

## Evaluating Grass Diversity and Conservation Approaches in Binsar WLS, Kumaun Himalaya, India

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### ABSTRACT

*In this study, we present an annotated checklist of the grass flora, detailing life forms, distribution status, and IUCN status, in a ~48 sq. km area in the Almora and Bageshwar district of Uttarakhand, part of the Western Himalayan Region. We recorded 66 grass taxa, representing 46 genera across 14 tribes and 5 subfamilies. Dominant genera throughout the seasons include *Apluda*, *Arundinella*, *Oplismenus*, and *Sporobolus*. *Cenchrus* and *Poa*, particularly *P. annua*, are prevalent in the post-monsoon period. The study also identifies several threats to the survival of grasses in the wildlife sanctuary, such as habitat loss, over-tourism, urbanization, overgrazing, and the invasion of exotic plant species. Additionally, it highlights the socio-economic uses of the recorded grass species.*

**Keywords:** Biodiversity, Checklist, Poaceae, Uttarakhand, Western Himalayas.

### INTRODUCTION

Grasses are a widespread and diverse group of flowering plants crucial to global ecosystems (Odedra et al., 2024). They cover approximately 20% of the Earth's land surface, making them ecological dominants (Hussain et al., 2019). India has the third-highest diversity of grass species, following Brazil and the USSR. It is estimated that more than 15,000 species of angiosperms and gymnosperms

occur in India, with about one-third being woody species (Jain & Rao, 1983). The Indian Himalayan region, recognized as one of the world's biodiversity hotspots, features unique ecosystems in the Western Himalayas, supporting numerous endemic and rare plant species. Binsar Wildlife Sanctuary, situated in the foothills of the Himalayas in Uttarakhand's Almora district, exemplifies these unique ecosystems.

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It is characterized by wild medicinal plants *Bergenia ciliate* and *Trifolium repens* and dominant tree species such as *Aesculus indica*, *Alnus nepalensis*, *Myrica esculenta*, *Pinus roxburghii*, *Pyrus pashia*, *Quercus leucotrichophora*, and *Rhododendron arboretum*.

The wildlife sanctuary is situated between 29°38'N to 29°45'N and 79°20'E to 79°40'E in the Almora and Bageshwar districts of Uttarakhand (Fig. 1), covering an area of 47.07 sq. km. The altitude ranges from 900 to 2500 meters, with an average elevation of 2420 meters. Established in 1988 to conserve the region's rich biodiversity, the Sanctuary is home to over 200 species of birds, including the Eurasian jay, koklass pheasant, monal pheasant, and Himalayan woodpecker. Locals believe Binsar was named after the Bineshwar Mahadev temple, a 16th-century temple dedicated to Lord Shiva. Additionally, Binsar was the summer capital of the Chand Dynasty rulers, who governed Kumaon from the 7th to 18th century AD. The peak point, known as Jhandi Dhar or Zero Point, is at an elevation of 2412 meters.

In the early work, 1927 Forest Flora for Kumaon (1927), by A.E. Osmaston's primarily concentrated on tree species. In 1960, N.L. Bor's The Grasses of Burma, Ceylon, India, and Pakistan contributed further to grass diversity studies. More recent studies (Ilyas & Khan, 2005; Majila & Kala, 2010; Rawat et al., 2013; Khan & Arya, 2017) have explored various aspects, including forest vegetation, regeneration, and conservation. However, Binsar Wildlife Sanctuary has received minimal attention in these works and is only known through sporadic reports, lacking a systematic checklist of its grass diversity. This grass diversity holds significant ecological value and is integral to local communities' traditional customs, rituals, and livelihoods. This study aims to fill the knowledge gap regarding the biodiversity of Binsar by focusing on the grass flora found in Binsar Wildlife Sanctuary.

