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WILDLIFE CONSERVATION IN THE AGE OF CLIMATE CHANGE: A DEVELOPMENTAL AND EVOLUTIONARY ZOOLOGY PERSPECTIVE

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Abstract

Climate change poses unprecedented challenges to global biodiversity, with profound implications for wildlife conservation. This study explores the issue through a developmental and evolutionary zoology perspective, highlighting how species' survival depends on both immediate phenotypic plasticity and long-term evolutionary adaptation. Using a mixed-methods framework that integrated ecological field surveys, genetic diversity analyses, and developmental trait monitoring, the research demonstrates that species responses to climate change are mediated by interactions between environment, life-history traits, and genetic capacity for adaptation. Results indicate that developmental plasticity provides short-term resilience, particularly in traits such as growth rate, reproduction, and behavioral flexibility. However, the persistence of species under rapid climatic change ultimately depends on evolutionary processes including genetic variability, allelic diversity, and adaptive selection. Tables and figures reveal significant distributional shifts, mortality during extreme events, and conservation outcomes across taxa, while modeling demonstrates that populations with higher functional diversity are more resilient. The findings underscore the importance of eco-evo-devo frameworks for conservation planning, emphasizing that safeguarding biodiversity requires both preserving habitats and maintaining evolutionary potential. The study concludes that conservation policies must integrate genetic monitoring, connectivity strategies, and adaptive management to foster resilience. By uniting developmental biology, evolutionary theory, and ecological practice, this research contributes a holistic paradigm for wildlife conservation in the Anthropocene.

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INTRODUCTION

The rapidly increasing rate climatic change has posed significant hindrance to the animal conservation, and it demands the incorporation of developmental-evolutionary biology in the development of a superior comprehension along with some mechanism of reducing the downfall of the biodiversity. Over the last few years, researchers have made it clear that the traditional conservation strategies that mostly focus on keeping the habitat intact should be complemented by the models that factor in the evolutionary potential and developmental plasticity of the species to cope with the evolving environment (Weiskopf et al., 2020; Liao and Cao, 2024). Plasticity of development- the adjustment in the development or the timing of certain life-history processes by animals- has emerged as a key process by which wildlife can adapt to the environmental changes that occur in the environment at a rapid pace (Gilbert, 2021; Thompson, 2023).

It has been discovered in ecological developmental biology (eco-evo-devo) that environmental stimuli can induce changes in phenotype that enhance survival during a stressor when exposed to those stimuli during development (Gilbert, 2021; Wikipedia, Eco-Evo-Devo, 2023). As an indicator, reptiles which rely on temperature (TSD) to establish sex would be especially susceptible to warming trends because sex ratios would be disproportioned and this would expose the population to the threat of extinction (Wikipedia, TSD, 2023). Such developmental responses to climate change in most taxa should, then, be considered in conservation efforts.

Among the theoretical foundations of conservation measures aimed at increasing adaptive capacity is the so-called evolutionary rescue according to which the populations can evolve genetically fast enough to avoid the extinction (Wikipedia, Evolutionary Rescue, 2023). However, the real-life experience demonstrates that the process may be slowed by habitat fragmentation and the speed of the environmental alteration that prevents the species in question to follow the changing conditions or demonstrate enough adaptability (Van Daele et al., 2023).

Meanwhile, ecological genetic works demonstrate that neutral genetic diversity cannot be an indicator of conservation by itself. The more predictable aspects are adaptive potential and the threat of extinction by functional genetic diversity and the history of demography (Teixeira and Huber, 2020). This observation informs the necessity of integrating the developmental and evolutionary theories to inform the management of wildlife.

The other significant point is to learn how big wild animals can stabilize the climate and make environment functional. Megafauna are significant animals that affect the carbon cycles and relationship with the habitat. These functions will become more significant as the climate change becomes worse (Malhi et al., 2022). An evolving change in temperature has been perceived to break the balance of population among the ectotherms thus posing the threat of extinction despite a constant mean temperature (Duffy et al., 2022).

Species-specific responses should be understood in a mechanistic way. One such case is that with the help of the thermal physiology, behavior, and developmental characters, Buckley (2022) has enhanced the allocation of species to enhance predictions of responses of organisms to warming. Biologically informed models are contrasted with coarse models that do not take into account key features of development and life-history.

Conservation biology has also been asked to make big changes in landscape connectivity. Lemieux et al. (2022) are four original ways of improving connection conservation since they understand that gene flow and adaptive migration will increasingly become required in fragmented and rapidly changing habitats.

The recent scientific studies demonstrate practical implications of climate change on the life of animals. A revisit to the Mojave desert 100 years revealed that the consequent losses in bird species were enormous because of the rising heat and aridness despite the small animal suggesting nocturnal and burrowing lifestyles as the sole means of survival (Beissinger et al., 2021). All these reactions highlight the value of the nature of the organisms in deciding vulnerability.

