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生态学报

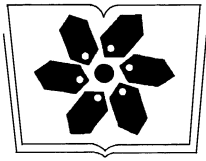
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生态学报

(SHENGTAI XUEBAO)

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封面图说:美丽优雅的新疆夏尔西里森林草地原始景观。夏尔西里国家级自然保护区建立在新疆博乐北部山区无人干扰的中哈边境上,图中雪地云杉为当地的优势树种。

彩图提供:国家林业局陈建伟教授 E-mail: cites.chenjw@163.com

骨顶鸡等游禽对不同人为干扰的行为响应

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摘要: 分别于 2008 年 4 月至 6 月和 2009 年 4 月至 6 月, 采用目标动物取样法在黑龙江省安邦河湿地和大庆龙凤湿地研究了骨顶鸡等水鸟对人为干扰的行为响应。结果表明: 骨顶鸡对行人和机动车辆两种干扰的反应距离类似, 但耐受程度有所不同, 骨顶鸡对机动车辆干扰的耐受性要好于行人干扰。在以游客等行人干扰为主的安邦河湿地, 骨顶鸡以及其他游禽对干扰产生行为反应的比例要高于以机动车辆干扰为主的龙凤湿地, 说明相对于行人干扰骨顶鸡对机动车辆更容易耐受; 在安邦河湿地, 骨顶鸡对划船的反应距离以及反应程度要大于人行走, 说明骨顶鸡对于侵入性的干扰更为敏感。此外, 对凤头鸕鶿 (*Podiceps cristatus*)、黑颈鸕鶿 (*Podiceps nigricollis*)、小鸕鶿 (*Tachybaptus ruficollis*)、黑水鸡 (*Gallinula chloropus*)、红头潜鸭 (*Aythya ferina*)、赤膀鸭 (*Anas strepera*)、绿头鸭 (*Anas platyrhynchos*)、斑嘴鸭 (*Anas poecilorhyncha*)、绿翅鸭 (*Anas crecca*)、白眉鸭 (*Anas querquedula*)、赤颈鸭 (*Anas penelope*)、琵嘴鸭 (*Anas clypeata*) 等游禽对人为干扰的反应距离、耐受距离以及遭受干扰时的反应比例进行了研究, 结果显示 3 种鸕鶿对干扰的耐受距离差异不显著, 12 种鸭类中红头潜鸭对人为干扰的敏感性要小于其他鸭类, 斑嘴鸭和绿头鸭则相对敏感。

关键词: 骨顶鸡 (*Fulica atra*); 人为干扰; 惊飞距离; 耐受距离; 游禽

Behavioral responses of the Common Coots (*Fulica atra*) and other swimming birds to human disturbances

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Abstract: The effects of human activities on the behavior of waterbird were conducted using the method of focal-animal sampling in wetlands of Anbanghe and Longfeng in Heilongjiang province from April to June in 2008 and 2009. Laser range finder was used to measure the responding distance and tolerance distance of the water birds. Three responding manners were mainly adopted by the coots when disturbance appeared: evade, run and flush. Our results showed that no significant difference was found between responding distances of the common coots to walking and motor vehicles ($t = -0.818$, $df = 51$, $P = 0.418$). However, the tolerance distance of the coots to motor vehicles were significantly greater than that to the walking ($t = 4.236$, $df = 198$, $P < 0.001$), indicated that the coots were more evasive to the noise caused by motor vehicles compared with the human activities. The percentage of coots' response to the disturbance was higher in Anbanghe wetland where the main disturbance type was the tourists' walking and the proportion of coots response to disturbances was less than 10%, indicating that the coots were more tolerant to motor vehicles than to human walking. In response to the boating disturbance, most of the coots flushed. However, when the disturbance source was human walking, 51.29% of the responding was evade, 38.46% was run on the water surface, and only 9.62% was flush. The degree of response manners was significantly correlated with the distance to disturbance. In Anbanghe wetland, the responding distance of the coots to

