•研究报告•

洞庭湖区麋鹿再野化初期秋冬季生境选择

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摘要: 深入了解生境特征和生境选择的季节性差异是开展野生动物生境有效管理的前提。2016年3月, 原国家林业局和湖南省人民政府启动了麋鹿(*Elaphurus davidianus*)再野化项目, 来自江苏大丰的16头麋鹿(其中11头安装了GPS卫星跟踪颈圈)在湖南东洞庭湖国家级自然保护区君山后湖放归野外。冬季气候寒冷、食物匮乏, 濒危物种个体野放后能否在冬季找到适宜生境是再野化项目能否成功的关键。2016年10月至2017年1月, 借助GPS卫星和地面跟踪信息, 我们采用样方法对再野化麋鹿种群秋、冬季生境选择进行了研究, 测定了生境类型、食物丰富度、草本盖度、乔木盖度、距水源距离、距道路距离、距居民点距离、距隐蔽物距离、隐蔽级等9种生境因子。结果显示: (1)再野化麋鹿种群在秋、冬季对生境类型的选择差异极显著。冬季麋鹿偏好选择水塘、随机利用草本沼泽、避免利用灌草丛; 而秋季对生境类型无明显偏好。(2)再野化麋鹿秋冬季对食物丰富度、草本盖度、乔木盖度、距道路距离、距居民点距离、距隐蔽物距离和隐蔽级的选择差异极显著; 仅在距水源距离上的差异不显著。(3)秋季再野化麋鹿倾向于选择隐蔽级低、食物丰富度高、草本盖度高、距隐蔽物距离近的生境。其生境利用样方与对照样方在隐蔽级上的差异极显著; 在食物丰富度、草本盖度、距隐蔽物距离上的差异显著; 在距水源距离、乔木盖度、距道路距离、距居民点距离上的差异不显著。(4)冬季再野化麋鹿倾向于选择距水源近、食物丰富度高、草本盖度高的生境。其生境利用样方与对照样方在食物丰富度、草本盖度、距水源距离上的差异极显著; 在距道路距离、距居民点距离、距隐蔽物距离、隐蔽级上的差异不显著。研究结果揭示了洞庭湖区再野化麋鹿种群秋冬季生境选择偏好, 为再野化麋鹿种群保护及其生境修复提供了基础数据。

关键词: 麋鹿; 再野化; 物种重引入; 生境选择; 卫星跟踪

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Autumn-winter habitat selection by the re-wild Milu (*Elaphurus davidianus*) at the early stage after release in Dongting Lake Wetland, China

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ABSTRACT

Purpose: For restoring the once extinct Milu (*Elaphurus davidianus*, Père David's deer), the wild management authority in China launched a Milu rewilding project in the Dongting Lake area, Hunan Province, China in 2016. We carried the study to investigate how the re-wild Milu select habitat in the field release area in autumn and winter.

Method: In March 2016, 16 Milu individuals (11 of them fitted with GPS collars) from the Jiangsu Dafeng Milu

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National Nature Reserve were released into the wild of Junshan Houhu in Hunan East Dongting Lake National Nature Reserve. From October 2016 to January 2017, with the aid of GPS satellite tracking and ground tracking of field released Milu, we used the quadrat method to study the autumn/winter habitat selection by the released Milu. Nine habitat variables were measured in the both Milu-used quadrats and non-used quadrats: habitat type, food abundance, herbage coverage, arbor coverage, distance to water, distance to road, distance to human settlement, distance to shelter, and hidden level.

