Electronic supplementary material for 'Resource-harvester cycles caused by delayed knowledge of the harvested population state can be dampened by harvester forecasting'

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1 Robustness of results to variation of other parameters

In this section we consider how the two-parameter bifurcation diagram in terms of s and varies when the other model parameters are changed. Figure 1 shows the resulting plots when the cost-per-unit-effort c is varied, 2 the resulting plots when the per-unit price p of the resource is varied, and 3 the resulting plots when the catchability coefficient q is varied. Higher costs of harvesting, lower resource prices and lower catchability of the resource are all beneficial for stability and persistence in the system, both being observed for larger regions of the $s-\tau$ plane (Figs 1B, 2A, 3A). For lower harvesting effort costs, higher resource prices and higher catchabilities, the opposite is true, and the combinations of s and which allow stability and persistence in the system are much more limited (Figs 1A, 2B, 3B). However, in all cases we see that the qualitative results do not change: higher time delay τ in the knowledge of the resource stock level is always destabilising, and intermediate levels of foresight s always promote stability, with too small levels being insufficient to compensate for delay-induced instability, and very high levels of foresight causing destabilisation of the system by overshooting. The main conclusions of the study are therefore robust with respect to variation in the model parameters. One difference in the dynamics can be observed in the transition from extinction to persistence in Fig 1A. In this case, limit cycles do not steadily grow in amplitude until the resource drops below the extinction threshold. Instead there is a range of farsightedness values which show bistability, with system states converging to two states: a large amplitude limit cycle, and either the bioeconomic equilibrium or a small amplitude limit cycle around it. After the bioeconomic equilibrium becomes unstable through a Niemark-Sacker bifurcation, it disappears in a fold bifurcation of limit cycles with the unstable limit cycle that forms the boundary between the two basins of attraction.

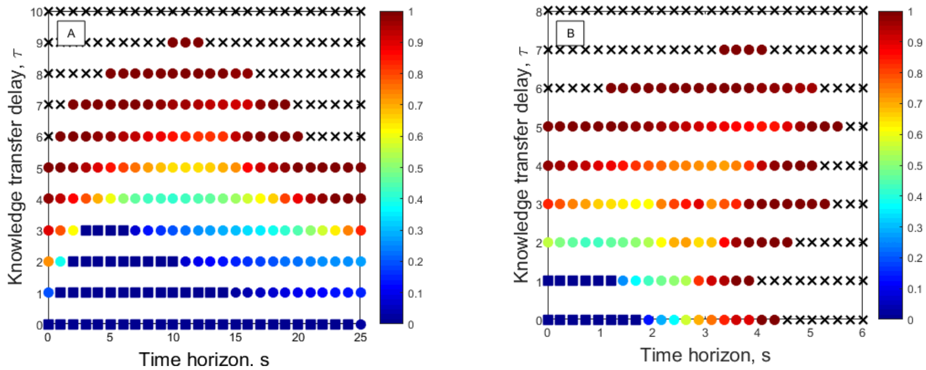

Figure S1: Dependence of equilibrium stability and the amplitude of undamped cycles on the farsightedness s and the delay in knowledge transfer τ for two different costs-per-unit-effort c. (A) Low cost-per-unit-effort, $c = 0.75$. (B) High cost-per-unit-effort, $c = 1.8$. Squares denote a stable equilibrium; circles denote undamped oscillations, with the colour corresponding to the amplitude of the oscillations; black crosses denote exhaustion of the resource. Other parameters take the values $r = 0.1, K = 1, q = 0.01, \eta = 1.05, p = 200$ and $c = 1.5$.

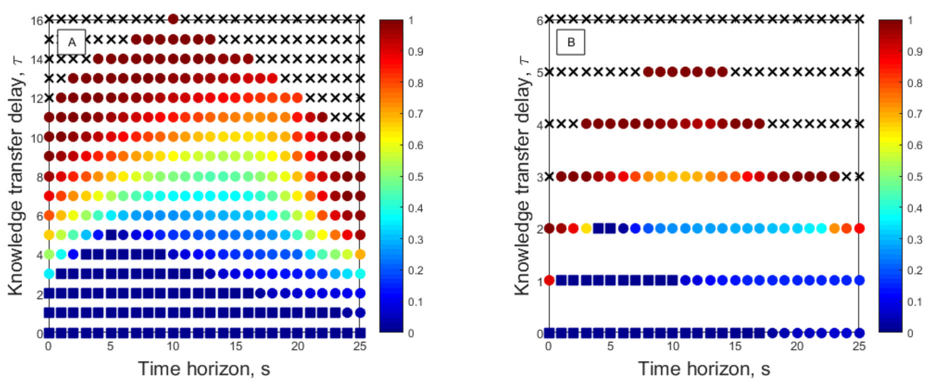

Figure S2: Dependence of equilibrium stability and the amplitude of undamped cycles on the farsightedness s and the delay in knowledge transfer τ for two different per-unit resource prices p. (A) Low resource price, $p = 180$. (B) High resource price, $p = 230$. Squares denote a stable equilibrium; circles denote undamped oscillations, with the colour corresponding to the amplitude of the oscillations; black crosses denote exhaustion of the resource. All other parameters are the same as in Fig 1.

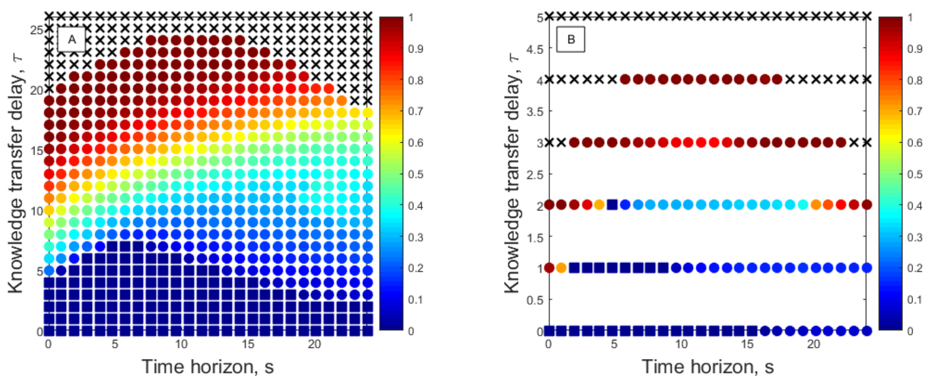

Figure S3: Dependence of equilibrium stability and the amplitude of undamped cycles on the farsightedness s and the delay in knowledge transfer τ for two different catchability coefficients q. (A) Low catchability, $q = 0.0085$. (B) High catchability, $q = 0.012$. Squares denote a stable equilibrium; circles denote undamped oscillations, with the colour corresponding to the amplitude of the oscillations; black crosses denote exhaustion of the resource. All other parameters are the same as in Fig 1.