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boating disturbance was much greater than to walking; indicating that the coots were less tolerant to invading activities. Additionally, the tolerance distance, responding distance as well as the percentage of response to disturbance were also studied in other waterbirds of the Great Crested Grebe (*Podiceps cristatus*), Black Necked Grebe (*Podiceps nigricollis*), Little Grebe (*Trachybaptus ruficollis*), Common Moorhen (*Gallinula chloropus*), Common Pochard (*Aythya ferina*), Gadwall (*Anas strepera*), Mallard (*Anas platyrhynchos*), Spotbill Duck (*Anas poecilorhyncha*), Common Teal (*Anas crecca*), Garganey (*Anas querquedula*), Wigeon (*Anas penelope*) and Shoveler (*Anas clypeata*). The results showed that there was no significant difference in tolerance distances among three kinds of grebes. Compared to other birds, ducks seemed more sensitive to human disturbance, and there were significant differences among eight kinds of ducks' tolerance distances ($F_{7,319} = 7.516, P < 0.001$). The Mallard and Spotbill Duck were more sensitive to human activities, and the flush response was about 60% when disturbance appeared. Compared to other ducks, the Common Pochards were more tolerant to the disturbance.

It is concluded that buffer zones between water birds and human activities were needed to reduce the ocular and acoustical disturbances, and a set back distance of at least 100 m was advised in the tourist area.

Key Words: the Common Coot (*Fulica atra*); human disturbance; flush distance; tolerance distance; swimming bird

随着人类活动范围的拓展,人为干扰已成为全球性受胁鸟类面临的主要威胁之一^[1],人为干扰对鸟类的效应及相关对策的探讨也已成为鸟类生态学家和保护工作者关注的热点之一。人类活动包括一系列人类产生的干扰事件,这些事件将通过产生行为、生理以及繁殖变化而对野生动物产生短期和长期的影响^[2-6],其中人类的休闲旅游活动对鸟类产生的潜在影响受到了特别关注^[7-10]。一般认为,人类活动的增加会对野生动物的生境适宜性造成威胁,从而降低该地区种群的可持续性^[11-12]。人类活动还会使野生动物的取食和繁殖机会受到限制,并会增加野生生物种区域性灭绝的概率^[13-16]。

当人类出现或接近动物时,动物通常会把人类作为可能的捕食者而做出反应^[4],许多物种都有对人类入侵做出反应的记录。鸟类在潜在捕食者出现后会做出相应的行为上和生理上的反应,其中行为反应包括警戒、警示、逃避以及生境利用的变化等^[4]。因此,在人类活动水平很高的地区,游人不断的干扰可能导致动物生存率或者繁殖成功率的降低^[4,8]。

湿地系统是人类休闲活动的重要场所,这对野生动物造成了强烈的影响,而鸟类通常是最易受到影响的类群^[2,17]。对湿地的休闲活动利用包括划船,滑水,喷气艇以及帆船,还有徒步行走,遛狗,骑单车等^[18]。在英国和威尔士有调查发现所有乡村旅游的14%是针对内陆水系的。这些活动导致了人和生活在淡水区域的野生动物之间的利益冲突^[19-21]。

水鸟对人为干扰的响应主要表现在觅食时间和惊飞距离的变化,水鸟对人类活动影响的反应会随着人类干扰的剧烈程度而有所不同。行为反应,例如对干扰源的惊飞距离,经常被用来支持管理建议^[22-24],惊飞距离是指人在鸟类惊飞之前能接近鸟类的距离,反映了鸟类对人为侵扰的适应程度^[25]。这样的行为无论在繁殖季节还是非繁殖季节均会导致种群的分布转移^[22,26]。

多数的人为干扰研究都是针对海滨以及河湾等水体系统中分布的鸕鹚类等涉禽^[27-33],很少有针对内陆芦苇沼泽型湿地中的游禽,而相对于体型较小的鸕鹚类,骨顶鸡、鸕鹚类以及鸭类等中型游禽对人为干扰的适应性可能会更弱。近年来随着生态旅游的兴起,我国许多湿地类型的保护区均不同程度的开展了各种旅游活动,而目前我国针对人为干扰对湿地内生存水鸟的影响研究以及相关保护政策研究均较国外发达地区匮乏。骨顶鸡是一种中型游禽,和鸕鹚类以及鸭类是我国湿地中广泛分布的物种,且数量众多,因此包括骨顶鸡在内的等广布物种是研究湿地系统内人为干扰对水鸟影响良好的模型动物,对其研究的结论可以为湿地类型的保护区以及湿地公园等水鸟相关保护政策的制定提供参考。