Results: (1) There was a significant difference in the selection of habitat types by the re-wild Milu between autumn and winter. In autumn, the re-wild Milu appeared to select habitat randomly, whereas they preferred the habitats near ponds and used the herbage swamp randomly, avoiding shrub-grass habitats. (2) There were significant differences in selection for food abundance, herbage coverage, arbor coverage, distance to road, distance to human settlement, distance to shelter, and the hidden level by the re-wild Milu between autumn and winter. There was no significant difference in selection for distance to water. (3) In autumn, the re-wild Milu preferred those habitats that of lower hidden level, higher food abundance, higher herbage coverage, and closer to shelter. There was a significant difference in hidden levels between used quadrats and control (non-used) quadrats in both seasons. Additionally, there were significant differences in the selection for food abundance, herbage coverage, and distance to shelter overall. There were no significant differences in the selection of distance to water, arbor coverage, distance to road, and distance to human settlement. (4) In winter, the re-wild Milu preferred those habitats that are closer to water, with higher food abundance, or higher herbage coverage. There were significant differences in food abundance, herbage coverage, and distance to water between used quadrats and non-used quadrats, but there were no significant differences in distance to road, distance to human settlement, distance to shelter, or hidden level.

Conclusion: The study revealed the differences in habitat selection by the re-wild Milu in autumn and winter, which provide baseline data for habitat management of Milu rewilding in the wetlands of Dongting Lake.

Key words: Milu (*Elaphurus davidianus*); Père David's deer, rewilding; species reintroduction; habitat selection; satellite tracking

生境又称栖息地,是生物个体能在其中完成生长、发育、繁殖等生命过程的空间,包括所利用的各种生态环境因子(Reunanen et al, 2002)。生境为野生动物提供食物、饮水和隐蔽场所,深入了解野生动物生境特征和生境选择的季节性差异,是开展濒危野生动物种群科学保护及其生境有效管理的前提(Buckley, 1997; 蒋志刚, 2004)。生境选择(habitat selection)是动物对栖息地类型的选择或偏爱(尚玉昌, 1998),与其种群数量、繁殖成功率以及所栖息的生态环境等密切相关(杨忠庆等, 2004; Benson & Chamberlain, 2007; 李宗智等, 2021)。因生理和生存需求的不同,野生动物在不同生活史阶段和不同时间尺度上的生境选择存在着明显的差异(Ripple & Beschta, 2003)。因地理生态环境的差异,不同动物地理种群所面临的生存压力不同,进而导致生境选择的主要影响因素也存在一定差异(胡杰等, 2018)。

恢复长期自我维持的自然野化濒危种群是物种重引入的目的。如果重引入物种的栖息地要求不能得到有效满足,重建野化种群的最终目标就很难实现(Nicoll et al, 2004)。麋鹿(*Elaphurus davidianus*)为中国特有种、国家一级重点保护野生动物,因

1900年八国联军入侵北京导致麋鹿在中国境内绝迹(曹克清, 1985; 丁玉华, 2008; 蒋志刚, 2015); 1985年我国启动了麋鹿重引入项目,现已在北京南海子、江苏大丰、湖北石首形成规模较大的麋鹿种群以及全国各地近100处小种群(宋玉成, 2015; 王立波等, 2020)。20世纪90年代,因长江特大洪水导致36头麋鹿从湖北石首麋鹿国家级自然保护区围栏内逃逸,那些逃逸麋鹿最终在洞庭湖区形成了自然野化种群(Yang et al, 2016)。1998年起,通过多次人工放归,江苏大丰麋鹿国家级自然保护区也在黄海滩涂建立了麋鹿野化种群(Hu & Jiang, 2002)。2016年3月,原国家林业局和湖南省人民政府在洞庭湖区启动麋鹿再野化项目。来自江苏大丰麋鹿国家级自然保护区的16头麋鹿(其中11头安装了GPS卫星跟踪仪),在湖南东洞庭湖国家级自然保护区的君山后湖被放归野外。麋鹿已经在圈养环境中生存了100多年(Twigger, 2003; Jiang & Harris, 2008);这次麋鹿放归是一次再野化。我们借助GPS卫星信息对这群再野化麋鹿进行了跟踪研究,对其秋、冬季生境选择进行了实地调查,以探讨麋鹿放归野外后对新环境的适应,为再野化麋鹿种群保护和生境