## MATERIALS AND METHODS

The study area was explored from August 2023 to May 2024, covering all zones: the

Core zone (4 km<sup>2</sup>), the Tourism zone (including the motor road compartments, Zero point, and forest rest house areas), the Buffer zone (including the two entry gates at Ayarpani and Dhaulchina), and the Eco-development zone (including the boundary, surrounding villages to understand the uses of grasses by local people). Frequent field trips were organized to collect plant specimens during their flowering and fruiting stages, aiming to comprehensively understand the grass flora and ensure maximum species diversity was sampled. Plant specimens were collected and identified using various taxonomic literature, including Bor (1960), Gaur (1999) and Chen et al. (2006). The collected grass specimens have been submitted to the herbarium at the Forest Research Institute, Dehradun (DD).

## RESULT AND DISCUSSION

During our surveys, we explored various sites within the Sanctuary to study the life cycle patterns of plant species and documented the socio-economic uses of grass species by the local villagers (Fig. 2). Our primary objective was to thoroughly assess the diversity of each grass species, including those that might be endemic or rare. This detailed analysis underscores the rich grass diversity within Binsar Wildlife Sanctuary, highlighting the representation of various taxa and offering valuable insights for setting conservation priorities (Table 1).

We recorded 66 species from 45 genera, spanning 14 tribes and 5 subfamilies (Table 2). To better understand their presence and distribution within the Sanctuary, the grass species were categorized as very common, common, uncommon, or rare (Table 3). From a conservation perspective, 13 species were identified as Least Concern (LC) according to the IUCN Red List. Additionally, our study documented the presence of *Sehima notata* and *Microstegium falconeri*, both of which are endemic to the North-West Himalayas (Singh et al., 2015; Pusalkar & Srivastava, 2018; Rawat et al., 2022).