1 研究地点和方法

1.1 研究地概况

于2008年4月末至6月末,2009年5月下旬至9月上旬在黑龙江省安邦河湿地自然保护区以及大庆龙凤湿地对骨顶鸡的繁殖种群进行了调查。安邦河湿地自然保护区位于黑龙江省东北部,地处安邦河下游,地理坐标为 $131^{\circ}06'—131^{\circ}32' E, 46^{\circ}53'—47^{\circ}03' N$,总面积 $10\,295\text{hm}^2$,隶属三江平原湿地的一部分,属温带大陆性季风气候,为低河河滩湿地,保护区内以芦苇沼泽生境为主。1993年成立安邦河自然保护区后,经引入安邦河水、芦苇栽植等措施使湿地得以恢复。保护区内水鸟资源丰富,从2004年起,在实验区的部分区域开展生态旅游,建立宣教馆,为游客提供划船游览湿地等休闲项目。

大庆龙凤湿地自然保护区位于黑龙江省大庆市龙凤区境内东南,是一处位于城区中的湿地,距离市中心仅8 km,地理坐标为 $125^{\circ}07'—125^{\circ}15' E, 46^{\circ}28'—46^{\circ}32' N$,也是芦苇沼泽型湿地。总面积约 5000hm^2 ,属温带大陆性季风气候区,四季明显,温差较大,年平均气温 4.5°C 。保护区内地势低洼平坦,泡沼相间,自然坡降小于千分之一。保护区以芦苇沼泽生境为主,水鸟以游禽和涉禽为主。

安邦河湿地水鸟受到的人为干扰主要来自旅游的压力,干扰主要来自游人行走以及划船等户外休闲活动,保护区内道路多为乡间小道,因此受机动车辆的影响较少。龙凤湿地被哈大高速公路贯穿,且湿地四周也均有车流量较大的公路,因此区内鸟类所受的干扰主要来自机动车辆,其次来自游客和行人。

1.2 方法

使用激光测距测速仪,采用目标动物取样法对鸟类的惊飞距离以及耐受距离进行测量。将惊飞距离定义为:惊飞鸟类起飞点与观察者当时立足点之间的地面距离;耐受距离定义为与观察者行走路径垂直距离在100m范围内,距离观察者最近且无规避反应的水鸟与观察点之间的距离。Reijnen等人对车辆对繁殖鸟类密度的影响做了研究,结果表明在每日有5000辆车经过的路上100m范围内鸟类的数量会减少12%—56%,但超过100m范围仅有两种鸟的数量有所下降。因此本研究选定100m作为水鸟未产生行为变化的最远距离^[34]。在样本分布特征分析中分别对反应距离、耐受距离进行正态分布检验,不服从正态分布的数据取对数后检验服从正态分布,之后用t检验和ANOVA分析来检验不同研究地、不同干扰方式以及不同物种之间反应距离和耐受距离的差异,数据分析均由SPSS统计软件完成。

2 结果

2.1 骨顶鸡对人为干扰的反应模式以及反应距离

骨顶鸡在受到人为干扰后一般表现出3种行为:躲避、奔跑、惊飞。观察中发现当公路上有机机动车辆经过时,骨顶鸡基本不会做出反应,而当车辆停止移动,有人下车时容易引起骨顶鸡的反应。在人行走时骨顶鸡一般会躲避到周围芦苇丛和蒲草丛中,当其和行人距离很小时(通常20m以内),对于突然出现的行人则表现出奔跑、惊飞等行为。骨顶鸡在安邦河湿地和大庆龙凤湿地的反应距离和耐受距离见图1、图2。骨顶鸡在两个研究地的反应距离差异不显著($t=-0.818, df=51, P=0.418$),但耐受距离差异极显著($t=4.236, df=198, P<0.001$)。安邦河骨顶鸡的耐受距离为 $(43.72\pm 2.38)\text{m}$ ($n=86$),显著小于大庆龙凤湿地 $(56.33\pm 1.861)\text{m}$,($n=114$)。

