



The Stilt

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Statistical Physics is for the Birds

At dusk each winter evening, millions of starlings fly in from the countryside to their roosting sites in Rome and, before settling into trees for the night, "they spend something like 20 minutes doing these incredible aerial displays. It's a truly amazing sight," says Andrea Cavagna, a statistical physicist at Italy's National Institute for the Physics of Condensed Matter (INFM). "If you watch a flock of starlings under attack by a predator, they split, merge, and do all these incredible maneuvers to confuse the predator. How can they keep cohesion in the face of that strong perturbation—the attack?"

Inspired by the aerial displays, a group of scientists led by theoretical physicists in Rome set up StarFlag, a multidisciplinary, multinational collaboration to study the birds' flocking behavior. The main aim was to determine "the fundamental laws of collective behavior and self-organization of animal aggregations in three dimensions," says Cavagna, the project's deputy coordinator. In addition to the Rome INFM group, which focuses on collecting quantitative data on flocking, the project includes physicists and theoretical biologists who do computer modeling, biologists who study details of starling flight and behavior, and physicists and economists who work on extending the starlings' collective behavior patterns to such systems as cells in wound healing, aggregates of robots, and financial markets.

Three-dimensional data

Many earlier flocking studies were done with fish. "You put them in a tank, and usually you watch only 20 to 40 fish. We wanted to take data in the field, and this is difficult and expensive to do in water, so we thought about birds," says Cavagna. "You have loads of models and theories [on flocking], but no data whatsoever, especially in three dimensions, so everyone could propose a model and be happy, since there was no comparison with experiments." The reason, he adds, "was that having three-dimensional data on

Three-dimensional mapping of starling flocks could shed light not only on the birds' collective behavior but also on a broad range of other aggregate systems.

large aggregations of moving animals was considered impossible until now." With StarFlag, he says, "we wanted to start from quantitative experimental data. The backbone of the project was to collect three-dimensional data on large aggregations—thousands, rather than tens, of animals—understand what's going on, and then formulate, or reformulate, models in feedback with the data."

Collecting the data involved setting up cameras each evening on the roof of a building near the Rome railway station. "To do three-dimensional imaging, you have to do stereoscopy. It takes an hour and a half to mount everything, align the cameras, synchronize the electronics," says Cavagna. Then, during the 20-minute aerial display, the team shoots 10 frames per second for a maximum of 8 seconds, until the cameras' memories are full. What they record is a matter of luck, since "once they're set up, we can't move the cameras, so we just stay there, fishing in one place." Flocks can be too big to photograph, or they may not stay in the field of view.

A given flock can have anywhere from 200 to 50,000 starlings, and once you have the data, says Cavagna, "you have to say who is who in two pictures, and you have more or less lots of black dots. Matching was the bottleneck. It took two years for us to crack this problem using statistical physics methods. It's an optimization problem."

