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DURHAM, N.H. -- Keeping track of one set of keys is difficult enough, but imagine having to remember the locations of thousands of sets of keys. Do you use landmarks to remember where you put them? Do you have a mental map of their locations?

Scientists at the University of New Hampshire hope to learn more about memory and its evolution by studying the Clark's nutcracker, a bird with a particularly challenging task: remembering where it buried its supply of food for winter in a 15-mile area. Like many animals preparing for the winter, every fall the Clark's nutcracker spends several weeks gathering food stores. What makes it unique is that it harvests more than 30,000 pine nuts, buries them in up to 5,000 caches, and then relies almost solely on its memory of where those caches are located to survive through winter.

Brett Gibson, a scientist studying animal behavior, began studying Clark's nutcrackers in graduate school and is continuing his research into memory and the behavior of nutcrackers as an assistant professor in UNH's psychology department.

"Nutcrackers are almost exclusively dependent upon cache recovery for their survival so if they don't remember where they've made those caches, then they are in trouble," Gibson says. "During winter, their cache locations are covered with snow so many of the small local features in the landscape during fall are no longer available to them. What's clear is that they are using spatial memory to recover these caches. They are remembering these caches based on landmarks and other features of the terrain."

The study of memory is important for several reasons. It helps us understand how memory develops and evolves. It teaches us about how we and other species successfully navigate using memory. It provides insights across species about brain function and the hippocampus, a part of the brain important for memory and one of the first regions of the brain to suffer damage in Alzheimer's patients.

"For us it would probably be very difficult to remember where we put 33,000 items, but these guys do it really well because of the environment they live in," Gibson says. "It's a problem evolution has solved by developing this very good memory for spatial information."

Clark's nutcrackers are native to the upper elevations of western North America, such as the Colorado Rocky Mountains. They are a member of the corvid family, which also includes blue jays and crows that are native to New England.

Gibson was part of an initial program of research focused on studying the Clark's nutcracker's spatial memory and how it compared to other members of the corvid family. That research has found that nutcrackers have a better spatial memory compared to related birds that are not as dependent upon the recovery of food caches during the winter for their survival.

His most recent research with the Clark's nutcracker looks at the nature of the spatial cues specified by memory – how the bird uses these cues to find its food caches. "How do they use landmarks? What information do they remember about these landmarks? Are they using just one landmark as a beacon? Do they remember multiple landmarks and the geometrical relationship between those landmarks and the goal location?" Gibson says.

"These pine seeds are very small and these caches are very small so they have to be very accurate about how they use these landmarks to remember those cache locations," he says.

One way that nutcrackers might solve the problem of returning to their caches is by developing a mental map of landmarks in their environment and recalling the location of the caches relative to the landmarks in the map. If they do have a map then they might be able to plan efficient routes to get from one cache site to the next – a problem called the Traveling Salesman Problem.

"Some mathematicians love this problem. We were interested in seeing how efficiently a non-human animal could solve it so we looked at pigeons. They were actually pretty very good at it so we're going to start looking at the same problem with nutcrackers," Gibson says. "We think they may be even better because nutcrackers have all of these places they have to travel in their environment; you might expect them to be very efficient in terms of where they travel."

Gibson, in collaboration with his graduate student Tyler Wilks, also is looking at whether the birds use another navigational strategy in finding their food -- dead reckoning, part of an internal sense of direction. Dead reckoning integrates awareness of direction and distance traveled in order to return to a previous location; no landmarks are used.

"As humans we rely on landmarks a lot so we don't think a lot about dead reckoning. But when you get lost in a forest and there aren't a lot of familiar landmarks, your dead reckoning system kicks in and you try to determine the direction from which you came," he says.

Investigations of dead reckoning in Clark's nutcrackers have been limited, although it has been explored in other animals, from ants to primates. "We suspect it might play an important role because they have this great demand for remembering locations in the environment," Gibson says.

Gibson also is interested in how animals create tools such as hooks and barbs out of items like twigs and branches, and use them to find food. "The Clark's nutcracker being a member of the corvid family might be quite good at understanding some of the physical relationships involved in solving problems that require using tools," he says.