2.2 骨顶鸡在两个研究地对干扰做出反应的比例

两地骨顶鸡对行走干扰产生反应的比例见图3,可以看出安邦河的骨顶鸡对人行走干扰的反应比例明显高于大庆龙凤湿地,实验中安邦河湿地骨顶鸡对人行走产生行为反应比例超过30%,而龙凤湿地则不足10%。

2.3 骨顶鸡对人行走干扰做出反应的行为类型

骨顶鸡对于人行走等干扰的典型反应方式是躲避,占51.92%;其次是奔跑,占38.46%;再次是惊飞,占9.62%。通常骨顶鸡极少采取惊飞的方式躲避人为干扰,但在与人距离非常小(一般小于20m)、且干扰是突然出现或者强度较大时才会有惊飞的现象,反应强度与距离干扰源的距离呈正相关, ($r^2=0.145, F=8.306$,

$P = 0.006$), 如图 4。

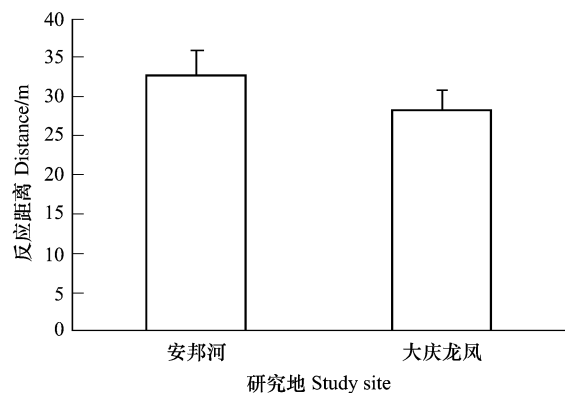


图 1 骨顶鸡对人行走干扰的反应距离

Fig. 1 The responding distance of the Common Coots to human walking

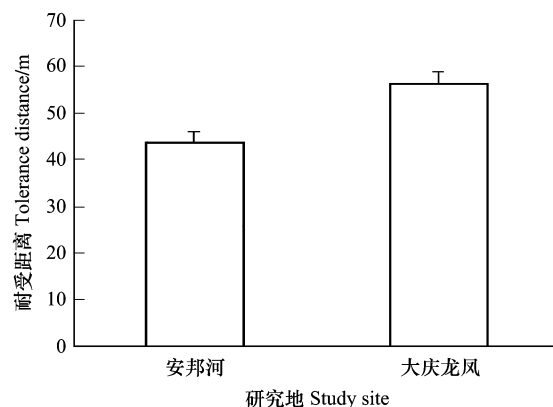


图 2 骨顶鸡的耐受距离

Fig. 2 The tolerance distance of the Common Coots

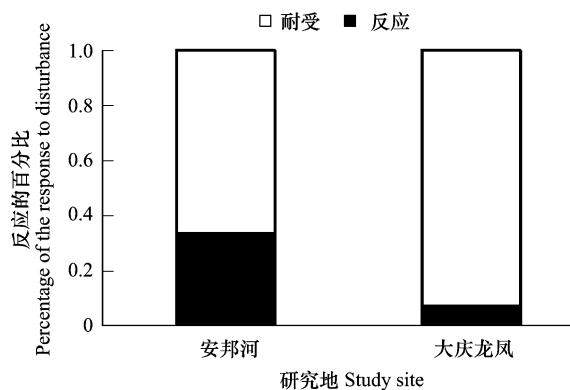


图 3 骨顶鸡在两个研究地对干扰做出反应的比例

Fig. 3 Percentage of the response to disturbance of the coots in different study sites

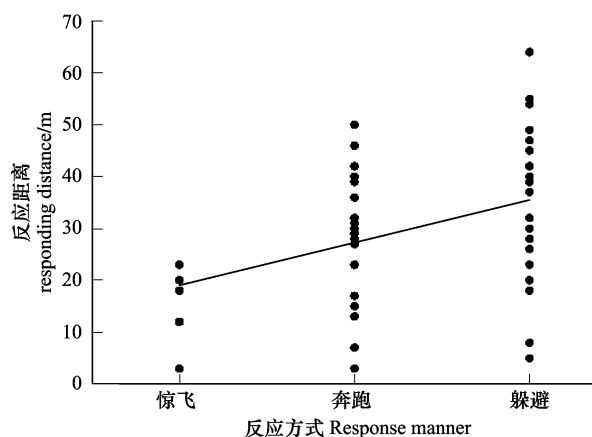


图 4 人行走时骨顶鸡不同行为类型的反应距离

Fig. 4 The responding distance of different kinds of behaviors of the Common Coots to the disturbances of human walking