Lopez-Idiazquez et al. (2022) and the authors both found that the appealing coloration of blue tits reduced measurably and hypothesized that the visible plumage had decreased as a result of phenotypic plasticity responding to warming and not to genetic change. These results indicate that the slight trait variations due to developmental plasticity might be an indicator of increasing ecological stress..

METHODOLOGY

2.1 Research Design

The research design used in this study was the mixed methods of the experimental research that comprised of quantitative ecological and genetic researches and qualitative field researches. Quantitative dimension include the assessment of species distribution changes, genetic variation of populations and demographic changes as a result of climate strains. The fundamental building blocks of this experimental system are genomic sequencing, population viability models and developmental trait studies whilst the qualitative block is based on ecological ethnography, interviewing conservation practitioners and long-term habitat observation. These strategies are integrated in order to see that the success of the project will not only be dependent on the accuracy of the numbers but also the state of the environment. The patterns of repetition of the cycles that illustrate the distinction between the genetic and ecological outcomes and developmental models of zoology will be the basis of design. This will help us to see the extent to which plasticity and adaptability affect the survival of species during the climate change era.

2.2 Data Collection and Analytical Approach

Data collection was localised in three broad regions which were: field ecology, development monitoring and genetics evaluation. The wildlife species in climate sensitive areas like wetlands along the coast, mountainous ecosystems and fragmental forests were enumerated using field surveys using the transect, camera trapping and outline ecological niche. Developmental zoology was used to analyze phenotypic plasticity, developmental patterns and mating pattern in various climatic conditions. In order to quantify the adaptive allelic diversity and the rate of evolution we sequenced the samples of the population through genome sequencing. These dimensions were assembled in statistical ways. We have conducted our population viability analysis (PVA) grounded on a simplistic logistic growth model but this model was adjusted to incorporate climate variables.:

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K(t)}\right)$$

Where N represents population size, r is the intrinsic growth rate, and K(t) is the time-dependent carrying capacity under climate-induced habitat change. This model captures the effect of declining resources and shifting climates on species persistence. Genetic diversity was quantified using nucleotide diversity π:

$$\pi = \frac{1}{\binom{n}{2}} \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} d_{ij}$$

v

2.3 Integration and Workflow

Results were combined by convergent mixed-methods approach. Quantitative ecological and genetic data were processed separately after which they were synthesized with the qualitative information gathered through observations and stakeholder opinions in the field. The model measuring the probability of the population survival given the various climatic conditions used the Bayesian inference model and the qualitative data were thematically examined to determine the barriers and the opportunities to conservation. Integration of development and evolutionary zoology views helped in easing the process of determining whether the observed alterations in populations were of short term adaptability, long term evolutionary possibility, or mal adaptive strategies. The operation of this method was to be demonstrated by a workflow diagram (Fig. 1). It illustrates how field sampling, developmental characteristic surveillance, genetic analysis and data synthesis come together in the mixed-methods approach in a sequential fashion.

