Supplementary material

Using an acoustic telemetry array to assess fish volumetric space use: a case study on impoundments, hypoxia and an air-breathing species (*Neoceratodus forsteri*)

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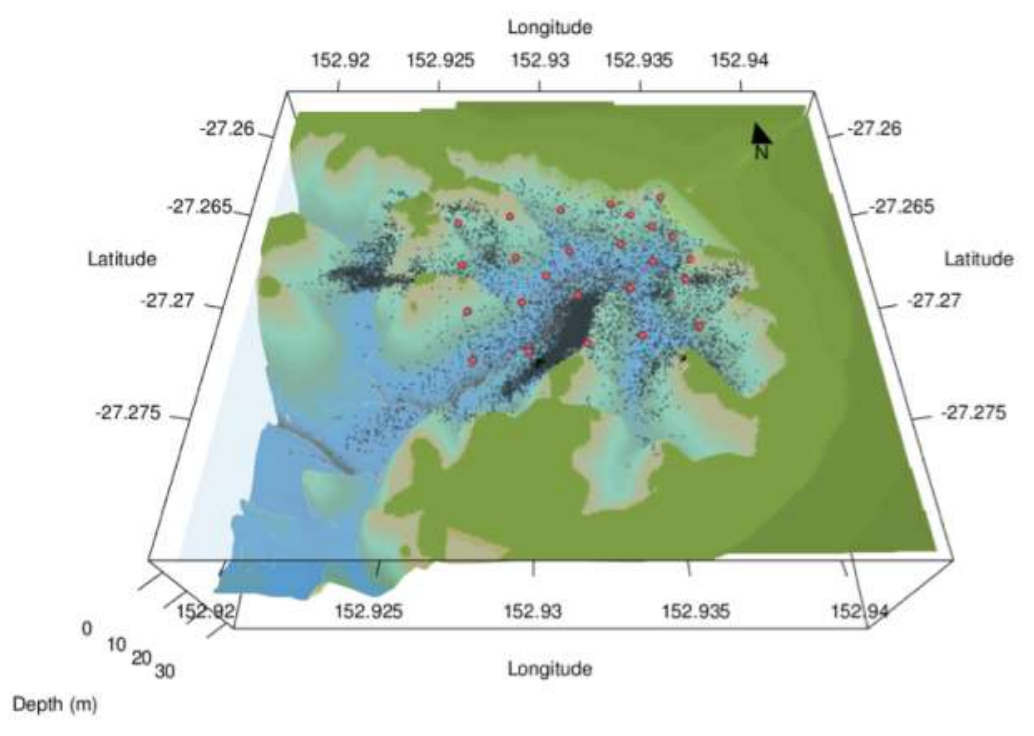

Fig. S1. Bathymetry of Lake Samsonvale displayed in three dimensions showing locations of acoustic receivers (red symbols) and individual positional fixes of tagged *N. forsteri* (black symbols), as determined by VPS detections. An interactive 3-D model of this figure can be accessed at http://bit.ly/2fzDD1 L (accessed 2 January 2017).