由图 5 可知,在两个研究地点观察到的骨顶鸡的 3 种行为类型占反应的比例有所不同,在车辆干扰频繁的大庆龙凤湿地,骨顶鸡对人行走干扰的反应仅出现两种类型:躲避和奔跑;而在隐蔽条件相对较好、以游客行走为主要干扰的安邦河湿地,骨顶鸡对干扰的反应程度更为强烈,除了躲避和奔跑之外还有惊飞,且反应程度最低的“躲避”在大庆龙凤湿地所占比例近 2/3,而在安邦河则不足 50%,说明骨顶鸡在安邦河湿地对人行走干扰的反应更为敏感和强烈。

2.4 两种干扰方式下骨顶鸡的反应距离

骨顶鸡对行走和划船两种干扰反应程度差异显著($t = 22.272$, $df = 175.676$, $P < 0.001$),结果见图 6。划船时骨顶鸡的反应距离为(119.35 ± 3.464)m ($n = 127$),而人行走时骨顶鸡平均反应距离仅为(30.33 ± 1.994)m ($n = 52$),且骨顶鸡对划船的反应程度更为剧烈,绝大部分为惊飞,人行走时回避反应占 51.92%,奔跑占 38.46%,惊飞仅仅占 9.62%。

2.5 其他游禽对人为干扰的反应距离以及耐受距离

由图 7 可见,相对于其他水鸟,骨顶鸡对人为干扰的耐受距离最小,反应距离接近最小(而同科下的黑水鸡对人为干扰则要敏感的多,其耐受距离大于骨顶鸡($t = -2.545$, $df = 209$, $P = 0.012$);鹈鹕科的 3 种对人为干扰的耐受距离差异不显著($F = 0.871$, $df = 2$, $P = 0.422$);鸭类对人为干扰较为敏感,距离人 100m 以上时即

可能惊飞,鸭科的 8 种鸭类之间的耐受距离差异极显著 ($F_{7,319} = 7.516, P < 0.001$), 其中红头潜鸭对人为干扰最为不敏感, 平均耐受距离为 (58.741 ± 1.455) m ($n = 189$)。

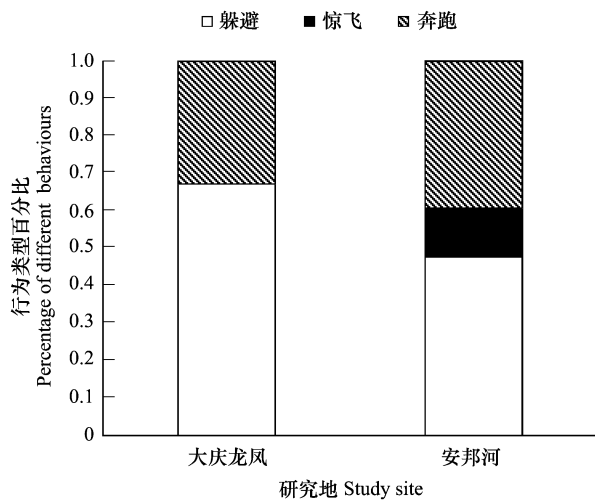


图5 不同地点骨顶鸡对人为干扰的行为类型百分比

Fig. 5 Percentage of different responding behaviors of the Common Coots in two study sites