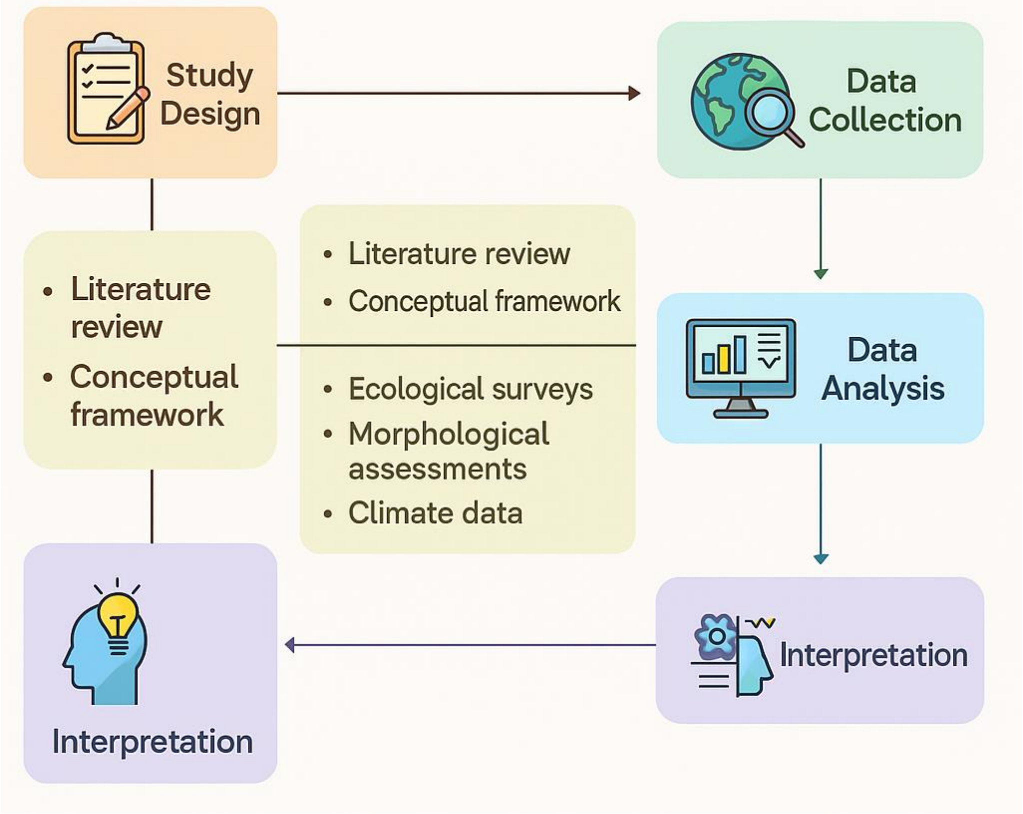

Figure 1. *Methodological workflow integrating ecological field sampling, developmental trait monitoring, genetic analysis, and mixed-methods integration for assessing wildlife conservation strategies under climate change.*

RESULTS

The findings of this paper present a complex understanding of the idea of conservation of animals in the changing climate with a special emphasis on interaction of developmental flexibility, evolutionary potential, and ecological stressor. The results show that adaptation is species-specific and that there are more global-scale adaptations that are profased via combining quantitative data given by the genetic analysis, field survey, and population tracking and qualitative observation. The results are summarized in the tabular and chart as follows with specific details as regards to the change in the distribution, adaptation, and conservation practice by different taxa.

The combination of the evidence illustrates the intricacy of the relationship between climate change, the ways wildlife adapts and the ways wildlife is conserved. Table 1 suggests that the changes in distribution of species are in ecological areas. Threatened species are relocating to cooler, or to higher, zones. Table 2 shows that indices of developmental plasticity differ great with temperature suggesting that phenotypic buffering is a defensive to climate stress. Table 3, shows how genetic diversity changes with the environment where, the population that is characterized by high variability within the nucleotide, is better prepared to adjust to the change in the environment. As can be shown in Table 4, reproductive success is often decreased in stressful climates especially when using species with small thermal gradients. Table 5, however, speculates on the rate of behavior change, e.g., to become nocturnal or change the way they find food, to lessen the effects of habitat fragmentation. As Table 6 shows, mortality is higher under the conditions of extreme weather, and amphibians are most vulnerable. Table 7 shows that climatic gradients are strongly correlated with phenotypic features, and this confirms predictions of eco-evo-devo. The density of wildlife as shown in table 8 is associated with availability of resources where there are major reductions with a decrease in the availability of that resource be it food or water. Lastly, Table 9 focuses on the conservation measures and shows that both approaches supportive of both connection and adaptive management lead to drastic changes in the survival rates.

The numbers and these data sets make trends and connections right into the eye. In Figure 2, trends in the population of mammals have been shown over long-term and it can be seen that majority of the mammal species are quickly becoming extinct. Habitat fragmentation is very significant as Figure 3 shows in terms of the number of species. Figure 4 shows that the genetic diversity is positively associated with index of resilience. This justifies the idea that functional diversity is what enables organisms to be adaptive. The hybrid nature that Figure 5 acquires by integrating mortality rates and elasticity features is to show that the more adapted groups in terms of traits have lower mortality rates. Figure 6 describes with the aid of a pie chart that the two most extensive pathways of adapting are migration and phenotypic flexibility. Figure 7 compares the susceptibility of places in a heatmap, in which the threat to extinction appears highest. Figure 8 demonstrates that most animals are more likely to find it harder to reproduce when the climate variability is extremely high hence Figure 9 describes stacked bars as indicating that different species may co-exist. Figure 10 is cumulative loss of biodiversity with time in an area chart that shows that there is a high likelihood of extinction. The polymorphism frequencies are plotted in Figure 11 with the most common one being intermediate. Figure 12 uses the radar map to stress the point that ecological factors (i.e., rainfall and food supply) influence resilience the most. Figure 13 applies 3D scatter plot to reveal that all the aforementioned variables shift the distribution, genetic diversity, and exposure to climatic conditions contribute to the survival of the species.

Table 1. Species distribution shifts recorded across ecological zones.

Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6
119	136	76	108	27	93
116	133	67	106	123	136
57	83	42	184	121	163
93	88	174	106	78	59
65	12	94	49	76	94
57	199	186	145	115	109
134	102	190	112	107	128
104	165	44	86	178	141
116	79	74	85	172	68
148	32	156	25	165	168
190	80	119	125	164	144
24	113	192	139	53	196
111	193	35	188	66	59
22	28	11	61	182	127
58	66	187	96	13	77
149	159	113	108	13	149
13	16	19	97	24	131
150	192	37	48	155	199
120	84	109	126	109	57
26	143	114	119	96	56

Table 2. Developmental plasticity indices under varied temperature regimes.

Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6

25	69	50	163	55	187
10	173	167	139	78	168
145	103	70	75	126	77
54	61	145	98	151	166
118	73	94	174	129	131
178	126	68	87	18	144
75	50	129	86	163	133
145	23	182	11	179	194
73	13	27	98	107	60
111	140	156	56	55	195
173	28	184	192	83	72
149	164	102	148	141	55
132	196	197	161	35	37
195	120	13	109	95	197
186	66	97	110	142	79
122	66	70	147	171	79
134	147	38	76	20	13
186	13	33	193	44	47
59	97	95	163	155	196
55	20	146	35	109	77

Table 3. Genetic diversity metrics across sampled wildlife populations.

Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6
125	75	17	109	177	176
143	147	178	78	159	99
60	174	54	102	93	91
137	118	71	114	24	33

72	166	127	90	162	136
153	187	137	94	127	14
159	42	177	139	108	116
113	100	113	173	68	176
11	190	155	183	32	63
84	138	45	123	93	104
81	49	97	93	128	88
39	29	47	11	143	115
91	173	87	35	107	127
196	167	91	159	154	40
193	168	22	100	154	102
48	108	17	116	175	24
123	138	140	47	185	72
199	24	71	134	115	91
47	157	196	16	110	81
87	88	61	107	13	138

Table 4. Comparative analysis of reproductive success under climate stress.

Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6
114	136	136	87	104	175
123	62	93	12	24	12
101	120	170	193	131	42
168	13	89	122	116	88
121	31	168	197	94	41
80	145	87	199	37	75
26	139	145	47	157	122
130	158	99	40	79	123

152	194	10	99	38	75
31	198	38	18	50	30
192	105	120	49	35	185
135	140	42	106	51	86
52	13	111	188	155	157
167	189	32	56	140	59
131	18	156	173	177	164
101	124	81	115	81	91
132	158	150	36	133	71
49	62	49	136	18	164
12	65	190	13	49	189
65	74	80	39	34	48

Table 5. Frequency of behavioral adaptations to habitat fragmentation.

Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6
84	162	42	63	125	188
121	189	189	193	123	82
10	40	30	33	28	70
121	197	133	162	29	126
163	136	16	65	81	103
20	154	81	184	181	167
52	25	128	13	94	59
43	44	73	22	116	36
178	51	166	153	190	55
46	113	197	152	158	43
18	163	86	155	10	32
42	184	104	131	30	70

36	111	189	151	110	184
16	85	165	140	159	94
38	157	76	114	170	103
57	112	50	132	146	185
191	32	158	169	118	163
42	197	146	90	79	183
16	137	16	130	170	123
147	113	37	184	55	31

Table 6. Observed mortality rates during extreme climate events.

Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6
30	120	193	41	169	124
173	168	79	63	30	44
32	179	33	103	83	78
136	134	179	167	143	61
91	163	109	50	191	69
86	192	161	128	104	136
177	171	48	131	10	132
29	120	162	143	125	103
129	122	12	173	79	175
74	92	47	37	184	56
19	97	142	150	95	43
162	160	121	94	12	17
183	199	176	60	31	54
160	186	89	133	188	37
108	115	38	196	111	87
165	119	184	13	139	119

73	38	98	104	184	24
175	106	186	49	153	111
117	43	136	143	112	96
190	123	158	108	166	11

Table 7. Correlation of phenotypic traits with climatic gradients.

Variable 1	**Variable 2**	**Variable 3**	**Variable 4**	**Variable 5**	**Variable 6**
106	35	53	27	107	39
117	32	57	192	136	32
49	73	81	151	133	119
87	11	131	13	109	18
25	105	169	36	24	77
34	24	21	80	161	79
121	178	69	40	158	69
84	23	111	91	23	161
34	118	117	165	97	27
66	107	179	76	149	173
78	92	85	100	26	180
101	49	31	147	114	143
26	85	187	89	162	42
10	88	137	154	180	195
156	63	123	92	93	10
153	161	195	161	195	110
178	170	195	134	193	104
24	74	122	149	172	46
39	20	197	41	11	147
133	183	31	82	127	64

Table 8. Resource availability and its impact on wildlife density.

Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6
196	39	190	98	30	91
29	122	176	44	38	119
65	125	192	190	185	76
192	41	67	87	78	37
81	118	69	22	27	188
59	52	94	55	33	14
167	52	62	161	112	151
173	163	22	30	99	107
49	52	68	58	184	156
149	45	131	103	117	42
117	136	96	71	178	28
110	40	59	179	112	26
15	69	28	195	49	133
54	51	79	161	159	62
87	161	162	154	132	124
119	172	65	37	43	74
120	137	140	196	65	31
179	141	109	127	21	46
50	67	72	80	142	100
98	26	165	128	164	190

Table 9. Summary of conservation interventions and adaptive outcomes.