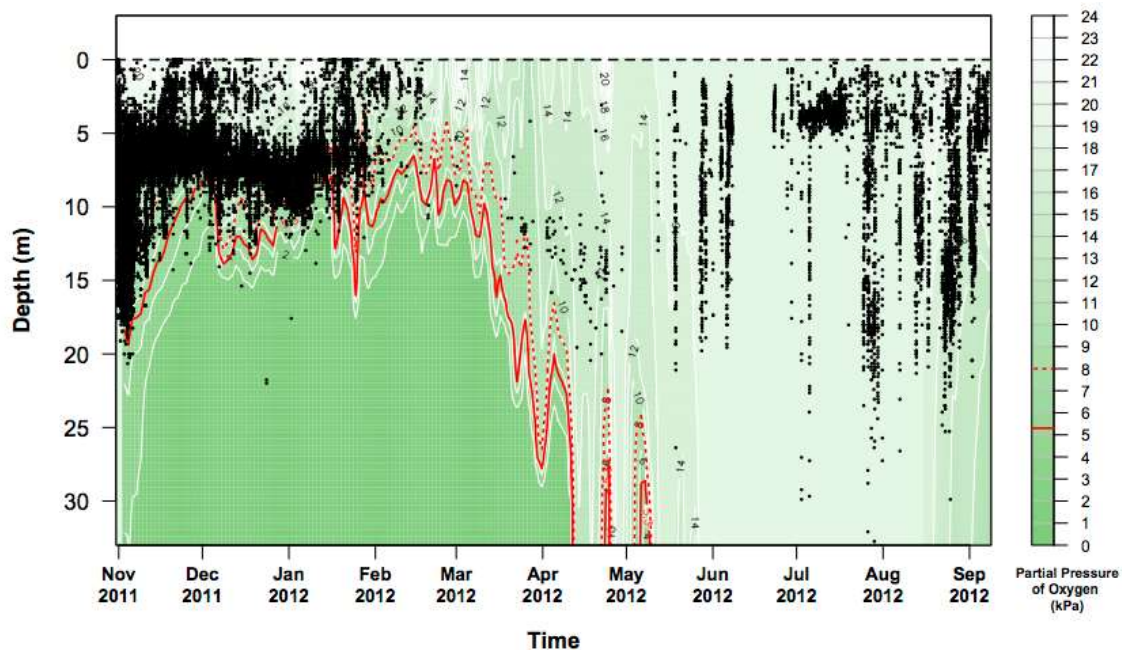
Fig. S2. Depth selection by tagged lungfish throughout the year, in relation to partial pressure of oxygen (PO$_2$) under normoxic (broken red contour), moderately hypoxic (solid red contour) and severely hypoxic water (below solid red contour) in Lake Samsonvale. PO$_2$ limits for normoxic and hypoxic conditions are based on experimental limits for *N. forsteri* as defined by Kind *et al.* (2002).
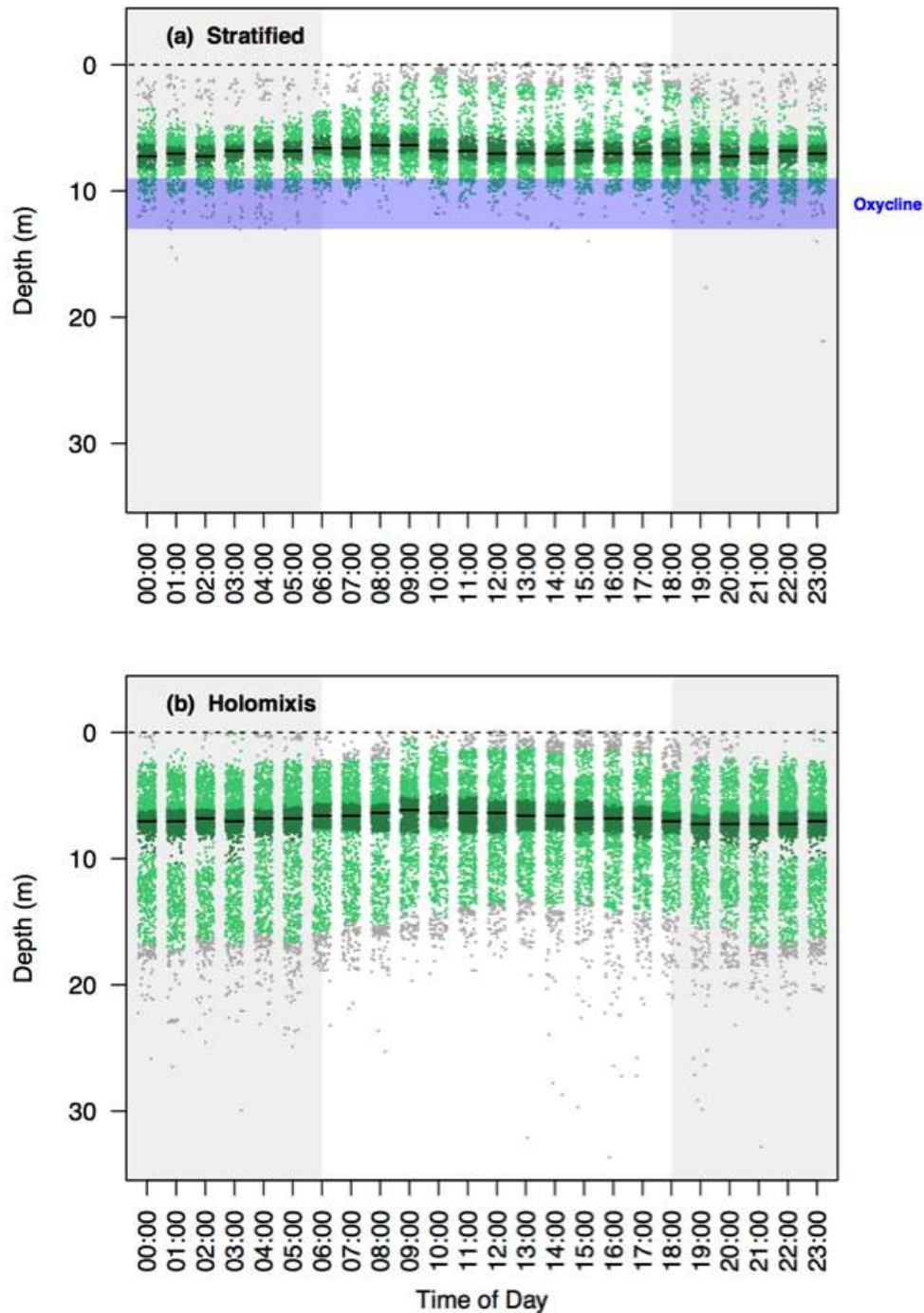
