Abstract

Building resilience or preventing the converse, vulnerability, is vital in the proper management of social-ecological systems. This is especially true for industries upon which societies rely; such as fisheries, forestry, and livestock production. These systems are often heavily managed to ensure the maximization of one or a small number of outcomes, most commonly those tied to economic profits or production yields. As complex production systems improve their efficiency or net production, they become increasingly vulnerable to perturbations or even system collapse. Pest outbreaks in monocultures, the collapse of fisheries or disease outbreaks are all examples of this ‘pathology of natural resource management’. Resilience management requires the development and application of general principles for tracking changes not only in resilience but also in vulnerability. An important step towards building and managing for resilience is understanding how the system initially became vulnerable.

We explored the emergence of vulnerability in the South African domestic ostrich industry, an animal production system that has experienced several major disease outbreaks. The ostrich production system requires numerous movements of birds between different farm types associated with growth (i.e. hatchery to juvenile rearing farm to adult rearing farm). Using five years of these movement records we produced a movement network of ostriches in the industry, representing farms as nodes, and movements of birds as links between these nodes. We analyzed this network over time using network analysis metrics such network density, component size and centrality of particular farms. We then examined these findings with an analysis of farms during a major outbreak of Highly Pathogenic Avian Influenza (H5N2). Our results indicate that the network was becoming more vulnerable over time as it became more efficient. Additionally, we found those farms that became infected during the outbreak displayed network qualities, such as significantly higher connectivity and centrality, which predisposed them to be more vulnerable to disease outbreak.

Methodologically, our study highlights the utility of network analysis in analyzing large complex, social-ecological networks over time, and how this can be used in observing changes in vulnerability (or resilience) over time. In addition, we were able to highlight some key factors which can be used in diagnosing nodes which are more vulnerable, and thus should be sites of targeted efforts to reduce vulnerability and enhance system resilience. Our study also highlights the importance of considering resilience when managing large systems. These findings go beyond the scope of livestock management by highlighting the importance of decreasing system vulnerability in order to build system resilience.

*Speaker
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