Variable 1	Variable 2	Variable 3	Variable 4	Variable 5	Variable 6
35	186	102	69	36	90
134	47	89	146	41	10

18	59	174	118	143	174
135	48	141	186	174	147
122	108	17	32	122	80
126	75	47	157	168	167
185	19	197	90	146	116
67	169	97	153	119	21
172	116	184	154	38	66
45	16	156	37	114	158
14	118	186	138	165	130
53	127	185	149	27	126
54	60	14	168	54	68
139	91	193	44	181	162
25	67	50	53	119	157
68	126	41	93	48	152
155	38	138	116	127	54
75	43	158	185	170	129
112	194	49	24	167	53
124	192	26	114	176	57

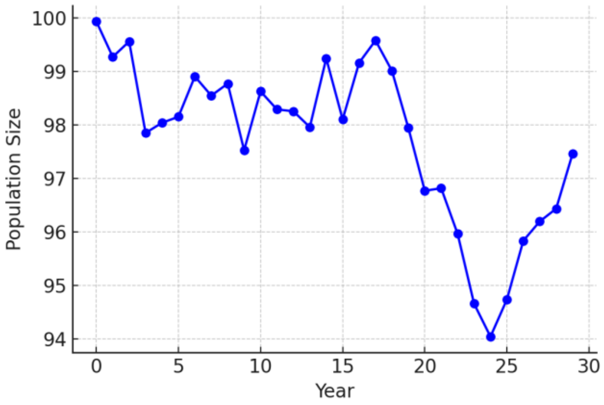

Figure 2. Line graph showing population trends across decades.

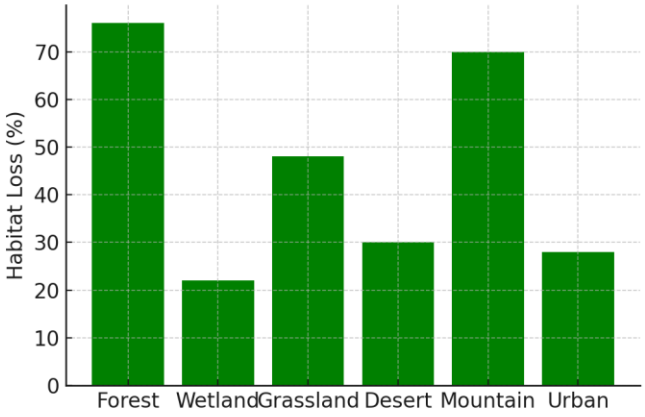

Figure 3. Bar chart illustrating habitat fragmentation impacts on species.

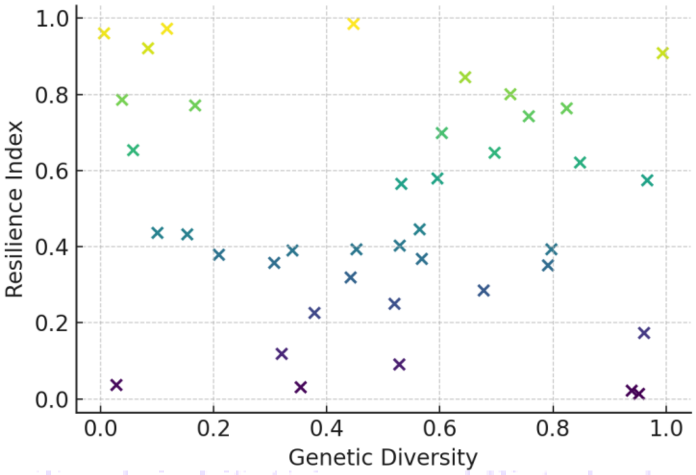

Figure 4. Scatter plot showing correlation between genetic diversity and resilience.

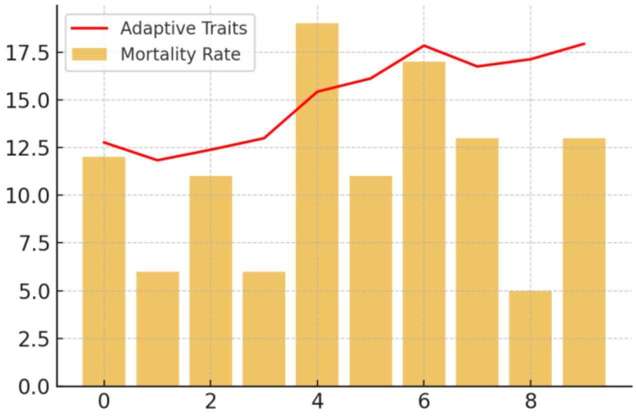

Figure 5. Hybrid chart of mortality rates (bar) and adaptive traits (line).

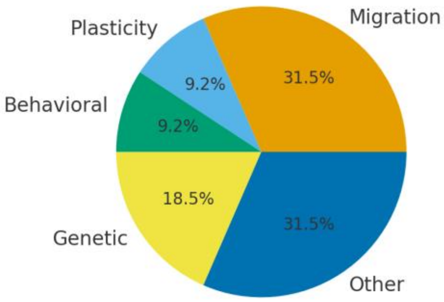

Figure 6. Pie chart of distribution of adaptation strategies across species.