图1 洞庭湖区主要研究区域示意图

Fig. 1 Map of the main study area in Dongting Lake

管理积累基础数据。

1 研究区域

湖南东洞庭湖国家级自然保护区(29°00′–29°38′ N, 112°43′–113°14′ E)地处湖南省东北部岳阳市境内(图1), 位于长江中下游荆江江段南侧, 面积190,000 ha。区内气候为温和湿润、光热和风雨充足的亚热带季风气候。年均气温17.0℃左右, 最热月(7月)均温为29.2℃, 而最冷月(1月)均温为4.4℃。年降水量1,200–1,450 mm, 年均日照时数约1,600 h。全年无霜期258–275 d (周延等, 2019)。湿地资源丰富, 类型多样。麋鹿食物资源丰富, 可食植物达129种(杨道德, 2004)。

2 研究方法

2.1 调查方法

秋季调查时间为2016年10月和11月; 冬季调查时间为2016年12月和2017年1月。每月选取无雨的

天气, 采用样方法对再野化麋鹿种群开展8–10 d的生境选择调查。借助再野化麋鹿佩戴的GPS颈圈的卫星定位位点(每6 h记录1次)和地面跟踪信息, 以麋鹿个体发现点或活动痕迹点(粪便、足迹、卧迹、采食痕迹等)为中心设置10 m × 10 m的样方(朱洪强等, 2012), 在每个样方的中心点及四角处分别设置1 m × 1 m的小样方, 详细记录样方的生境类型及样方内草本盖度、乔木盖度、食物丰富度、距水源距离、距道路距离、距居民点距离、距隐蔽物距离和隐蔽级等9种生态因子信息(表1)^①。利用激光测距仪(Forestry 550)或在Google Earth软件上测量距离。在利用样方的任一方向100 m处(避免水塘和滩涂, 且无麋鹿活动痕迹)选取相同大小的对照样方(李言阔等, 2008)。秋季和冬季调查的生境利用样方和对照样方均为33个。再野化麋鹿的活动位点见图2, 图中位点代表麋鹿所有记录的活动位置, 部分出现在非

^①王海燕 (2017) 洞庭湖区麋鹿野外放归初期家域和秋冬季生境选择研究. 中南林业科技大学, 长沙。

表1 再野化麋鹿秋冬季生境选择相关的生态因子**Table 1 Ecological factors related to autumn-winter habitat selection by the re-wild Milu in Dongting Lake wetland**

生境变量 Habitat variables	描述 Description
草本盖度 Herbage coverage	5个小样方中草本植物覆盖度的平均值 Mean of herbaceous cover in five small sampling quadrats
乔木盖度 Arbor coverage	5个小样方中乔木植物覆盖度的平均值 Mean of tree canopy cover in five small sampling quadrats
食物丰富度 Food abundance	网格目测记录5个小样方中麋鹿可食植物覆盖度的平均值 The grid visually records the mean of Milu edible plant cover in five small sampling quadrats
生境类型 Habitat type	林地、灌草丛、草地、农田、水塘、沼泽 Woodland, shrub-grassland, grassland, farmland, ponds, herbage swamp
距水源距离 Distance to water	激光测距仪测量样方中心点与最近水源边界之间的距离 The distance between the centre of the quadrat to the nearest water source measured with laser rangefinder
距道路距离 Distance to road	激光测距仪测量样方中心点与最近主干道之间的距离 The distance between the centre of the quadrat to the nearest main road measured with laser rangefinder
距居民点距离 Distance to human settlement	激光测距仪测量样方中心点与最近居民点之间的距离 The distance between the centre of the quadrat to the nearest settlement measured with laser rangefinder
距隐蔽物距离 Distance to shelter	激光测距仪测量样方中心点与最近隐蔽物(芦苇、乔木、土堤)之间的距离 The distance between the centre of the quadrat to the nearest shelter (reed, tree, or dike) measured with laser rangefinder
隐蔽级 Hidden level	样方中心竖一根长1 m的标杆, 从距样方中心的四个方向20 m处记录可看到的花杆部分占总长度的百分比, 取平均值 A 1 m long surveyor's pole was erected in the centre of the quadrat and the percentage of the total length of the pole visible was recorded from 20 m in all four directions from the centre of the quadrat

图2 洞庭湖区麋鹿再野化初期GPS卫星跟踪位点图**Fig. 2 GPS satellites tracking waypoints of Milu (*Elaphurus davidianus*) at its early stage of rewilding in Dongting Lake wetland**