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Audubon Calendar

November 2008

- 1 Birding the South End of Cache Valley** Spend a morning looking for migrating waterfowl, hawks, and other birds of interest with local experts. For the last several years, we have had a very productive and fun time birding this area. Probable stops include Hyrum Reservoir (Long-tailed Ducks, Surf Scoters, Trumpeter Swans and loons), the Little Bear River Bottom West of Paradise (songbirds and owls), and the fields, power poles, and brush in between (raptors). Beginning birders are welcome. Carpooling will be available and encouraged. Meet at 9 a.m. at the parking lot between Caffe Ibis and the Logan Fire Station. Bring binoculars and a snack. Dress for the season. We will be back early in the afternoon. For more information, call Dick Hurren or Dorothy Egan at (435)744-2017.
- 6 Board of Trustees Meeting** BAS Trustees meet at 7 p.m. at the Cache Valley Learning Center, 75 S. 400 West, Logan. Enter through the building's west doors. All are welcome to attend.
- 8 Birding Southern Box Elder County** We will go to either Willard Bay State Park, Salt Creek Wildlife Management Area, the Bear River Bird Refuge, the Golden Spike Historical Sit, or any combination of the above. This time of year is usually good for Tundra Swans, Bonaparte's Gulls, and various waterfowl. Willard Bay State Park often yields "lost" eastern warblers and owls. Bing binoculars and dress for the season. Meet at 9 a.m. at the parking lot between Caffe Ibis and the Logan Fire Station. Bring a snack because we will not return until mid-afternoon. Carpooling will be available and encouraged. For more information, call Dick Hurren or Dorothy Egan at (435)744-2017.
- 13 General Meeting** Join us at our same great location, the Cache Valley Learning Center (75 S. 400 West), when Robert Schmidt will be presenting on Sea Turtles. The meeting will start at 7 p.m. Enter through the building's west doors. All are welcome to attend and refreshments will be provided by Crumb Brothers and Caffe Ibis. Enter through the building's west doors. We hope to see you there.
- 15 Willow Park Zoo and Habitats around Logan for Beginning Birders** To help beginning birders, we will go to the Willow Park Zoo where we can learn to identify birds up close and personal. We will then go to habitats around Logan where we can put our newly learned skills to work. This will be a good trip for families. Bing binoculars and dress for the season. Meet at 9 a.m. at the parking lot between Caffe Ibis and the Logan Fire Station. We will finish up around noon. Carpooling will be available and encouraged. For more information, call Lyle Bingham at 563-6003 or Dick Hurren at (435)744-2017.
- 22 Logan Sewer Lagoons and Polishing Ponds** The Logan Sewage Lagoons and Polishing Ponds are real hot spots for late-migrating and over-wintering waterfowl. Join us for a trip with local expert birder Buck Russell. Meet at 9 a.m. at the parking lot between Caffe Ibis and the Logan Fire Station. Bing binoculars and dress for the season; a cold wind often blows through the lagoons. Beginning birders are welcome. Carpooling will be available. We will finish up around noon. However, a group from HawkWatch International will be joining us. They will then bird around the valley in search of raptors. Anyone is welcome to keep birding with them into the afternoon. For more information, call Dick Hurren or Dorothy Egan at (435)744-2017.



If you'd like to come along on a field trip but do not have binoculars, call Dick Hurren (435)720-7074. He'll try to find a pair for you to use.

Local Bird Spotlight

Ring-necked Pheasants (the state bird of South Dakota) are not an uncommon sighting in Cache Valley, since they are year-round residents. For some, however, it might be easier to spot them now that the leaves have all dropped and the vegetation is sparse.

Male pheasants are medium "chicken-sized" birds. They are very distinguishable with a bare, red face, iridescent green head, and a white ring around the neck. Sexes in this species are definitely dimorphic with the female being smaller, drab brown with small black spots on her back.

Ring-necked Pheasants aren't very picky when it comes to food. They eat seeds, grasses, leaves, roots, fruits, nuts, and insects by scratching the ground and digging with their beaks. Interestingly, pheasants have been known to roost for several days without eating due to inclement weather. The birds prefer farmland habitats with grassy areas in which they build their nests.

Pheasants were introduced to America (California) from Asia in 1857 as a game bird. They have established themselves across much of North America and are still popular amongst bird hunters. They are so popular that several pheasant farms can be found in most states. These farms raise pheasants to be purchased to "stock" an area for hunting. It is an unfortu-



nately thing that habitat loss, not hunting, is the main cause of population declines. The state of New York, for example, raises more than 25,000 birds to plant around the state. (<http://nature.lohublogs.com/2007/09/>)

Referring to the 2008 forecast for hunters, Pheasants Forever, the self-proclaimed habitat organization, claims "Utah pheasant habitat continues to dwindle with urban sprawl and improved agricultural efficiency, which reduces habitat quality and abundance on the remaining farm lands." (<http://www.pheasantsforever.org/page/1/2008forecast.jsp>)

For these reasons, pheasant farms find themselves in such high demand. Perhaps you have seen a farm or two in the area. There are some smaller farms in the Benson

area and some larger ones in Box Elder County. When spotting the birds near these locations, chances are they're recent escapees that haven't been picked off by local hunters or dogs yet.

Image from www.whatbird.com

Article by Brandon Spencer

Information gathered from http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/Ring-necked_Pheasant_dtl.html and http://identify.whatbird.com/obj/261/_/target.aspx

Utah Audubon Council Retreat Report

The fall meeting of the Utah Audubon Council in Bridgerland was a great success. Despite the stormy weekend, we had a good showing at our field trips and the business meeting.