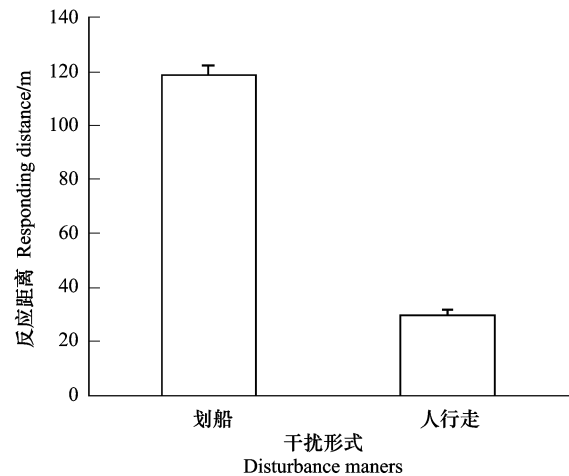


图6 骨顶鸡对两种干扰形式的反应距离比较

Fig. 6 Comparison of the responding distance of the Common Coots to two kinds of disturbances

2.6 游禽对干扰的反应比例

由图 8 可见,在大庆龙风湿地,斑嘴鸭和绿头鸭对人为干扰的反应比例较高,遇到行人 60% 以上的情况会惊飞;而赤膀鸭和红头潜鸭对高速公路上的行人和机动车辆干扰耐受程度较高,尤其是红头潜鸭,观察中发现对人行走干扰做出反应的比例不足 10%;反应距离相似的黑颈鸊鷉和凤头鸊鷉在受到干扰的情况下反应的百分比也相似,两种鸊鷉,对人为干扰均不敏感。

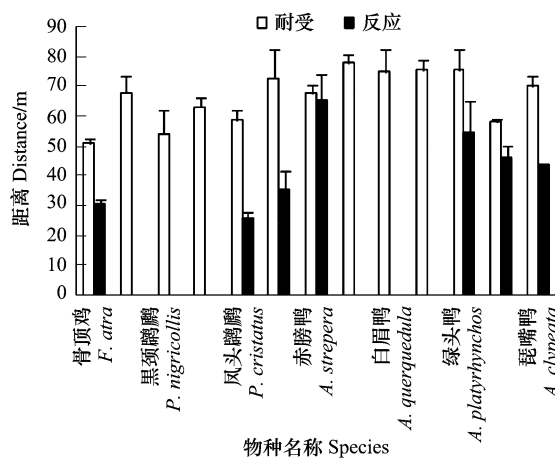


图7 13 种游禽的耐受距离和反应距离

Fig. 7 The tolerance distance and responding distance of 13 kinds of swimming birds

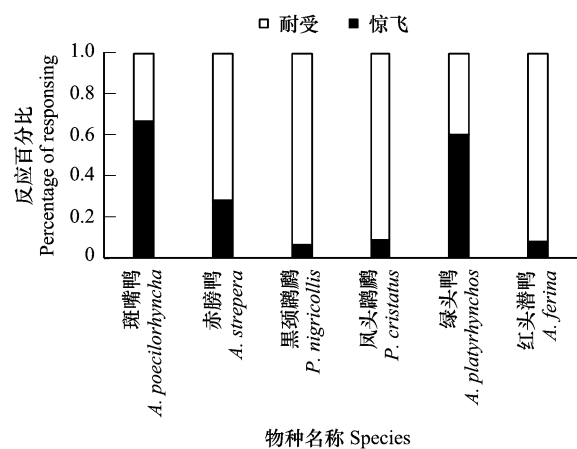


图8 几种水鸟对干扰反应的百分比

Fig. 8 Percentages of several water birds' responses to human interruptions

3 讨论

动物有 3 种不同的习得行为:躲避、吸引和适应^[6]。游客频繁出现的区域与游客稀少处的鸟类相比对干扰更加不敏感^[35-36]。尽管安邦河湿地有开展生态旅游,但旅游的旺季集中在 7—9 月份,6 月份之前较少有游人,且干扰频率不恒定,通常仅在天气晴好的周末游人较多,平时游客量很小,骨顶鸡等游禽对人为干扰并未

