

For each individual and wintering year t , let H_t denote the home range of the current year, H_{t-1} the home range of the previous year, and $H_{<t-1}$ the union of home ranges from all earlier wintering years prior to $t - 1$. The overlap between consecutive years was defined as:

$$H_t \cap H_{t-1} \quad (1)$$

Since home ranges consist of multiple spatially disjoint patches, classifications were performed at the level of individual home range patches to differentiate between spatial continuity, peripheral expansion, and spatial reoccupation. For any location $x \in H_t$, let $P(x)$ denote the unique connected component of H_t such that $x \in P(x)$ (i.e., the specific patch containing location x).

Category 1. Persistent Core:

$$x \in H_t \cap H_{t-1} \quad (2)$$

Category 2. Proximal Exploration:

$$x \in H_t \setminus (H_t \cap H_{t-1}) \text{ and } P(x) \cap H_{t-1} \neq \emptyset \quad (3)$$

Category 3. Historical Reoccupation:

$$x \in H_t \setminus (H_t \cap H_{t-1}), P(x) \cap H_{t-1} = \emptyset, \text{ and } P(x) \cap H_{<t-1} \neq \emptyset \quad (4)$$

Category 4. Novel Colonization:

$$x \in H_t \setminus (H_t \cap H_{t-1}), P(x) \cap (H_{t-1} \cup H_{<t-1}) = \emptyset \quad (5)$$

Category 5. Former core:

$$x \in H_{t-1} \setminus H_t \quad (6)$$

Category 6. Transient/Corridor Space:

$$x \in (H_t \cup H_{t-1})^c \quad (7)$$

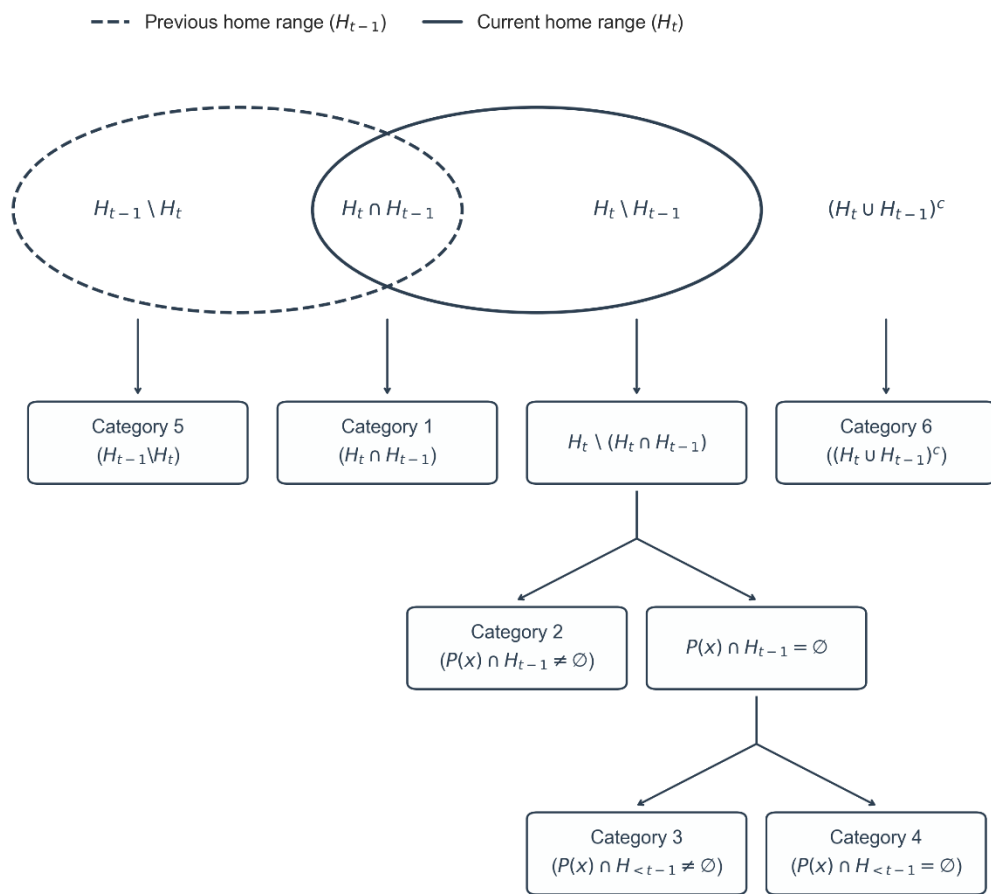


Fig S1. Flowchart of the spatio-temporal categorization process.