One of the goals of the UAC is to share information and coordinate the separate Utah Audubon chapters in working together. To help achieve that goal, and to make it easier for all Audubon members to get involved, we're working on creating a website where anybody can easily see what the UAC is working on and what our policy advocate is doing to promote bird-related issues in the legislature. We'll have more information about the new website when it launches in the near future.

We'd like to thank all of the attendees for making our weekend a success. We'd also like to thank our gracious hosts, Betsy Beneke of the Bear River Migratory Bird Refuge and Holly Strand of the Stokes Nature Center for making their facilities and themselves available to our group.

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Anisotropic interactions

Flock cohesiveness was a mystery, says Cavagna. "It's clear that the interaction [between birds] decreases with increasing separation, but how do the birds measure distance? We came in as physicists, our experience was with spin glasses, and we used the same tools." Those tools include techniques from statistical physics, optimization theory, and computer vision. Quantifying the interaction among birds is StarFlag's most important result so far, Cavagna says.

The Rome team found that a given bird interacts not with all birds within a certain distance, as most models had assumed, but rather with a fixed number of neighboring birds, independent of how far apart they may be. "If flocks always had the same density, there would not be a striking difference between this [behavior] and interacting with all birds within a certain distance,"

says Irene Giardina, another statistical physicist in the 10-strong INFM group. "But when a flock is attacked, it undergoes rapid changes in density. You can watch a flock split, but it comes together again. We asked what sort of interaction can guarantee such a robust resilience to perturbation."

"We looked at our three-dimensional data and considered a given bird, and then we measured the angular positions of its nearest neighbors," she continues. The distribution of angular positions turns out to be anisotropic, a result that StarFlag scientists presented at a couple of conferences over the summer. "There is much more probability of finding its nearest neighbor on the side, rather than in front or back along the direction of motion," says Giardina. "We measured this probability also for the second and third neighbors, and so on. And we found that birds inter-

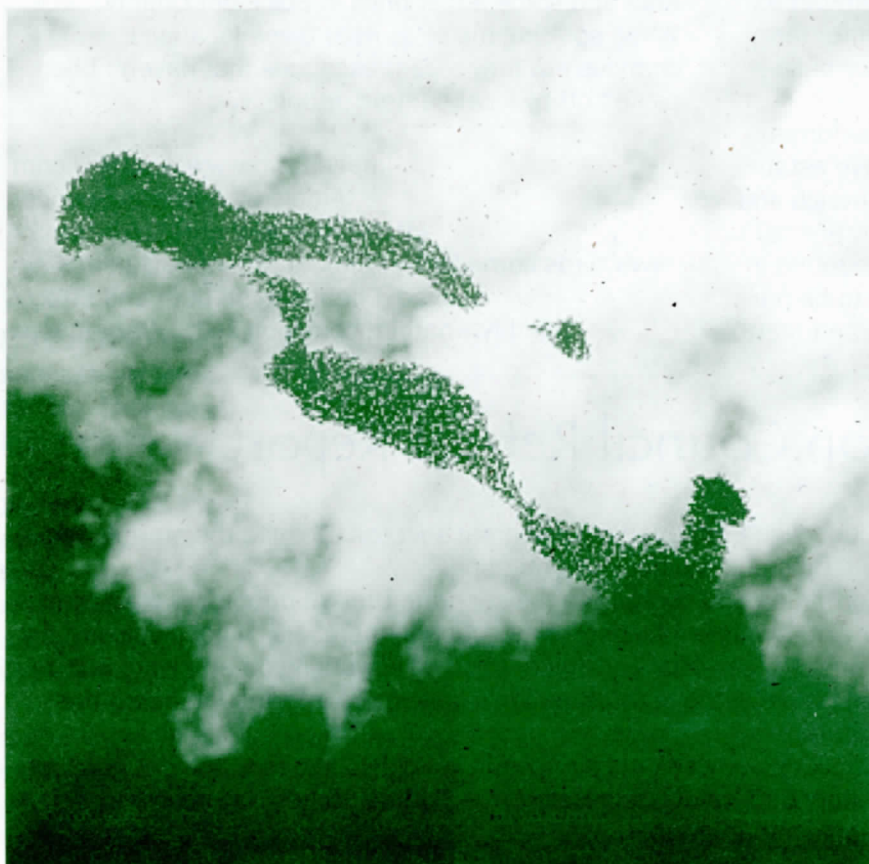
act with six or seven neighbors. After that, the anisotropy decays. That's the point where the spatial structure becomes isotropic."