Fig. S3. Diel fish depth detections of *Neoceratodus forsteri* within the VPS detection area of Lake Samsonvale in relation to (*a*) periods with an oxycline present (blue shaded zone) and (*b*) in the absence of an oxycline, over the entire study period, grouped into 1-h bins, throughout the 24-h cycle. The black bars in each hourly bin is the centre point of the 3-D Kernel Utilisation Distribution (3-D-KUD), dark green circles are detections within the 50% 3-D-KUD, light green circles detections within the 95% 3-D-KUD, grey circles are detections outside the 3-D-KUD areas.
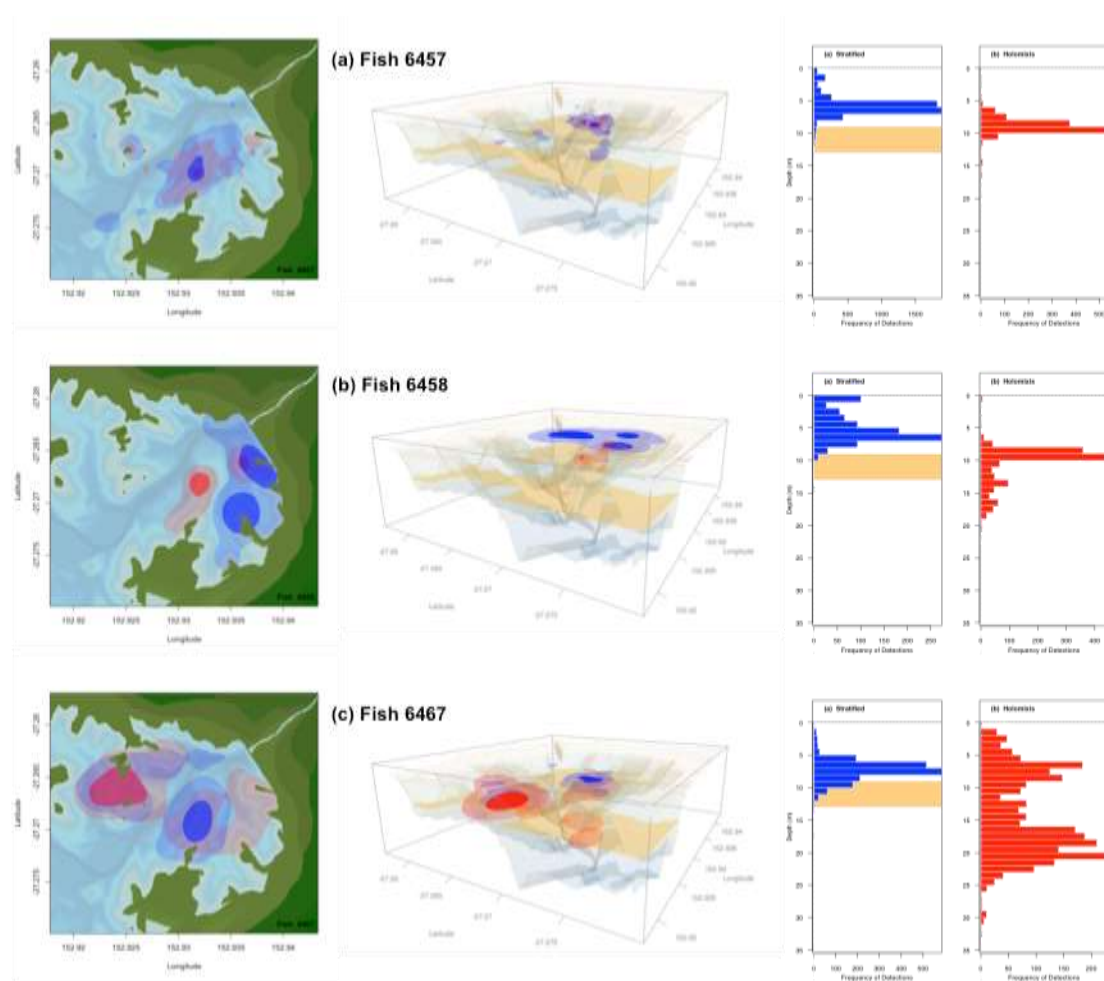
Fig. S4. Activity space metrics measured in 13 tagged lungfish during periods of lake stratification (blue) and holomixis (red). The activity space was measured using traditional 2-D kernel utilisation distribution (KUD) analyses (left panels), as well as using 3-D KUDs (centre panels). Darker shaded areas represent core activity space (50% KUD contour) and lighter shaded areas represent the extent of activity space (95% KUD contour). Orange plane on 3-D plots and bar plots