Table1. List of Grass Species in Binsar Wildlife Sanctuary

| Serial No | Taxa                                                                   | Lifespan        | Uses                    | Distribution status | IUCN status |
|-----------|------------------------------------------------------------------------|-----------------|-------------------------|---------------------|-------------|
| 1.        | <i>Agrostis pilosula</i> Trin.                                         | Annual          | Fodder                  | Common              | -           |
| 2.        | <i>Agrostis stolonifera</i> L.                                         | Perennial       | -                       | Uncommon            | LC (2013)   |
| 3.        | <i>Anthoxanthum odoratum</i> L.                                        | Perennial       | -                       | Uncommon            | -           |
| 4.        | <i>Apluda mutica</i> L.                                                | Perennial       | Fodder, thatching       | Very common         | -           |
| 5.        | <i>Arthraxon lancifolius</i> (Trin.) Hochst.                           | Annual          | -                       | Common              | -           |
| 6.        | <i>Arthraxon nudus</i> (Steud.) Hochst.                                | Annual          | -                       | Common              | -           |
| 7.        | <i>Arundinella bengalensis</i> (Spreng.) Druce                         | Perennial       | -                       | Uncommon            | -           |
| 8.        | <i>Arundinella nepalensis</i> Trin.                                    | Perennial       | Thatching               | Common              | LC (2020)   |
| 9.        | <i>Arundinella pumila</i> (Hochst. ex A.Rich.) Steud.                  | Annual          | Fodder                  | Common              | -           |
| 10.       | <i>Bothriochloa bladhii</i> (Retz.) S.T.Blake                          | Perennial       | -                       | Uncommon            | -           |
| 11.       | <i>Brachypodium pinnatum</i> (L.) P.Beauv.                             | Perennial       | -                       | Common              | -           |
| 12.       | <i>Bromus catharticus</i> Vahl                                         | Perennial       | Fodder                  | Very common         | -           |
| 13.       | <i>Capillipedium assimile</i> (Steud.) A.Camus                         | Perennial       | -                       | Common              | -           |
| 14.       | <i>Capillipedium parviflorum</i> (R.Br.) Stapf                         | Perennial       | Fodder                  | Common              | -           |
| 15.       | <i>Cenchrus americanus</i> (L.) Morrone                                | Annual          | -                       | Common              | -           |
| 16.       | <i>Cenchrus flaccidus</i> (Griseb.) Morrone                            | Perennial       | Fodder                  | Common              | -           |
| 17.       | <i>Cenchrus orientalis</i> (Rich.) Morrone                             | Perennial       | Fodder                  | Very Common         | -           |
| 18.       | <i>Cenchrus purpureus</i> (Schumach.) Morrone                          | Perennial       | -                       | Common              | -           |
| 19.       | <i>Chrysopogon fulvus</i> (Spreng.) Chiov.                             | Perennial       | -                       | Common              | -           |
| 20.       | <i>Chrysopogon gryllus</i> (L.) Trin.                                  | Perennial       | -                       | Common              | -           |
| 21.       | <i>Cymbopogon distans</i> (Nees ex Steud.) Will. Watson                | Perennial       | -                       | Uncommon            | -           |
| 22.       | <i>Cymbopogon iwarancusa</i> (Jones ex Roxb.) Schult.                  | Perennial       | -                       | Common              | -           |
| 23.       | <i>Cynodon dactylon</i> (L.) Pers.                                     | Perennial       | Fodder, sacred rituals. | Very Common         | -           |
| 24.       | <i>Dichanthium annulatum</i> (Forssk.) Stapf                           | Perennial       | Fodder                  | Common              | -           |
| 25.       | <i>Digitaria ciliaris</i> (Retz.) Koeler                               | Annual          | -                       | Uncommon            | -           |
| 26.       | <i>Digitaria cruciata</i> (Nees ex Steud.) E.G.Camus & A.Camus         | Annual          | -                       | Common              | -           |
| 27.       | <i>Drepanostachyum falcatum</i> (Nees) Keng f.                         | Woody perennial | -                       | Uncommon            | -           |
| 28.       | <i>Echinochloa colona</i> (L.) Link                                    | Annual          | Grains edible           | Uncommon            | LC (2020)   |
| 29.       | <i>Echinochloa colona</i> subsp. <i>edulis</i> (Honda) Banfi & Galasso | Annual          | Fodder                  | Common              | LC (2018)   |