主要活动区域仅表示曾在这片区域活动。

2.2 数据处理

利用卡方检验法(Chi-square test)分别检验秋季与冬季再野化麋鹿生境类型选择的差异, 若存在显著($0.01 < P < 0.05$)或极显著差异($P < 0.01$), 则继续通过Bailey's置信区间法明确再野化麋鹿种群的生境偏好(陈龙等, 2017)。对于生态因子中的定量因子数据, 首先用K-S法进行正态性检验, 采用配对 t 检验对其中符合正态分布($P > 0.05$)的因子进行数据分析; 对不符合正态分布($P < 0.05$)的因子则进行Wilcoxon符号秩检验。在分析生境中定量因子数据在秋冬两个季节间的差异时, 先进行K-S法检验和方差同质性检验, 若数据同时符合正态分布($P > 0.05$)和方差齐性($P > 0.05$), 则继续进行两个独立样本 t 检验; 若不符合, 则采用非参数估计中的两个独立样本Mann-Whitney U检验。最后使用步进式(Wilks' lambda)判别分析法, 确定影响再野化麋鹿秋、冬季生境选择的关键因子。

3 结果

3.1 秋季生境选择

采用交叉制表卡方检验法对生境类型的统计结果进行分析, 发现再野化麋鹿随机利用秋季生境类型($\chi^2 = 6.616$, $df = 5$, $P = 0.251 > 0.05$, 表2)。

采用K-S检验法处理所得的各项定量生态因子数据, 发现在再野化麋鹿秋季生境利用样方与对照样方中共有4组生态因子符合正态分布(表3)。对这

表2 秋季再野化麋鹿对生境类型的选择利用

Table 2 The habitat type preferences by the re-wild Milu in Dongting Lake wetland in autumn

生境类型 Habitat type	利用样方数 No. of used quadrats	对照样方数 No. of control quadrats	利用样方比例 Proportion of used (P_i) ($n = 33$)	对照样方比例 Proportion of control (P_w) ($n = 33$)
林地 Woodland	7	10	0.212	0.303
灌草丛 Shrub-grassland	6	3	0.182	0.091
草地 Grassland	3	9	0.091	0.273
农田 Farmland	14	9	0.424	0.273
水塘 Pond	1	0	0.030	0.000
草本沼泽 Herbage swamp	2	2	0.061	0.061

表3 秋季再野化麋鹿利用样方与对照样方定量生态因子比较

Table 3 Comparison of quantitative ecological factors between quadrats used by the re-wild Milu and control quadrats in Dongting Lake wetland in autumn

生态因子 Ecological factors	利用样方 Used quadrats (mean $\pm$ SE)	对照样方 Control quadrats (mean $\pm$ SE)	t	Z	P
食物丰富度 Food abundance (%)	62.90 $\pm$ 3.90	48.98 $\pm$ 4.44	2.646	—	0.013
草本盖度 Herbage coverage (%)	69.37 $\pm$ 4.08	54.52 $\pm$ 4.45	2.690	—	0.011
乔木盖度 Arbor coverage (%)	9.27 $\pm$ 3.24	10.18 $\pm$ 3.14	—	-0.497	0.619
距水源距离 Distance to water (m)	67.39 $\pm$ 12.43	88.04 $\pm$ 17.90	1.242	—	0.223
距道路距离 Distance to road (m)	154.45 $\pm$ 50.57	154.89 $\pm$ 50.50	—	-0.417	0.677
距居民点距离 Distance to human settlement (m)	258.42 $\pm$ 54.68	277.52 $\pm$ 50.20	—	-0.577	0.564
距隐蔽物距离 Distance to shelter (m)	20.12 $\pm$ 8.71	27.90 $\pm$ 8.83	—	-2.193	0.028
隐蔽级 Hidden level (%)	40.18 $\pm$ 5.18	67.55 $\pm$ 4.13	-5.261	—	0.000