represent the average depth of the oxycline during periods of lake stratification. Bar plots (right panels) show the depth distribution of detections for each individual during periods of stratification (blue bars) and holomixis (red bars). Panels (*a–i*) represent the nine fish used in the LMM analyses. Panels (*j–m*) represent the four fish that were excluded from the LMM analyses due to the limited number of days the fish were detected during the period of lake stratification (<21% of total days detected). Interactive 3-D activity space models for all fish tagged in this study can be accessed at http://bit.ly/2_gw81_go (accessed 2 January 2017).
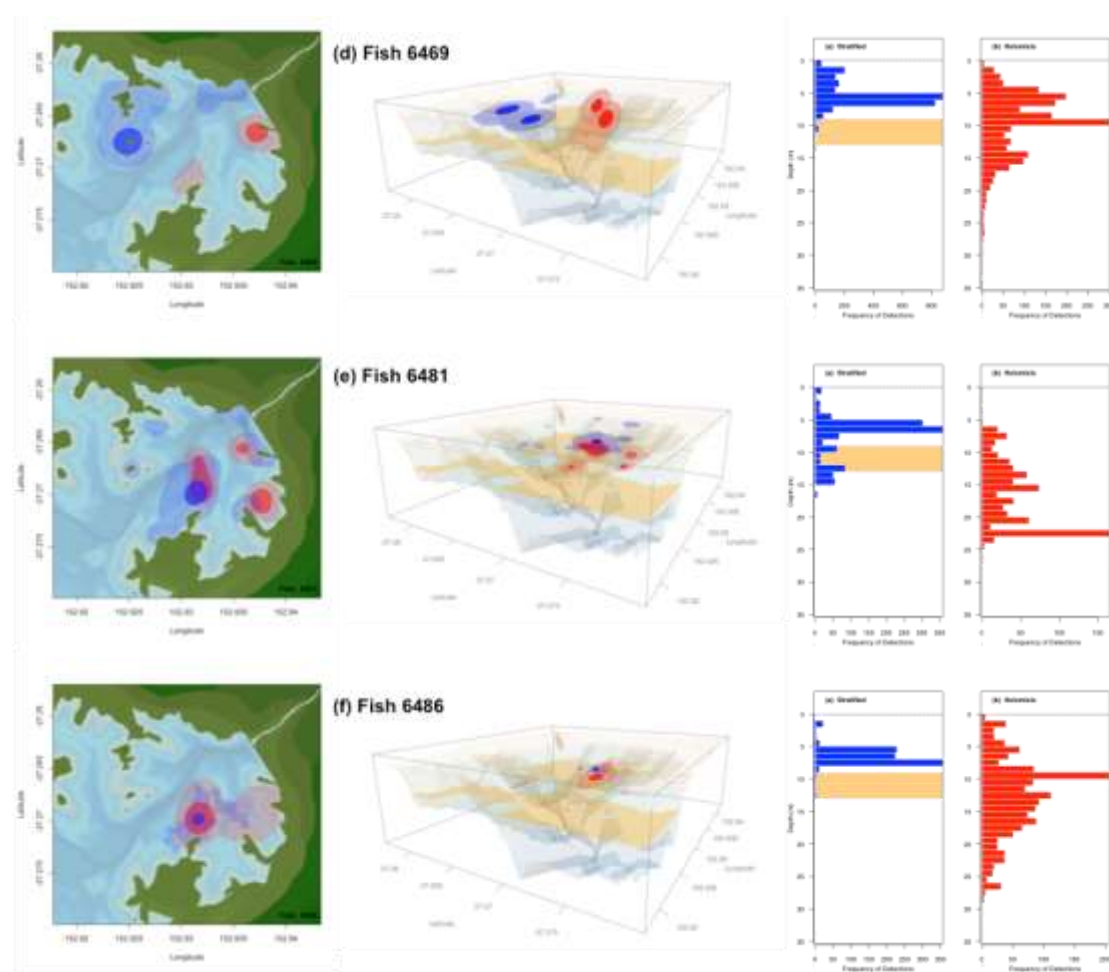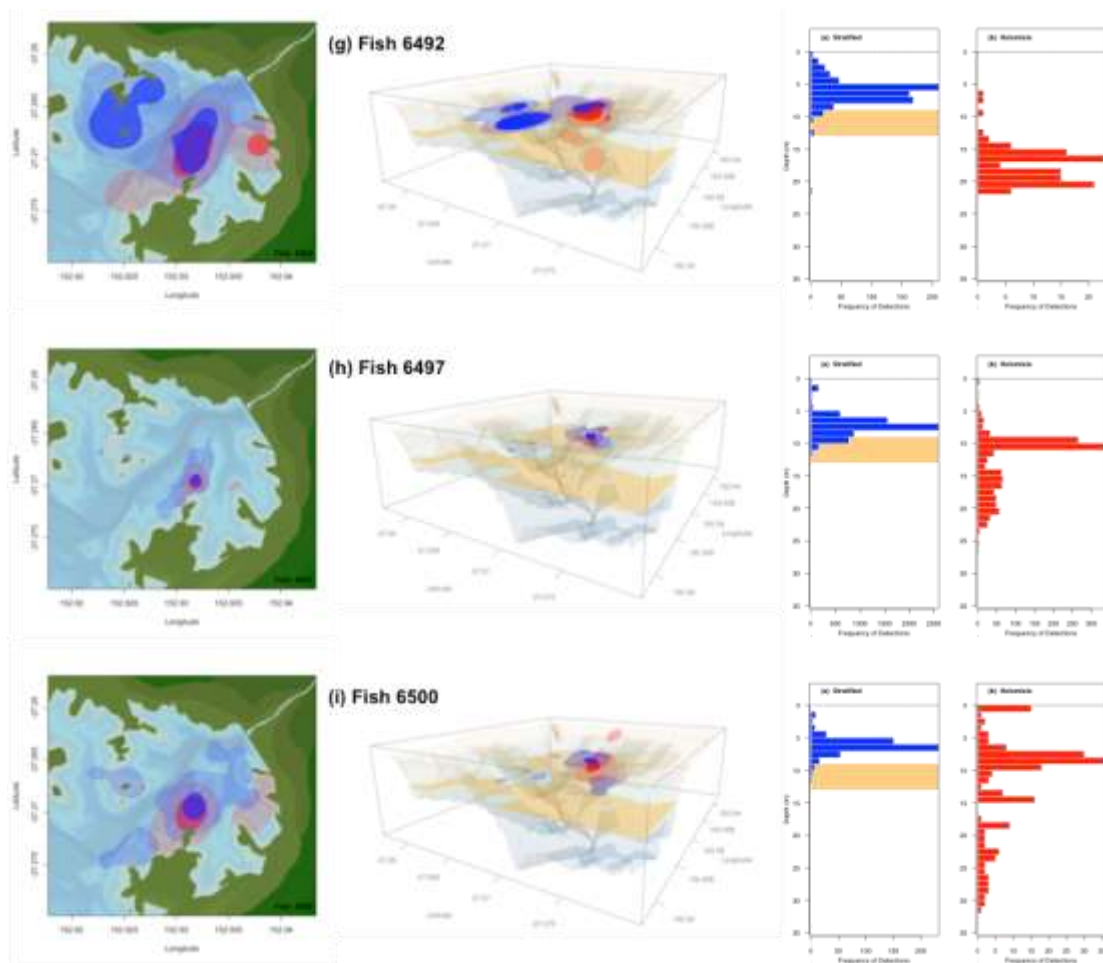
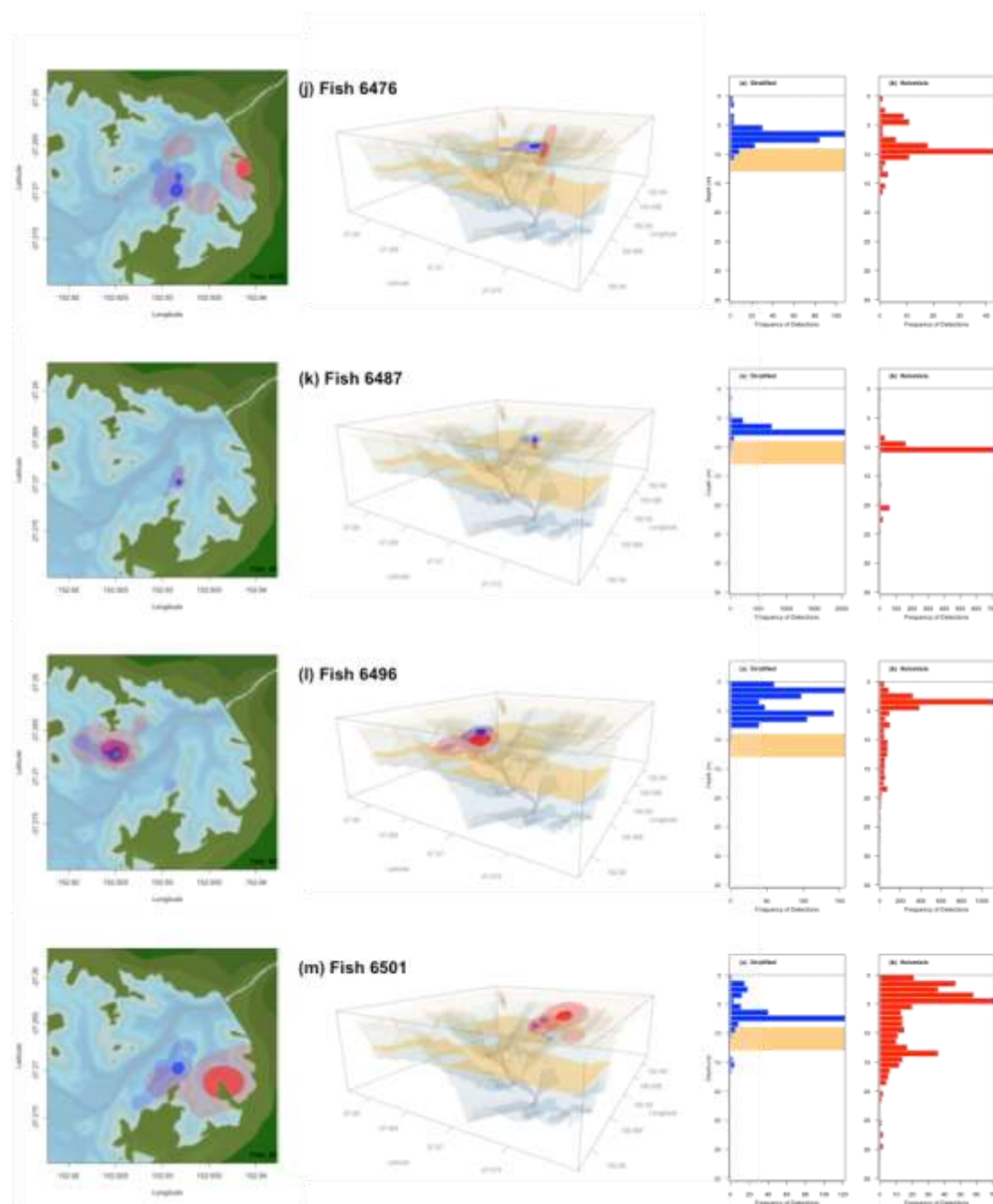**Fig. S4.** (*Cont*.)

Fig. S4.   (*Cont*.)

Fig. S4. (*Cont*.)

Reference

Kind, P. K., Grigg, G. C., and Booth, D. T. (2002). Physiological responses to prolonged aquatic hypoxia in the Queensland lungfish *Neoceratodus forsteri*. *Respiratory Physiology & Neurobiology* **132**, 179–190. doi:10.1016/S1569-9048(02)00113-1