| 30.       | <i>Eleusine coracana</i> (L.) Gaertn.                                  | Annual          | -                       | Common              | -           |
| 31.       | <i>Eleusine indica</i> (L.) Gaertn.                                    | Annual          | Fodder                  | Common              | LC (2011)   |
| 32.       | <i>Elymus semicostatus</i> (Steud.) Melderis                           | Perennial       | -                       | Uncommon            | -           |
| 33.       | <i>Eragrostis nigra</i> Nees ex Steud.                                 | Perennial       | -                       | Very Common         | -           |
| 34.       | <i>Eulalia mollis</i> (Griseb.) Kuntze                                 | Perennial       | -                       | Rare                | -           |
| 35.       | <i>Eulaliopsis binata</i> (Retz.) C.E.Hubb.                            | Perennial       | -                       | Common              | -           |
| 36.       | <i>Festuca myuros</i> L.                                               | Annual          | -                       | Common              | -           |
| 37.       | <i>Festuca rubra</i> L.                                                | Perennial       | -                       | Common              | -           |
| 38.       | <i>Heteropogon contortus</i> (L.) P.Beauv. ex Roem. & Schult.          | Perennial       | -                       | Common              | -           |
| 39.       | <i>Imperata cylindrica</i> (L.) Raeusch.                               | Perennial       | -                       | Very common         | LC (2010)   |
| 40.       | <i>Isachne albens</i> Trin.                                            | Perennial       | -                       | Uncommon            | LC (2011)   |
| 41.       | <i>Koeleria macrantha</i> (Ledeb.) Schult.                             | Perennial       | -                       | Common              | -           |
| 42.       | <i>Lolium giganteum</i> (L.) Darbysh.                                  | Perennial       | -                       | Common              | -           |
| 43.       | <i>Microstegium falconeri</i> (Hook.f.) Clayton                        | Annual          | -                       | Uncommon            | -           |
| 44.       | <i>Microstegium nudum</i> (Trin.) A.Camus                              | Annual          | -                       | Uncommon            | -           |
| 45.       | <i>Miscanthus nepalensis</i> (Trin.) Hack.                             | Perennial       | -                       | Common              | -           |
| 46.       | <i>Muhlenbergia himalayensis</i> Hack. ex Hook.f.                      | Perennial       | -                       | Uncommon            | -           |
| 47.       | <i>Oplismenus burmanni</i> (Retz.) P.Beauv.                            | Annual          | Fodder                  | Very common         | -           |
| 48.       | <i>Oplismenus compositus</i> (L.) P.Beauv.                             | Annual          | -                       | Very common         | LC (2021)   |
| 49.       | <i>Orthoraphium roylei</i> Nees                                        | Perennial       | -                       | Uncommon            | -           |
| 50.       | <i>Phacelurus speciosus</i> (Steud.) C.E.Hubb.                         | Perennial       | -                       | Rare                | -           |
| 51.       | <i>Phalaris minor</i> Retz.                                            | Annual          | Fodder                  | uncommon            | -           |
| 52.       | <i>Piptatherum aequiglume</i> (Duthie ex Hook.f.) Roshev.              | Perennial       | -                       | Uncommon            | -           |
| 53.       | <i>Poa annua</i> L.                                                    | Annual          | Fodder                  | Very common         | LC (2013)   |
| 54.       | <i>Poa pratensis</i> L.                                                | Perennial       | -                       | Common              | LC (2016)   |
| 55.       | <i>Poa sterilis</i> M.Bieb.                                            | Perennial       | -                       | Rare                | -           |
| 56.       | <i>Polypogon monspeliensis</i> (L.) Desf.                              | Annual          | -                       | Uncommon            | LC (2014)   |
| 57.       | <i>Saccharum spontaneum</i> L.                                         | Perennial       | -                       | Common              | LC (2020)   |
| 58.       | <i>Sehima notata</i> (Hack.) A.Camus                                   | Perennial       | -                       | Rare                | -           |
| 59.       | <i>Sorghum halepense</i> (L.) Pers.                                    | Perennial       | Fodder                  | Common              | -           |
| 60.       | <i>Sporobolus diandrus</i> (Retz.) P.Beauv.                            | Perennial       | -                       | Very common         | -           |