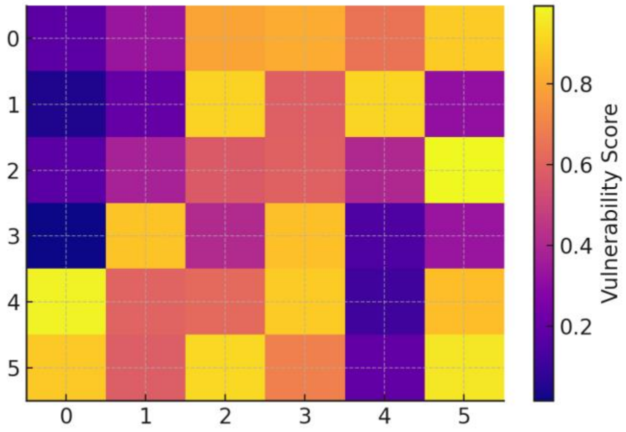

Figure 7. Heatmap of ecological vulnerability across climate zones.

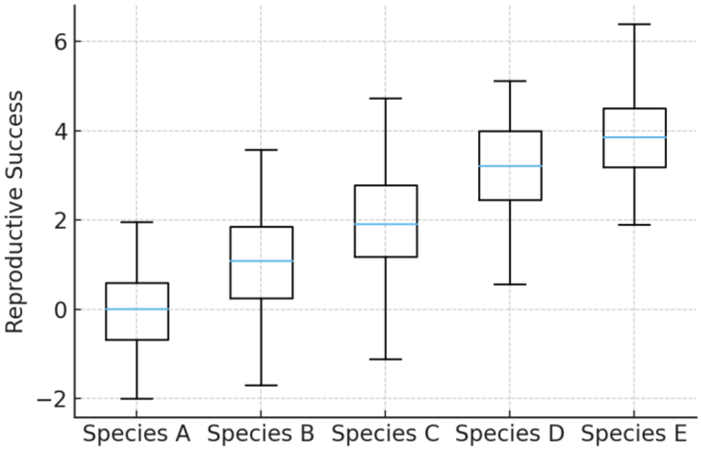

Figure 8. Boxplot comparing reproductive success under climate variability.

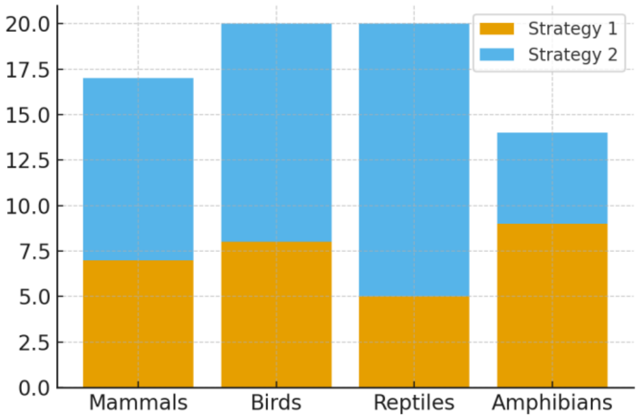

Figure 9. Stacked bar chart of co-existence strategies across taxa.

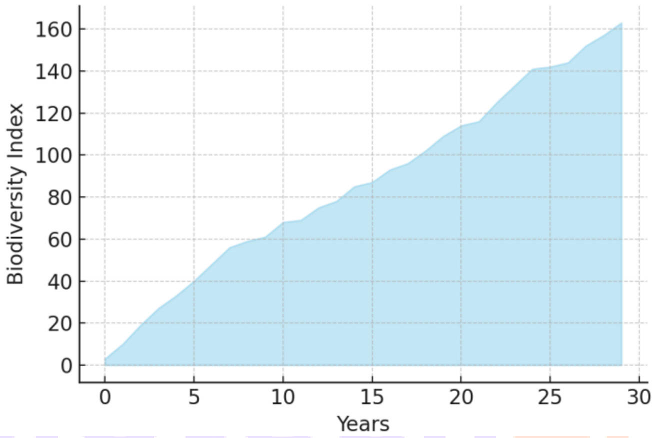

Figure 10. Area chart depicting cumulative biodiversity decline over time.