表现出过多的适应,和大庆龙凤湿地相比骨顶鸡的惊飞距离没有表现出明显差异。此外,噪音是一个影响因子,噪音大的交通工具对动物的干扰更强,吵杂的人群会使水禽用于取食的时间减少。大庆龙凤湿地的骨顶鸡对人行走干扰会有躲避和奔跑,但对公路上行驶的车辆基本不做出明显的行为反应,说明相对于行人,骨顶鸡对车辆干扰较为耐受;但大庆龙凤湿地骨顶鸡的耐受距离显著大于安邦河湿地,说明虽然骨顶鸡对车辆不敏感,但很可能对车辆行驶时产生的噪音干扰有所回避,骨顶类是靠鸣叫进行通讯的鸟类^[37-38],游人、拖拉机产生的噪音及过往车辆均会干扰繁殖期白骨顶的正常活动^[38]。车辆行驶过程中产生的噪音可能会影响其与配偶以及子代等的通讯,因此在大庆龙凤湿地高速公路两侧的骨顶鸡距离观察路线——公路的距离要大于安邦河湿地。

不同类型的旅游活动会对野生动物产生不同的影响。游人行走和骑自行车对越冬鸭类的干扰远超过驾驶机动车^[39],在观察中发现骨顶鸡在车辆经过时一般不做任何反应,但当行人经过时则有回避行为,游人干扰较多的安邦河湿地骨顶鸡的反应比例要高于大庆龙凤湿地,说明相对于车辆,骨顶鸡对游人行走更为敏感。

在水上活动项目中,自由行进的船只对繁殖期鸟类的干扰更明显^[40-41]。骨顶鸡对水面上船只反应的距离要远大于岸上行走的游客。安邦河湿地开展水上划船以及快艇等旅游项目的水面上常常有骨顶鸡活动,当船只经过时成群的骨顶鸡惊飞,对骨顶鸡的觅食等活动产生严重干扰,尤其是对繁殖的骨顶鸡,许多骨顶鸡的巢建在大的明水面边缘,船只经过时很容易对正在孵化的骨顶鸡造成惊扰。

对于正在接近的人类,体形较大的鸟类的容忍度低于体形较小的^[6,42-43],因此,相比于骨顶鸡,鸭类的耐受距离较大,受到惊扰后表现出更高层次的回避反应——惊飞;同科下的黑水鸡和骨顶鸡相比,体型小的黑水鸡对人为干扰表现出更高的敏感性。此外,位于观察者与鸟类之间的植被能够增加鸟类的容忍度^[6]。繁殖季节斑嘴鸭和绿头鸭多成对分布在距离公路较远且植被覆盖度相对较大的区域,因此斑嘴鸭在发现行人之后容易惊飞,耐受干扰的程度较低,而红头潜鸭则常集小群分布在较开阔的水面上,对人行走等干扰表现较不敏感。

通常较为敏感的鸟类喜出没在隐蔽的草丛处,而较为耐受的鸟类常出现在开阔处。和骨顶鸡类似,鸕鶿也是湿地中常见的游禽,喜好在较开阔的水面上活动。有研究表明凤头鸕鶿的惊飞距离随着游人侵扰程度的增大而显著减小,对人为侵扰表现出一定的适应性^[44],在安邦河,旅游区除了骨顶鸡之外,最常见的游禽就是凤头鸕鶿。说明凤头鸕鶿相对于其他水鸟,特别是游禽,对人为干扰的耐受性和适应性较好。

与机动车辆相比,水鸟对人的行走、跑动等活动更为敏感,进入繁殖季节后,在安邦河湿地人为活动较为频繁的旅游区水面上很少可以看到除骨顶鸡、凤头鸕鶿、黑翅长脚鹬(*Himantopus himantopus*)之外的其他水鸟,鸭类在人接近时会惊飞;而在大庆龙凤湿地,鸭类在高速公路两侧的种类和数量仍然很多,且极少会对机动车辆做出回避、惊飞等行为反应。骨顶鸡对侵入性的干扰行为更为敏感,而对人行走或者机动车则较为耐受,因此在湿地开展划船等旅游项目时应当选择距离骨顶鸡等水鸟繁殖场或者集群的水面较远的地方,避免对其造成影响;此外,在鸟类繁殖期,开展旅游活动的保护区以及湿地公园等应对旅游者的活动范围有所限制,在旅游路线与水鸟繁殖区之间设置适当的规避距离可以减少对水鸟的干扰。

致谢:本研究得到了安邦河自然保护区、大庆龙凤湿地自然保护区以及大庆市野生动物保护协会的大力支持。

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