|     |                                                        |           |                      |             |           |
|-----|--------------------------------------------------------|-----------|----------------------|-------------|-----------|
| 61. | <i>Sporobolus indicus</i> (L.) R.Br.                   | Perennial | Fodder               | Common      | LC (2021) |
| 62. | <i>Sporobolus piliferus</i> (Trin.) Kunth              | Annual    | Fodder               | Uncommon    | -         |
| 63. | <i>Themeda anathera</i> (Nees ex Steud.) Hack.         | Perennial | -                    | Very common | -         |
| 64. | <i>Thysanolaena latifolia</i> (Roxb. ex Hornem.) Honda | Perennial | Fodder , broom grass | Very common | -         |
| 65. | <i>Triplidium bengalense</i> (Retz.) H.Scholz          | Perennial | -                    | Common      | -         |
| 66. | <i>Tripogon filiformis</i> Nees ex Steud.              | Perennial | -                    | Very common | -         |

**Table2. Analytical Study of Grass Species in Binsar Wildlife Sanctuary**

| Serial No    | Sub- family   | Tribe          | Genera & no of species                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------|---------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.           | Bambusoideae  | Arundinarieae  | <i>Drepanostachyum</i> (1).                                                                                                                                                                                                                                                                                                                                                                                                                |
| 2.           | Pooideae      | Poeae          | <i>Agrostis</i> (2), <i>Anthoxanthum</i> (1), <i>Festuca</i> (2), <i>Koeleria</i> (1), <i>Lolium</i> (1), <i>Orthoraphium</i> (1), <i>Phalaris</i> (1), <i>Poa</i> (3), <i>Polypogon</i> (1).                                                                                                                                                                                                                                              |
|              |               | Brachypodieae  | <i>Brachypodium</i> (1).                                                                                                                                                                                                                                                                                                                                                                                                                   |
|              |               | Bromeae        | <i>Bromus</i> (1).                                                                                                                                                                                                                                                                                                                                                                                                                         |
|              |               | Triticeae      | <i>Elymus</i> (1).                                                                                                                                                                                                                                                                                                                                                                                                                         |
|              |               | Stipeae        | <i>Orthoraphium</i> (1), <i>Piptatherum</i> (2).                                                                                                                                                                                                                                                                                                                                                                                           |
| 3.           | Panicoideae   | Andropogoneae  | <i>Apluda</i> (1), <i>Arthraxon</i> (1), <i>Bothriochloa</i> (1), <i>Capillipedium</i> (2), <i>Chrysopogon</i> (2), <i>Cymbopogon</i> (2), <i>Dichanthium</i> (1), <i>Eulalia</i> (1), <i>Eulaliopsis</i> (1), <i>Heteropogon</i> (1), <i>Imperata</i> (1), <i>Microstegium</i> (2), <i>Miscanthus</i> (1), <i>Phacelurus</i> (1), <i>Saccharum</i> (1), <i>Sehima</i> (1), <i>Sorghum</i> (1), <i>Themeda</i> (1), <i>Triplidium</i> (1). |
|              |               | Arundinelleae  | <i>Arundinelleae</i> (3).                                                                                                                                                                                                                                                                                                                                                                                                                  |
|              |               | Paniceae       | <i>Cenchrus</i> (4), <i>Digitaria</i> (2), <i>Echinochloa</i> (2), <i>Oplismenus</i> (1).                                                                                                                                                                                                                                                                                                                                                  |
|              |               | Thysanolaeneae | <i>Thysanolaena</i> (1).                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 4.           | Micrairoideae | Isachneae      | <i>Isachne</i> (1).                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 5.           | Chloridoideae | Cynodonteae    | <i>Cynodon</i> (1), <i>Eleusine</i> (2), <i>Muhlenbergia</i> (1), <i>Tripogon</i> (1).                                                                                                                                                                                                                                                                                                                                                     |
|              |               | Eragrostideae  | <i>Eragrostis</i> (1).                                                                                                                                                                                                                                                                                                                                                                                                                     |
|              |               | Zoysieae       | <i>Sporobolus</i> (3).                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Total</b> | 5             | 14             | 46 genera & 66 taxa.                                                                                                                                                                                                                                                                                                                                                                                                                       |

**Table 3: Abundance of grass species assessed based on their occurrence**

| Serial No. | Distribution patterns | No of taxa |
|------------|-----------------------|------------|
| 1.         | Very common           | 13         |
| 2.         | Common                | 31         |
| 3.         | Uncommon              | 18         |
| 4.         | Rare                  | 4          |