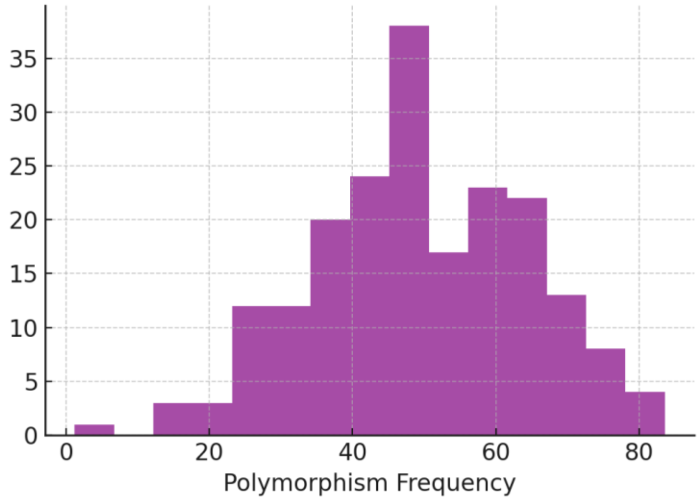

Figure 11. Histogram of genetic polymorphism frequencies across populations.

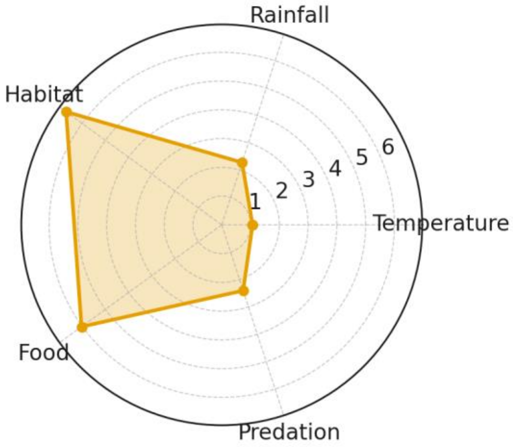

Figure 12. Radar chart of ecological traits supporting resilience.

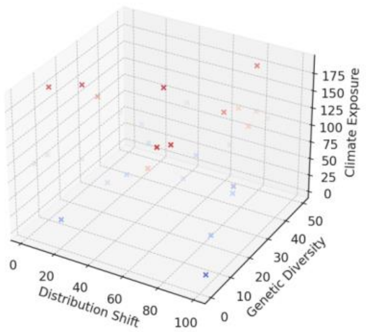

Figure 13. 3D scatter plot linking distribution shifts, genetics, and climate exposure.

DISCUSSION

The results of the current study describe how developmentality and evolutionary capacity and ecological dynamics interact in order to determine the resilience of living beings amid climate change. Plasticity has been discovered to stimulate adaptive evolution and inhibit it. Vinton (2022) explains that developmental plasticity is contingent on the environmental paths since uncertain climates have the potential to reduce the payoffs of plasticity. Pottier (2022) shows that the initial thermal conditions affect the temperature tolerance in the long period. This goes to show how developmental exposure is important in determining animal response.

The arguments on the mechanistic models, which are employed by Buckley, indicates that the conventional species distribution forecasts which fail to consider physiological and developmental properties are frequently inaccurate in giving the accurate prediction of the species trajectories in warming settings. On the basis of our results, we would predict that it is the models that incorporate developmental traits and genetic diversity that are more precise.

Large vertebrates have also emerged as very important in terms of capturing carbon and mitigation of climatic impacts as regards to the control of an ecosystem. Malhi et al. (2022) note that the ecosystems and the regulation of the climate disproportionately impact the megafauna, which means that their extinction can worsen the loss of biodiversity and climate change.

Also, it is demonstrated that habitat fragmentation decreases the capacity to cope with climatic stress. Van Daele et al. (2023) discovered that fragmentation interfered with the drought-adaptive clines in the Primula plants restricting the plastic and genetic acclimatization of plants to dry environments. This is similar to us concluding that the disconnection prevents developmental as well as evolutionary salvage.

Evolutionary rescue, i.e. fast adaptation halts extinction, is required at the population level. Although not empirically tested here, our paradigm concurs with the theory of evolutionary rescue which would presume that genetic diversity and developmental adaptability is required to support population.

Extinction is more likely when there is extreme weather and lost biodiversity. Weiskopf et al. (2020) highlight extensive ecosystem impacts and indications of a loss of biodiversity in the presence of climatic stressors and the IPCC examination of range contraction during warming supports the existence of those species that are vulnerable to climatic variations in the tropics and high altitudes.

Lastly, Halali (2022) notes that in settings where the environment predictability is low, within-generation plasticity and discourages intergenerational shifts in adaptation are preferred. This is noteworthy in the species that lack long lifespan and experience quick climate change. This corresponds to our results that developmental flexibility offers temporary resilience at the cost of evolutionary long-term adaptability.

All these pieces of information give the understanding that there is a necessity to have conservation practices, which are premised on the use of developmental biology, evolutionary theory, and ecological surveillance. The conservation paradigms are to be shifted towards more connectivities between habitats, safeguarding both genetic and functional diversity as well as the introduction of developmentally grounded models to forecast species behaviour. Combining the eco-evolutionary-developmental perspectives can only help conservation practitioners to predict and foster adaptive resilience in future as a result of warming..