It turns out, Giardina says, that these "topological interactions are much more robust to perturbations" than a model in which a bird interacts with other birds within a fixed distance. The anisotropy, she adds, makes sense biologically: "It's related to vision, since the physiology of the eye is not isotropic."

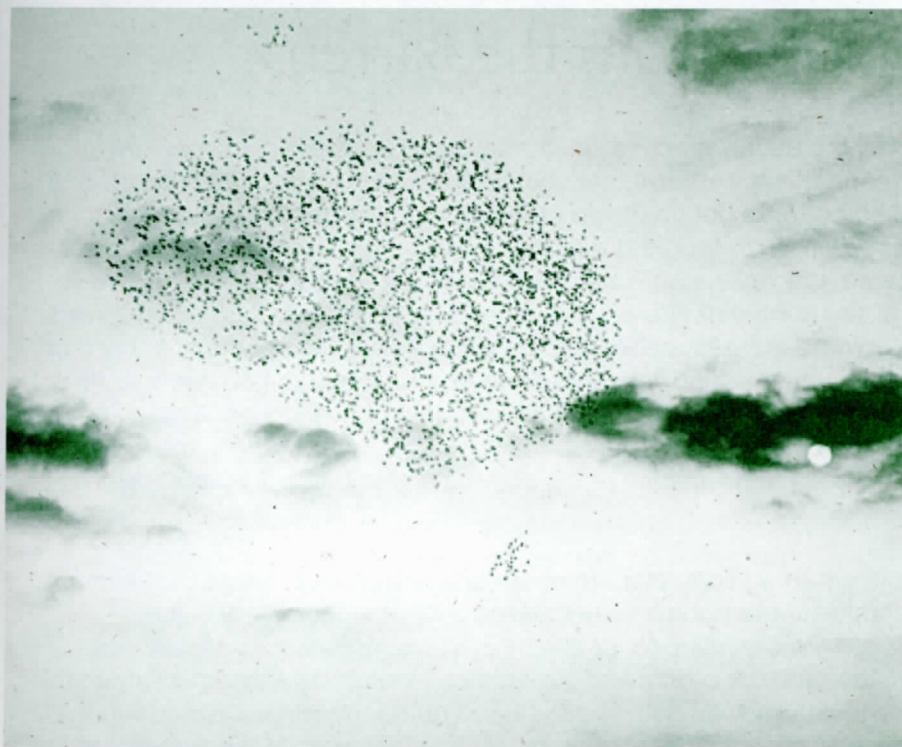
The Rome team is now extending the data analysis to reconstruct trajectories of individual birds. "We don't have results yet," says Cavagna. "We have to find algorithms for dynamical matching. But we will be able to ask new questions, such as 'How long does a bird remain correlated with its neighbors?' and 'How does a flock rearrange itself when it turns?'"

Model behavior

Although computer models of flocking don't yet explicitly build in the anisotropy, StarFlag's modelers have refined their simulations since the collaboration began in 2005; the project's three-year grant from the European Commission runs through this year. "We keep three old rules—hard-core repulsion, longer-range attraction, and we assume that the particles [birds] assume the average direction of their neighbors," says Tamás Vicsek of Hungary's Loránd Eötvös University. "But now we feed into the model details of the dynamics, such as that the birds change direction, in order to understand landing and how they self-organize behavior." In particular, Vicsek and others have extended their models to three dimensions. "We have developed a very nice—fast, beautiful—visualization of flocking data points. The graphics shows birds flapping their wings and contracting when



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moving away," says Vicsek.

Hugues Chaté, a physicist at the Atomic Energy Commission in Saclay, France, says that to incorporate anisotropy into the attractive and repulsive potentials of his models, "we need to introduce not just an axis for the flight direction, but another for the wings. Then we can modulate the strength of the interactions." So far, he adds, the interactions in his models rely on a "nice mix of topological and metric criteria"—a bird interacts with its neighbors, but the strength of each pair interaction is modulated by distance, and the "interactions are strictly local, which makes the emergence of collective motion more spectacular."