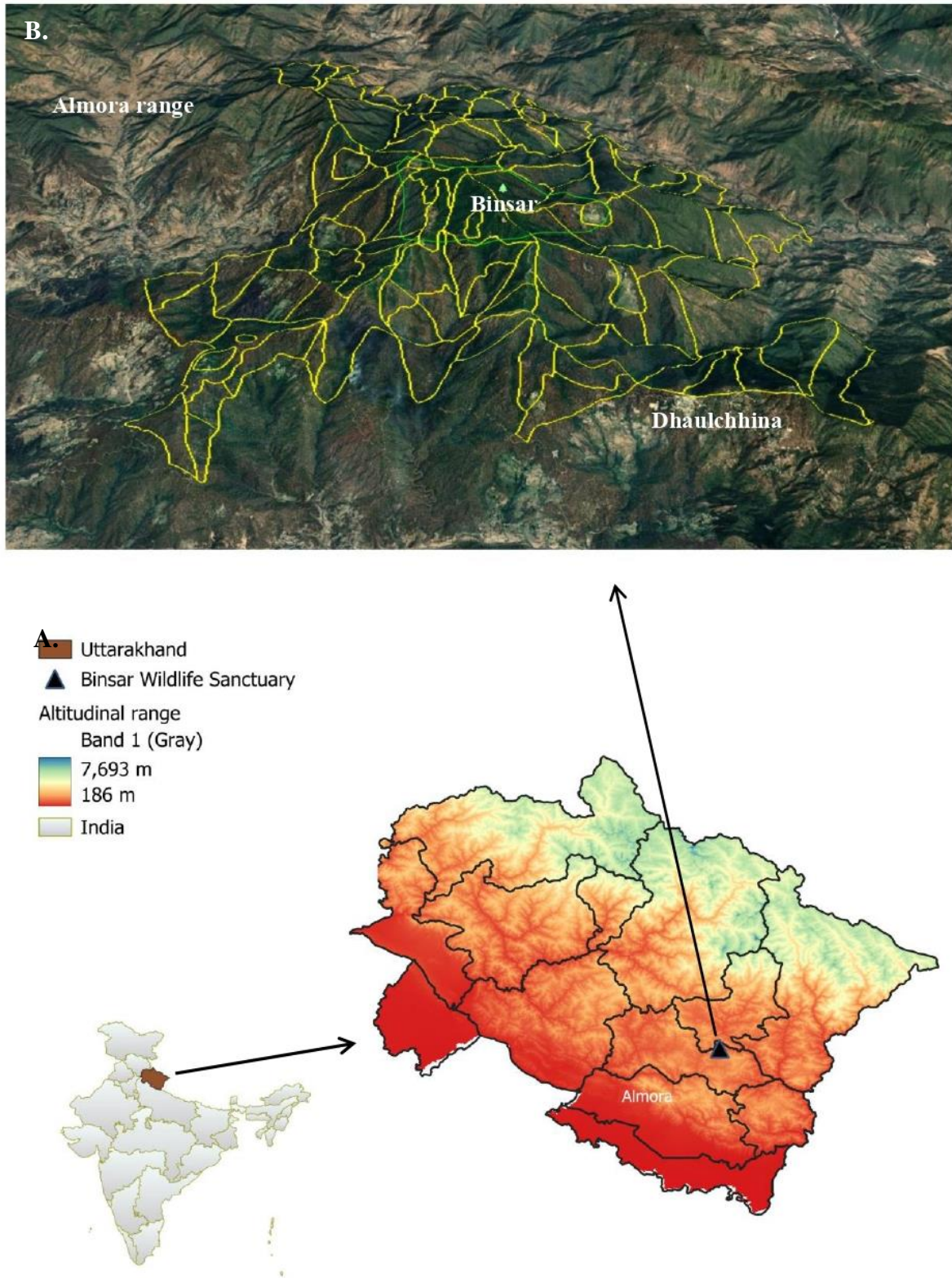


Figure 1: A) Represent the India map along the Uttarakhand. B) Map showing the location of Binsar Wildlife Sanctuary



**Figure 2:** A. *Arthraxon nudus* (Steud.) Hochst.; B. *Echinochloa colonum* subsp. *edulis* (Honda) Banfi & Galasso; C. *Eulalia mollis* (Griseb.) Kuntze; D. *Isachne albens* Trin.; E. *Sporobolus piliferus* (Trin.) Kunth; F. *Phalaris minor* Retz.; G. *Saccharum spontaneum* L.; H. A villager carrying grasses for fodder purposes

## CONCLUSION

Binsar Wildlife Sanctuary, with its grass diversity largely unexplored, has unnoticeable biodiversity conservation and management strategies; protecting grass species in the Sanctuary is vital for ecological and cultural reasons, as well as for enhancing resilience, biodiversity, and sustainability in the face of ongoing environmental challenges. The decline in grass diversity and grasslands due to natural and human factors could have significant impacts (Majila, 1992). The comprehensive checklist of grass diversity provided serves as a valuable biodiversity data source for biological studies. It will aid in biodiversity conservation and management plans and in monitoring floristic changes as we progress into the Anthropocene in the 21st century.