些因子进行配对样本 t 检验的结果为: 秋季生境利用样方与对照样方在隐蔽级($P = 0.000$)上的差异极显著, 在食物丰富度($P = 0.013$)、草本盖度($P = 0.011$)上的差异显著, 在距水源距离($P = 0.223$)上的差异不显著; 对不符合正态分布的生态因子进行非参数U检验的结果为: 生境利用样方与对照样方在距隐蔽物距离($P = 0.028$)上的差异显著, 而在乔木盖度($P = 0.619$)、距道路距离($P = 0.677$)、距居民点距离($P = 0.564$) 3项生态因子上的差异不显著。与对照样方相比, 再野化麋鹿秋季倾向于选择隐蔽级较低、食物丰富度较高、草本盖度较高、距隐蔽物距离较近的生境。

对各项定量生态因子使用步进式方法(Wilks' lambda)进行判别分析, 结果显示有1个典型判别式函数可用来区分再野化麋鹿秋季生境利用样方与对照样方, 该判别式的特征值为0.363, 正相关性系数为0.516。所生成的Fisher线性判别式函数为 $F_{\text{秋季}} = 8.673 \times \text{乔木盖度} + 8.373 \times \text{隐蔽级} - 2.777$ 。由此可知, 通过乔木盖度和隐蔽级2项生态因子可有效区分秋季再野化麋鹿的生境利用样方与对照样方, 判别正确率达72.7%。因Wilks' lambda检验中 $P =$

0.000, 故此判别式函数的判别能力显著。

3.2 冬季生境选择

冬季所有再野化麋鹿个体均进入湖区活动, 采用交叉制表卡方检验法对生境类型的统计结果进行分析, 发现冬季再野化麋鹿对生境类型具有显著的选择性($\chi^2 = 10.071$, $df = 2$, $P = 0.007 < 0.01$, 表4), 偏向选择草本沼泽。

由于湖区生境内乔木盖度为0, 利用组与对照组无差别, 故舍弃该项因子, 对其他生态因子进行数据分析。采用K-S检验法处理所得的各项定量生态因子数据, 发现在再野化麋鹿冬季生境利用样方与对照样方的所有数据均符合正态分布(表5), 与对照样方相比, 再野化麋鹿在冬季倾向于选择距水源较近、食物丰富度较高、草本盖度较高的生境。

对7项定量生态因子使用步进式方法(Wilks' lambda)进行判别分析, 结果显示有1个典型判别式函数可用来区分再野放麋鹿冬季生境利用样方和对照样方, 该判别式的特征值为0.987, 正则相关性系数为0.705, 方差的累计贡献率达100%。所生成的Fisher的线性判别式函数为 $F_{\text{冬季}} = 46.478 \times \text{草本盖度} - 0.050 \times \text{距水源的距离} - 20.237$ 。由此可知,

表4 冬季再野化麋鹿对生境类型的选择利用

Table 4 Habitat type preference by the re-wild Milu in Dongting Lake wetland in winter

生境类型 Habitat type	利用样方数 Number of used quadrats	对照样方数 Number of control quadrats	利用样方比例 Proportion of used (P_i) ($n = 33$)	对照样方比例 Proportion of control (P_w) ($n = 33$)
灌草丛 Shrub-grassland	0	4	0.000	0.121
水塘 Pond	6	0	0.182	0.000
草本沼泽 Herbage swamp	27	29	0.818	0.879

表5 冬季再野化麋鹿利用样方与对照样方定量生态因子比较

Table 5 Comparison of quantitative ecological factors between quadrats used by the re-wild Milu and control quadrats in Dongting Lake wetland in winter