The Rome group's findings of anisotropic interactions and a fixed number of partners with which birds interact were no surprise to Charlotte Hemelrijk, a theoretical biologist at the Netherlands' University of Groningen, whose earlier models of fish schools showed a similar anisotropy. Modifying the fish models to account for bird be-

havior and interactions, she says, "caused a remarkable switch in emergent patterns" and yielded the "variable patterns of flocking observed in aerial displays of starlings. We do not need to incorporate these findings [of anisotropic interactions] in our model. They come out automatically due to the coordination among individuals and their movement direction. It is what you expect of animals, due to limitations of perception and cognition." Compared with physicists' flocking models, she adds, biologists "make models that are closer to animals. We try to incorporate flight dynamics—how birds cope with gravity to produce lift and how they turn corners."

"We come from very different viewpoints," says Chaté. As a biologist, Hemelrijk "is worried about the details [of flight]." In contrast, he adds, physicists try to get rid of details. "StarFlag is an opportunity to talk to each other and learn each other's points of view, and to meet somewhere in the middle, or at least get closer to each other." The

StarFlag scientists expect their results on starlings to apply, with tweaking, to other birds, fish, insects, bats—any species that swarms or travels in schools.

Collective glue

And then there is the question of whether starlings might shed light on human behavior. StarFlag's Jean-Philippe Bouchaud, a theoretical physicist who heads research at a hedge fund in Paris, asks, "How do people coordinate and imitate each other to create collective phenomena that are surprising if you think about individuals? People are extremely influenced by their neighbors, by fashions and fads. This might have an impact on markets—possibly events like crashes or bubbles are due to the coordination of people. We are looking for situations where you can measure, or try to measure, the ways people interact and create a collective effect."

Bouchaud is currently focusing on two examples of human behavior. One involves how others' choices affect what music people download. The other—topical to France's summer elections—is how people are influenced by others when they vote. Along the same lines, a group of economists in Pisa, Italy, is studying the collective behavior of banks as indicated by where they open branches. Starling flocking is more complex, says Bouchaud, "because it's a three-dimensional organization of birds in space. But the idea is to work up from the behavior of individual birds to the behavior of the flock." The connection to studies of people is indirect, he adds. "Behind these projects is the same fascination with collective effects that glues the whole project together. We have a lot of things to share when we meet."

Toni Feder

Autumn Notes from the Barrens

It has been a dry summer, evidenced by the deeply parched soil at the Barrens. There are only a few survivors among the golden currants, sagebrush and winterfat that volunteers planted this spring, this despite several waterings. Probably it would be better to pot up plants obtained in the spring and hold them for fall planting, if someone in our Chapter would be willing to tend them at their home. Meanwhile, the mix of grasses seeded nearly two years ago are now in large part well-established, particularly in the south parcel. Where establishment was spotty, as across some of the north parcel, weed pressure is evidenced by the huge ragweed, prickly lettuce and Russian thistle plants. Where grasses are well-established, weeds are sparse or altogether absent, unable to compete with the grasses. Native sunflowers also expanded their population in the south parcel, feeding flocks of goldfinches. At the end of September, I transplanted robust native globemallow plants into three small plots in these grassland restorations, as well as filling a small seed bed by the sign in the north plot with a native prairieclover (*Dalea searlsiae*), bee plant (*Cleome lutea*) and the tiny of bulbs of a native wild onion (*Allium acuminata*).

I inadvertently trapped some native bees in upturned containers from our spring transplants that I left to mark our little plants. Represented among the unfortunate victims were carcasses of the following bee genera: *Agapostemon*, *Andrena*, *Apis*, *Bombus*, *Coelioxys*, *Dialictus*, *Dianthidium*, *Halictus*, *Megachile*, *Melissodes*, *Osmia*, *Triepeolus*. All but the honeybee (*Apis*) and the alfalfa leaf-cutting bee (one of the *Megachile*) are native, a surprising diversity for a place consisting mostly of wind-pollinated grasses (and formerly, cultivated wind-pollinated grains). Most all of these bees are either floral generalists or focused on plants of the Asteraceae, such as the native sunflowers and balsamroots out there, for which they are essential pollinators.

