickman, 2010).

Value Orientations Concerning Siamese Crocodiles

This research studied value orientations concerning Siamese crocodiles for the first time in Thailand. Value orientations can be used to predict attitudes, behaviors (Perry-Hill et al., 2014), and acceptance of wildlife management (Jacobs et al., 2014). We found 86.54 % of the respondents valued the Siamese crocodile as mutualist, followed by pluralist (7.21 %) and distanced (2.88 %). This aligns with the research by Tanakanjana and Saranet (2007), who found the local communities around Khao Yai and Kui Buri National Parks valued wildlife in the mutualist dimension which encompasses caring for wildlife in terms of emotions and feelings (caring: Dayer et al., 2007). Meanwhile, students in natural resource management valued wildlife in the mutualist dimension, ranked as second after the human safety dimension.

Furthermore, it is possible that the positive orientation towards Siamese crocodiles, which involves mutualistic interactions with humans, and the support for their conservation among respondents, may contribute to a positive attitude. This observation aligns with the findings of Abidin and Jacobs (2019), who found a correlation between emotional attachment to wildlife and the endorsement of wildlife conservation efforts.

Acceptance, risk perception, and factors affecting acceptance of reintroduction

The acceptance of Siamese crocodiles' reintroduction methods, both wild-collected eggs for artificial incubation (52%) and soft release (40%) are still ambivalent between acceptance and non-acceptance. Non-acceptance of the hard release method (12%) attributed to the highest risk perceptions of about reintroduced Siamese crocodiles have low a low rate of adaption to the natural environment and their inability to search for food may increase the risk of human injury.

We assessed the acceptance of three Siamese crocodile reintroduction methods among local people in Pong Luek and Bang Kloy villages. Their preference was for wild-collected eggs for artificial incubation before reintroduction (42.47%: 2.74±1.31), followed by soft release (38.36%: 2.59±1.39) and hard release (12.33%; 1.92±1.08). This contrasts with Deekaew et al. (2018), who reported that 85% of locals in Pong Luek and Bang Kloy opposed artificial incubation for reintroduction and 96% disagreed with releasing farmed crocodiles, primarily due to their belief (83%) in moderate to high natural hatching success in the wild.

The acceptance of Siamese crocodile reintroduction appears to be evolving, possibly due to insufficiently detailed explanations of reintroduction methods, such as soft and hard releases as per Deekaew et al. (2018). This has led to a lack of understanding among local people regarding

the associated consequences. Local beliefs regarding the high natural hatching success of Siamese crocodiles, as reported by Deekaew et al. (2018), may not align with the fact that no successful hatching of Siamese crocodiles occurred at Wang Kha in KKNP during the years 2009-2011 and 2022, despite 31, 40, 32, and 16 eggs being laid in those respective years (WCS-Thailand, 2023). At this moment, the above-mentioned fact about the unsuccessful natural hatching of the Siamese crocodiles at Wan Kha in KKNp had never been shared with local people or the general Thai public.

According to Deekaew et al. (2018), 72% of respondents perceived community benefits of Siamese crocodile reintroduction as low to moderate. Sixty-four percent of all respondents also indicated low to moderate levels of collaboration in managing Siamese crocodiles. In contrast, our study found that over 65% of villagers in Pong Luek and Bang Kloy accepted various collaborative conservation efforts, except for supporting community-based Siamese crocodile tourism and crocodile farming businesses creating community benefits, which received only 47.95% acceptance. These contrasting results might be due to several reasons. In the past, KKNP may have lacked a framework for establishing cooperation and communication that local people could comprehend, leading to low awareness and limited collaboration opportunities. The evolving trend of acceptance, as reported in our study, may be attributed to its implementation following the conservation education activities conducted by WCS-Thailand around KKNP (Angkana Makvilai, Personal communication). This underscores the urgency of increasing community participation in Siamese crocodile conservation through various initiatives (Chanpradub et al., 2023; WCS-Thailand, 2023).

Our research suggests that collaboration should be directed towards males due to their low-risk perception of human injury from Siamese crocodiles. Males also tended to be more accepting of the three reintroduction methods than females. Both KKNP and WCS-Thailand should support conservation education activities to communicate accurate information about managing fear of Siamese crocodiles and their reintroduction, enhancing awareness of risk perceptions, and adjusting behaviors when encountering released reintroduced Siamese crocodiles. Conservation education should also aim to elevate resilience through proper risk perception and foster acceptance of potential conflicts between humans and released Siamese crocodiles in the future. This aligns with the concerns of those that if Siamese crocodiles are reintroduced, clear boundaries must be established between spaces used by Siamese crocodiles and humans. These suggested

actions could impact the acceptance level, as seen in the case of the American crocodile (*Crocodylus acutus*) in Southern Florida (Smithem and Mazzotti, 2008).

Conclusion

This study provided valuable insights into the human dimensions of Siamese crocodile conservation in KKNP, using two conceptual frameworks commonly employed in human-wildlife conflict studies to predict human behavior toward wildlife. The majority of participants are mutualist and pluralist, showing their support for the coexistence of humans and crocodiles and viewing the species' economic utilization favorably.

Despite existing fears and perceived risks of reintroducing farm-bred crocodiles potentially causing human injury, conservation efforts for this species are not fully opposed. Potential local support for the reintroduction and conservation of farm-bred Siamese crocodiles in KKNP were identified. However, several plans and actions are urgently required to establish sustainable pathways for managing potential human-crocodile conflicts post-reintroduction. These actions should begin with identifying existing conflicts related to Siamese crocodile conservation and developing solutions. Establishing community-based Siamese crocodile conservation initiatives may serve as a starting point for fostering genuine collaboration with local communities. Further research in both ecological and social sciences is needed to enhance understanding of potential human-crocodile conflicts in KKNP. This information should be used to devise management plans in collaboration with local residents along the Phetchaburi River, ensuring long-term sustainable pathways for Siamese crocodile conservation.

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