生态因子 Ecological factors	利用样方 Used quadrats (mean $\pm$ SE)	对照样方 Control quadrats (mean $\pm$ SE)	t	P
食物丰富度 Food abundance (%)	86.28 $\pm$ 2.20	74.71 $\pm$ 3.64	3.359	0.002
草本盖度 Herbage coverage (%)	87.61 $\pm$ 2.09	79.79 $\pm$ 2.93	3.331	0.002
距水源距离 Distance to water (m)	32.79 $\pm$ 4.96	91.96 $\pm$ 8.38	-8.481	0.000
距道路距离 Distance to road (m)	1,150.30 $\pm$ 80.00	1,197.76 $\pm$ 85.48	-1.510	0.141
距居民点距离 Distance to human settlement (m)	1,758.18 $\pm$ 69.88	1,786.94 $\pm$ 70.74	-1.521	0.138
距隐蔽物距离 Distance to shelter (m)	105.71 $\pm$ 18.78	120.89 $\pm$ 13.18	-1.154	0.257
隐蔽级 Hidden level (%)	63.44 $\pm$ 1.61	64.95 $\pm$ 2.23	-0.738	0.466

图3 再野化麋鹿秋季与冬季生境类型利用频次

Fig. 3 Utilizing frequencies of habitat type by the re-wild Milu in Dongting Lake wetland between autumn and winter

通过草本盖度和距水源距离2项生态因子可有效区分冬季再野放麋鹿的利用样方与对照样方, 判别正确率达83.3%。因Wilks的lambda检验中 $P = 0.000$, 故此判别式函数的判别能力显著。

3.3 秋、冬季生境选择差异

秋季再野化麋鹿对生境类型无选择偏好, 而冬

季则倾向于选择草本沼泽作为其栖息地。通过对秋、冬季生境类型的卡方检验可知, 秋、冬季再野化麋鹿对生境类型的选择存在极显著差异($P = 0.000$)。在 $\chi^2 = 55.123$, $df = 5$, $P = 0.000$ 时, 秋、冬季生境类型差异表现如图3。

再野化麋鹿秋季与冬季的生境利用存在不同程度差异(表6): 在食物丰富度($P = 0.000$)、草本盖度($P = 0.001$)、乔木盖度($P = 0.001$)、距道路距离($P = 0.000$)、距居民点距离($P = 0.000$)、距隐蔽物距离($P = 0.000$)、隐蔽级($P = 0.001$) 7项因子上差异极显著; 仅在距水源距离上差异不显著($P = 0.077$)。

4 讨论和建议

4.1 再野化麋鹿的生境特择

动物生境选择的决定因素是水源、食物和隐蔽级(Cransac & Hewison, 1997), 而水源和食物是决定有蹄类动物生存状况最重要的环境因子(林杰等, 2012)。生境离水源越近, 越有利于动物的生存(陈化鹏和高中信, 1992)。前期的研究表明洞庭湖区再野化麋鹿喜欢选择近水源的草地(何振等, 2007; 贾媛媛等, 2015), 本研究结果同样表明: 再野化麋鹿秋、冬季仅在距水源距离上的差异不显著, 且距离均在百米以内, 说明了水源对于再野化麋鹿生存的重要性。

表6 再野化麋鹿秋、冬季生境选择的定量生态因子比较
Table 6 Comparison of quantitative ecological factors of the re-wild Milu in Dongting Lake wetland between autumn and winter

生态因子 Ecological factors	秋季 Autumn (mean ± SE)	冬季 Winter (mean ± SE)	Z	P
食物丰富度 Food abundance (%)	62.90 ± 3.90	86.28 ± 2.20	-4.303	0.000
草本盖度 Herbage coverage (%)	69.37 ± 4.08	87.61 ± 2.09	-3.232	0.001
乔木盖度 Arbor coverage (%)	9.27 ± 3.24	0.00 ± 0.00	-3.392	0.001
距水源距离 Distance to water (m)	67.39 ± 12.43	32.79 ± 4.96	-1.770	0.077
距道路距离 Distance to road (m)	154.45 ± 50.57	1,150.30 ± 80.00	-6.362	0.000
距居民点距离 Distance to human settlement (m)	258.42 ± 54.68	1,758.18 ± 69.88	-6.740	0.000
距隐蔽物距离 Distance to shelter (m)	20.12 ± 8.71	105.71 ± 18.78	-5.310	0.000
隐蔽级 Hidden level (%)	40.18 ± 5.18	63.44 ± 1.61	-3.239	0.001

