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Stackelberg evolutionary games for managing evolving resources, pests and cancer

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Nature plays games, evolutionary games that is. Organisms evolve strategies to better survive in their environment and to more successfully interact with conspecifics, competitors and predators. For example, one can ask the almost Zen-like question: "Why is there wood?" The answer lies as the solution to an evolutionary arms race for height as woody plants strive for light. Human actions also exert selection forces. Humans can wittingly or unwittingly become part of nature's games. When humans alter the ecologies of other species the wrong question to ask is "Will they evolve?"; rather we should ask "How fast and into what will they evolve?". As humans alter the eco-evolutionary dynamics of other species – valuable and pesky ones alike – the game can and should become a Stackelberg evolutionary game where the manager or decision makers take the lead by anticipating and steering both the ecological and evolutionary dynamics of the managed species. Using the G-functions approach to evolutionary game theories (akin to adaptive dynamics), managing fisheries falls with the realm of Stackelberg evolutionary games. Cancer does as well. The evolution of therapy resistance by cancer cells explains most patient deaths. Novel evolutionary therapies have proven effective in several clinical trials of prostate cancer. In these clinical trials and others, mathematical models are leading the way towards "algorithms as drugs" (sensu Christopher Gregg) with the goal of rendering some currently incurable cancers as containable, and others as curable.