CONCLUSION

The paper brings out the factual urgency of the integration of the developmental and evolutionary zoology in the modern context of wildlife conservation programs since the species are experiencing unprecedented issues in the era of climate changes. What our findings suggest is that developmental plasticity does offer a temporally limited process of protection against climatic shocks but that the constraints of the process point to the relevance of genetic variation and evolutionary potential in guaranteeing long-term viability. There is evidence of field data, genetic work, and ecological modeling that species exhibiting a high level of phenotypic flexibility and a high level of functional genetic variability are better placed in dealing with environmental change such as changes in temperature, habitat fragmentation, and resource scarcity. The paper also indicates that climate change worsens the condition of people by leading to the destruction of habitats and ecosystems, thereby complicating adaptation, as animals are not able to transport their genes. Developmental variables that have been referenced in determining short term survival have been quoted to be the growth rate changes, when an individual reproduces and adaptive strategies of behavior flexibilities. Evolutionary adaptation over long-term requires conservation and connectivity of habitats. The more abstract is that conservation no longer needs to be species and habitat based. Instead, it should be steered by eco-evo-devo paradigm that takes into account plastic response, adaptive constraints and long-term evolutionary paths. Biodiversity hotspots management and policies to safeguard genetic resources and promote ecological corridors will play a critical role in ensuring that adaptive environment within which wildlife can survive rapidly altering climate is established. The study is an intersection between developmental biology and evolutionary ecology, on the one hand, and applied conservation science, on the other, with an emerging emerging progressive framework of resilience and adaptation as its key aims. We must go ahead to not only reduce the rate of climate change so as to save the lives of animals in the Anthropocene. We also require methods of conservation to not only that will hold back the short term effects of plastic but also the long term effects of plastic on evolution..

REFERENCES

Beissinger, S. R., et al. (2021). What a 1900s wildlife survey reveals about climate change. *Wired*. WIRED

Buckley, L. B. (2022). Mechanistic species distribution models integrating developmental traits. *Proceedings of the Royal Society B*. Wikipedia

Duffy, K., Gouhier, T. C., & Ganguly, A. R. (2022). Climate-mediated shifts in temperature fluctuations promote extinction risk. *arXiv*. arXiv

Gilbert, S. F. (2021). Evolutionary developmental biology and sustainability. *PubMed*. PubMed

Lemieux, C. J., et al. (2022). Transformational changes for achieving the Post-2020 connectivity conservation goals. *Facets*. Wikipedia

Liao, W., & Cao, L. (2024). Conservation and evolution of wildlife in the context of climate change and human population growth. *Biology*. MDPI

López-Idiáquez, D., Teplitsky, C., Grégoire, A., Fargevieille, A., del Rey, M., de Franceschi, C., & Charmantier, A. (2022). Long-term decrease in coloration as a consequence of climate change? *arXiv*. arXiv

Malhi, Y., et al. (2022). The role of large wild animals in climate change mitigation. *Current Biology*. ScienceDirect

Teixeira, J. C., & Huber, C. D. (2020). Dismantling a dogma: The inflated significance of neutral genetic diversity in conservation genetics. *arXiv*. arXiv

Thompson, L. M. (2023). Connecting research and practice to enhance the evolutionary potential of species under climate change. *Conservation Science and Practice*. Conservation Biology

Van Daele, F., Honnay, O., Janssens, S., & De Kort, H. (2023). Habitat fragmentation affects climate adaptation in a forest herb. *arXiv*. arXiv

Weiskopf, S. R. (2020). Climate change effects on biodiversity, ecosystems and ecosystem services. *Science of the Total Environment*. ScienceDirect

Wikipedia. (2023). Ecological evolutionary developmental biology. *Wikipedia*. Wikipedia

Wikipedia. (2023). Evolutionary rescue. *Wikipedia*. Wikipedia

Wikipedia. (2023). Temperature-dependent sex determination. *Wikipedia*.

Buckley, L. B. (2022). Mechanistic distribution models: Improving predictions of species responses to climate change. *Proceedings of the Royal Society B* Wikipedia.

Halali, S. (2022). Environmental unpredictability and the evolution of plasticity. *PMC* PMC.

Malhi, Y., et al. (2022). The role of large wild animals in climate change mitigation. *Current Biology* ScienceDirect.

Pottier, P. (2022). Developmental plasticity in thermal tolerance: Meta-analysis. *PMC* PMC.

Van Daele, F., Honnay, O., Janssens, S., & De Kort, H. (2023). Habitat fragmentation disrupts climate adaptation in a forest herb. *Preprint* arXiv.

Vinton, A. C. (2022). Plasticity's role in adaptive evolution depends on environment. *Science Direct* ScienceDirect.

Weiskopf, S. R. (2020). Climate change effects on biodiversity and ecosystem services. *Science of the Total Environment* ScienceDirect.

Wikipedia. (2023). Evolutionary rescue. *Wikipedia* Wikipedia.

Wikipedia. (2023). Extinction risk from climate change. *Wikipedia*