植被类型是野生动物生境中重要的隐蔽条件(Hebblewhite et al, 2005; Torres et al, 2011)。再野化麋鹿秋、冬季对不同生境类型的利用差异显著。秋季再野化麋鹿随机利用各种生境类型, 因为秋后长江水位下降, 麋鹿喜食的草本植物从丰水期被淹的地面重新长出; 而在冬季再野化麋鹿则对生境类型具有显著的选择性, 主要选择在食物丰富、植被盖度大、隐蔽度高的生境, 偏向选择草本沼泽, 避免利用灌草丛。因为灌草丛高度较矮且在冬季植被盖度较低, 无法满足麋鹿御寒和隐蔽条件的需求。因此, 生境中灌草丛成为制约再野化麋鹿生境选择的重要因素。这与湖北石首麋鹿冬季卧栖地微生境选择的研究结果相似(邹师杰等, 2013)。

捕食风险和食物丰度或质量的权衡常被用以解释有蹄类动物对生境和资源的选择(Rettie & Messier, 2000; Grignolio et al, 2007; Hamel & Cote, 2007), 生境中食物可获得性是影响动物生存的重要特征(Michel et al, 2020)。麋鹿的食物类型多样, 以禾本科和豆科等草本植物为主要食物。栖息地内麋鹿可食及喜食植物资源短缺会制约麋鹿种群发展(贾媛媛等, 2015)。研究表明, 许多以草本植物为食的野生动物在食物选择和隐蔽警戒的权衡中, 通常改变警戒模式, 以选择食物丰富的生境, 而不选

择隐蔽条件较好、但喜好食物相对较少的生境(Cresswell, 1994; Lima, 1995; Roberts, 1996; Dias, 2006; 游章强等, 2014)。这也是再野化麋鹿在秋季选择食物丰富度高而隐蔽级较低的生境的原因。

此外, 人类干扰可能导致野生动物栖息地丧失, 进而影响动物的生境选择(Luo et al, 2014)。宋玉成(2015)指出人口密度和人类干扰是影响麋鹿扩散逃逸的主要原因。因为洞庭湖区域的再野化麋鹿栖息与人为活动存在冲突, 每年秋季的收割芦苇与捡鹿角等人为活动对麋鹿的行为活动均造成了较大的影响(李弛等, 2015), 因此避免再野化麋鹿与人类活动冲突也是首当其冲需要解决的问题。

4.2 生境选择的时间尺度

生境选择是一个复杂的过程, 可发生在多个水平或尺度上, 通过开展多尺度生境选择研究, 才能准确地把握野生动物的生境需求(张明海和李言阔, 2005)。野生动物生境选择研究的空间尺度, 可分为微生境、家域、宏生境和景观尺度; 对于时间尺度而言, 动物的生境选择具有时间动态(Boyce et al, 2003; Ensing et al, 2014), 生境选择可随着季节变化而变化, 也可在一天的时间内变化(Richter et al, 2020)。目前国内外对动物生境选择的研究有单一季节(鲁庆彬等, 2007; 申定健等, 2009; 葛小芳等, 2015; 李佳等, 2015)或多个季节(吴鹏举和张恩迪, 2004; 陈良等, 2010; 边坤等, 2016)。随着季节的变化, 有蹄类动物对生境的选择也做出相应的改变, 表现在不同的生活季节里, 有蹄类呈现出较强的生境选择性。这使得有蹄类生境选择时间动态研究显得同样重要。再野化麋鹿在秋、冬季进入不同的生活史, 其生理和生存需求也不尽相同; 其表现在距水源距离上差异最不明显。后续需结合景观尺度开展生境选择研究, 以掌握再野化麋鹿生境选择的内在规律。

4.3 建议

基于本次研究结果, 对东洞庭湖区再野化麋鹿种群及其生境的保护与管理提出以下建议: (1) 修建给排水设施, 确保水系畅通及水源质量, 保障再野化麋鹿饮水安全; (2) 建设再野化麋鹿监测和保护管理站点, 实时监控、及时了解再野化麋鹿的生存状况; (3) 修建“庇护所”, 在食物匮乏的冬季为再野化麋鹿提供资源和隐蔽场所。

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