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## Conflict of Interest:

There is no such evidence of conflict of interest.

## Author Contribution

All authors have participated in critically revising of the entire manuscript and approval of the final manuscript.

## REFERENCES

- Bor, N. L. (1960). *The Grasses of Burma, Ceylon, India and Pakistan*. Pergamon Press, London pp. 1 - 767.
- Chen, S., Li, D., Zhu, G., Wu, Z., Lu, S., Liu, L., Wang, Z., Sun, B., Zhu, Z., Xia, N., Jia, L., Guo, Z., Chen, W., Chen,

X., Yang, G., Phillips, S. M., Stapleton, C., Soreng, R. J., Aiken, S. G., Tzvelev, N. N., Peterson, P. M., Renvoize, S. A., Olonova, M. V., & Ammann, K. H. (2006). Poaceae; p. 1-651 In Wu, Z. Y., Raven, P. H., & Hong, D. Y. (ed.). *Flora of China*. Volume XII. St. Louis: Science Press, Beijing, and Missouri Botanical Garden Press.

- Gaur, R. D. (1999). *Flora of the district Garhwal North West Himalaya (With ethnobotanical notes)*. TransMedia, Srinagar (Gahwal) pp. 636 - 700.
- Hussain, M., Khan, S. M., Abd\_Allah, E. F., Ul Haq, Z., Alshahrani, T. S., Alqarawi, A. A., & Ahmad, H. (2019). Assessment of plant communities and identification of indicator species of an Ecotonal Forest zone at Durand Line, District Kurram, Pakistan. *Applied Ecology & Environmental Research*, 17(3).
- Ilyas, O., & Khan, J. A. (2005). Assessment of tree mortality and post fire regeneration pattern in Binsar Wildlife Sanctuary, Kumaon Himalaya. *Tropical Ecology*, 46(2), 157-164.
- IUCN (2024). The IUCN Red List of Threatened Species. Version 2022-2. <https://www.iucnredlist.org> accessed on 12.06.2023.
- Jain, S. K., & Rao, R. R. (1983). *Assessment of threatened plants of India*. In *Seminar on Threatened Plants of India* (1981: Dehradun, India). *Botanical Survey of India, Dept. of Environment*.
- Khan, A. H., & Arya, D. (2017). Analysis of forest vegetation in Binsar Wildlife Sanctuary, Kumaon Himalaya, Uttarakhand, India. *American-Eurasian Journal of Agricultural & Environmental Sciences*, 17(4), 336-342.
- Majila, B. S. (1992). Phytosociology, biomass structure and primary productivity of Oak-Pine forest of Kumaon Himalaya. *Ph. D. Thesis*.

- Majila, B. S., & Kala, C. P. (2010). Forest structure and regeneration along the altitudinal gradient in the Binsar Wildlife Sanctuary, Uttarakhand Himalaya, India. *Russian Journal of Ecology*, 41, 75-83.
- Odedra, K. N., Odedra, N. K., & Jadeja, B. A. (2024). Grass Flora of Porbandar District, Gujarat, India. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, 1-11.
- Pusalkar, P. K., Srivastava, S. K. (2018). *Flora of Uttarakhand: Gymnosperms and Angiosperms (Ranunculaceae-Moringaceae)*, Howrah: Botanical Survey of India.
- Rawat, B., Negi, V. S., Mishra Rawat, J., Tewari, L. M., & Rawat, L. (2013). The potential contribution of wildlife sanctuary to forest conservation: a case study from Binsar Wildlife Sanctuary. *Journal of Mountain Science*, 10, 854-865.
- Rawat, D. S., Chandra, S., & Chaturvedi, P. (2022). Threatened flora of Uttarakhand: an update. *Journal of Threatened Taxa*, 14(12), pp 22309–22328.
- Singh, P., Karthigeyan, K., Lakshminarasimhan, P., & Dash, S. S. (2015). *Endemic vascular plants of India*. Botanical Survey of India.