It will be interesting to see how Clay Slough at the heart of our Barrens Sanctuary responds to the planned draw-down of Cutler Reservoir by Pacific Power in November. We may get to see bottom!

I continue to look for one or more Audubon members who would be willing to perform bird counts at the Barrens Sanctuary, committing just three morning a year to a walking count of birds, once each in the spring, summer and fall. Compilations from previous surveys and a field form can be made available...it is mostly ducks and shorebirds, plus a few species of sparrows, blackbirds, swallows and raptors, so not daunting. Please, please call me if you would like to volunteer!

"Thank You" to XMission

For the last couple of years, Xmission has hosted the www.bridgerlandaudubon.com web site and donated the services. All they ask is that we post their banner on our home page and re-certify yearly as a non-profit organization. Their generosity extends to many non-profit organizations throughout the state, including Hawkwatch International, Utah Opera and the Utah Symphony.

Xmission also manages the registration for our domain name at a competitive rate and through a recognized registrar, Tucows. XMission can also serve the BAS board as an Internet and technology resource. They have been very willing to provide the help we need. They helped us set up WildAboutUtah.com/wildaboututah.org and point these names both to a www.bridgerlandaudubon.org web site directory. This gives us an archive for audio, text and pictures supporting the weekly UPR/Stokes Nature Center/Bridgerland Audubon Wild About Utah radio spot.

All members of Bridgerland Audubon Society qualify for discounted Internet service through Xmission. This includes officers, board members and our valued members. Simply mention BridgerlandAudubon to receive the discount. Xmission can be contacted online at www.xmission.com or on the phone at 801-539-0852 or toll-free at 1-877-964-7746

"Thank You" to Crumb Brothers and Caffe Ibis

Caffe Ibis and Crumb Brothers have been treating Bridgerland Audubon Society very well for quite some time now. At every general meeting, the tasty morsels and abundant coffee that have been devoured by attendees have been generously donated by the two businesses.

At the Utah Audubon Council Retreat last month, Crumb Brothers provided BOXES of food for both days and, of course, Caffe Ibis gave us "crates of coffee." It was very generous of both of them and all the attendees were really impressed. So, to Crumb Brothers and Caffe Ibis, thank you very much for your continued and generous support of Bridgerland Audubon Society activities.

Bridgerland Audubon contacts

Trustees

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- 2008-2011 Jim Cane, 713-4668; William Masslich, 753-1759;
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Membership in the Bridgerland Audubon Society includes a subscription to *The Stilt*, as well as *Audubon* magazine. The editor of *The Stilt* invites submissions, due on the 15th of each month. Send to birdnerdut@gmail.com.

National Audubon Society Chapter Membership Application

Yes, I'd like to contribute to Audubon and receive the Bridgerland Audubon newsletter, *The Stilt*, and the *National AUDUBON* magazine, as a:

_____ **New** member of the National Audubon Society and Bridgerland Audubon.

My check for \$20 is enclosed (this is a special first-year rate).

Name _____

Address _____

City _____ State _____ ZIP _____

Please make all checks payable to National Audubon Society and send with this card to:

National Audubon Society
Membership Data Center
PO Box 51001
Boulder, CO 80322-1001
W-52 Local Chapter Code: 7XCHA



National Audubon occasionally makes its membership list available to selected organizations. To have your name omitted from this, please check this box.

Note to new National Audubon members: To get on *The Stilt* newsletter mailing list without the usual 8-week delay, contact Susan Durham, 752-5637, sdurham@cc.usu.edu.

Prefer the local newsletter only? Send \$20 (make checks payable to Bridgerland Audubon Society) and this form to: Bridgerland Audubon Society, PO Box 3501, Logan, UT 84323-3501 for a subscription to *The Stilt*.



The *Stilt*

Newsletter of the Bridgerland Audubon Society

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Remember the Date

December 20

BAS's 49th Christmas Bird Count.

Mark your calendars for a full day of winter birding with an evening of potluck dinners and the traditional compilation. You must register for this count; cost is \$5 per person (students are free). Details will be forthcoming in the December Stilt. To register or for more information, contact Bryan Dixon at 752-6830.