**TABLE 1** Hypothesized covariates and relationships for the July–September (*S*) and October–March (*N*) landings. The models are structured as response ∼ explanatory variable(s). The tests did not impose a direction (positive or negative) and some covariates have been hypothesized to have both positive and negative impacts on oil sardines. References for the description and justification appear in the main text introduction.

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| **Model** | **Description and justification** |
| DD1: *St* ∼ *Nt-1* | *St* comprises fish aged ≥ 1 year. These fish would have appeared in *Nt*−1as aged 0–2 year age fish. |
| DD2: *St* and *Nt* ∼ *St-1* and *St-2* | *St* comprises predominantly post-spawned spent fish and is correlated with spawning stock abundance and cohort strength. If cohort strength persists over time, *St* and *Nt* should correlate with *St-1* and *St-2*. |
| DD3: *Nt* ∼ *Nt-1* | *Nt*−1comprises fish aged 0 to >2 years, which will appear one year older in the next season in *Nt* landings. |
| S1: *St* ∼Jun–Jul and Apr-Mar oceanic precipitation | The April-May and June–July precipitation over the ocean directly or indirectly prompts spawning, after which spent adults migrate inshore and are exposed to the fishery. |
| S2: *St* and *Nt* ∼Jun–Jul land precipitation | Precipitation over land during the monsoon leads to high nutrient input from river discharge which leads to eutrophication and anoxia in the nearshore areas during the monsoon, while at the same time supporting productivity post-monsoon. |
| S3: *Nt* ∼Apr–Mar precipitation | Spring precipitation is an indicator of climatic conditions during egg development, which aﬀect spawning success and thus the cohort strength in the current and future seasons. |
| S4: *St* ∼Jun–Sep upwelling | High upwelling drives by the offshore advection of phytoplankton biomass and brings hypoxic water to the surface. Both drive mature fish further oﬀshore, reducing fishery exposure. Conversely, moderate upwelling leads to phytoplankton blooms which bring fish closer to the coast and to the fishery. |
| S5: *St* and/or *Nt* ∼Mar–May r-SST | Extreme pre-monsoon heating events drive mature fish from spawning areas, resulting in poor recruitment and fewer 0-year fish in *Nt*. |
| L1: *St* and/or *Nt* ∼Oct–Dec ns-SST | Larval and juvenile growth and survival are aﬀected by temperature and October-November are peak somatic growth months. Thus post-monsoon nearshore SST can affect current and future abundance. |
| L2: *St* and/or *Nt* ∼Jun–Sep UPW | Upwelling drives phytoplankton productivity, which in turn leads to better larval and juvenile growth, and higher future landings, but extreme upwelling leads to hypoxic conditions and phytoplankton biomass advection. |
| L3: *St* and *Nt* ∼ Jul-Sep and Oct-Dec CHL | The surface chlorophyll concentration is a proxy for phytoplankton abundance which supports greater fish abundance and catches in the current and future years. Peak chlorophyll abundance is in July-September but October-December are critical months for juvenile growth and survival. |
| A1: *St* and *Nt* ∼2.5-year average r-SST and 2.5-year average DMI | Spawning, early survival, and recruitment depend on many cascading factors summarized by the average regional SST over the lifespan of an oil sardine. DMI is correlated with regional SST in the SE Asia Sea and is another proxy for the average SST. |
| A2: *St* and *Nt* ∼ONI | The El Niño–Southern Oscillation has impacts on precipitation, SST, frontal zones, wind and upwelling patterns which impact spawning and early survival and current and future abundance. |
| A3: *St* and *Nt* ∼Sep-Nov DMI | Negative DMI values in September–November are associated with anoxic events along the Kerala coast which could move fish offshore (and inaccessible to the fishery) or cause lower juvenile growth and survival. |

*Notes.* Model codes: DD, density dependence–related; S, spawning-months catch–related; L, larval and juvenile growth and survival–related; A, affecting all ages. Environmental covariates: UPW, upwelling; r-SST, regional (0-160km) sea surface temperature; ns-SST, nearshore (0-80km) sea surface temperature; CHL, chlorophyll surface concentration; ONI, Oceanic Niño Index; DMI, Dipole Mode Index.