

Fish species richness and community composition across peat swamp landscapes in Southeast Asia

A report on preliminary results

Xingli Giam (Ecology and Evolutionary Biology, Princeton University)

Summary of methods

Fieldwork was conducted in Brunei Darussalam from 12-24 August 2012. Prior to the start of field work, two patches of intact peat swamp forests were identified with the help of Dr. Jonathan Davies of Wetlands International and Dr. Rahayu Sukmaria of University Brunei Darussalam. The first patch can be categorised as having phasic vegetation community 1 (sensu Anderson 1961; Yamada 1997), hereafter referred to as a stage 1 PSF in this report. Stage 1 PSFs occur at the edges of a peat dome and the forest crown resembles that of the lowland dipterocarp forest. It has also more species of plants compared to the other stages. The second patch can be categorized as having phasic vegetation community 2 and 3, hereafter referred to as a stage 2-3 PSF. It is dominated by tall *Shorea albida* trees reaching a maximum height of ca. 60 m.

In the Stage 1 PSF, we sampled three 30 m reaches of the single stream that cuts through the patch of forest. Each sampling reach was > 400 m apart to maximise independence of samples. In the Stage 2-3 PSF, streams are typically absent, and we sampled three pools of water, each >400 m apart. We caught fish using a tray net with 2mm mesh that is custom built for catching small fish characteristic of the blackwaters of Southeast Asian PSFs. We visited each site twice in order to obtain a more comprehensive sample of the fish community. Fish were subsampled and a piece of dorsal tissue was removed from a maximum of three individuals per species per site for stable isotope analysis.

We also took measurements of the physical environment, namely % canopy cover, width and depth of stream or pool. Physicochemical parameters of stream or pool water were also measured. We took measurements of pH, water temperature, concentration of dissolved oxygen. Stream and pool water samples were also filtered through a syringe filter fitted with 0.7 μm glass-fibre filters (GF/F; Whatman®, Maidstone, UK) and sent for stable isotope analysis.

Summary of results

- 1. Both total and mean fish species richness are higher in Stage 1 PSF compared to Stage 2-3 PSF.** In total, eight species of fish were present in the Stage 1 PSF and five species of fish were present in the Stage 2-3 PSF. The number of species of fish

collected per site was also higher in Stage 1 PSF compared to Stage 2-3 PSF (two sample t -test, $t_2 = -4$, $P = 0.057$) (Figure 1).

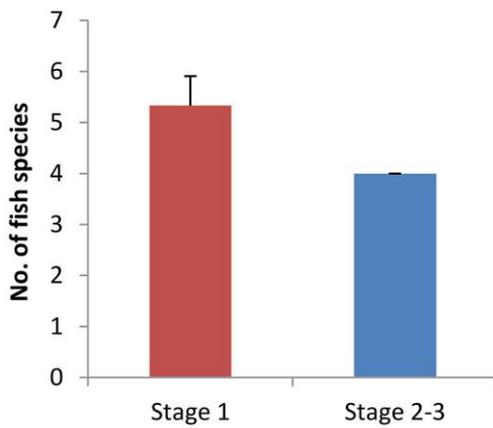


Figure 1. Mean number of species in Stage 1 ($n=3$) and Stage 2-3 ($n=3$) sites. Error bars denote the standard deviation.

2. **% Canopy cover, pH, and dissolved oxygen concentration (DO) correlates with species richness (log-transformed).** Species richness is strongly positively correlated with % canopy cover, and moderately negatively correlated with pH, and positively correlated with DO (Figure 2).

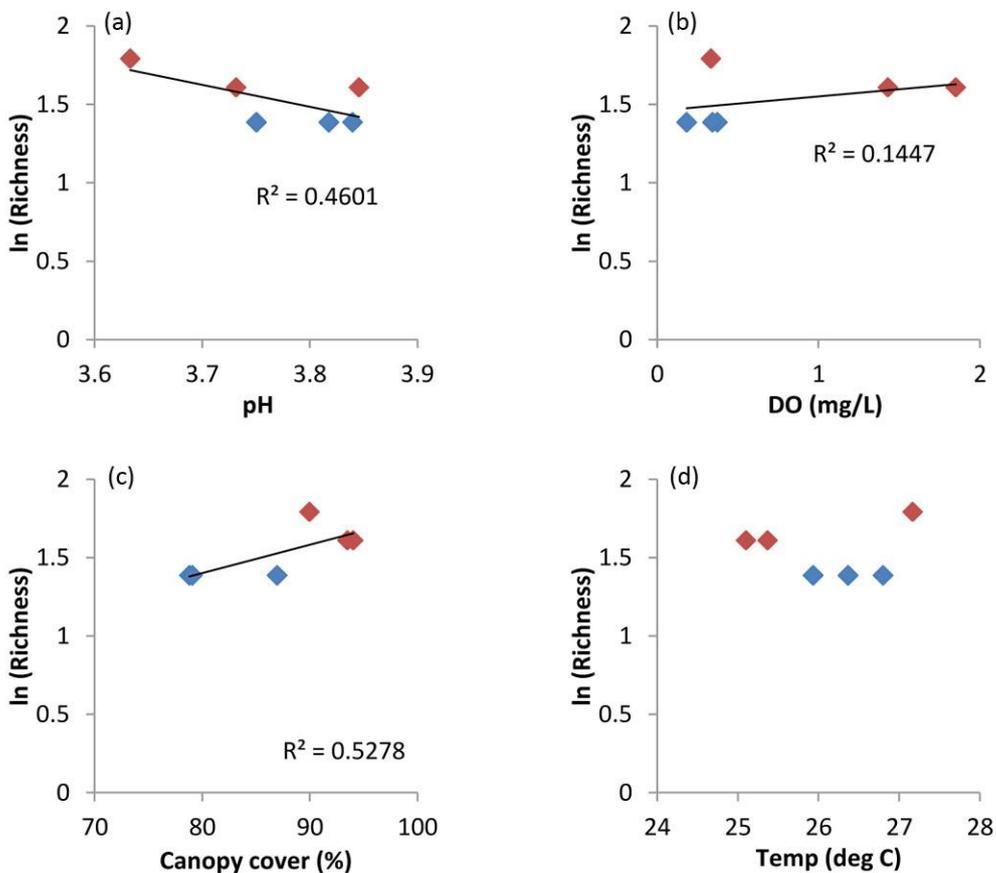


Figure 2. Correlations of log-transformed species richness with (a) pH, (b) dissolved oxygen concentration, (c) canopy cover (%), and (d) water temperature. Least-squares regression lines are drawn when effect sizes are moderate ($R^2 > 0.09$) or large ($R^2 > 0.25$). Red points are Stage 1 sites and blue points are Stage 2-3 sites.

3. **Stage 1 and Stage 2-3 PSF sites have distinct fish communities.** Using non-metric multidimensional scaling (NMDS), the fish communities in each site are summarized into 2 dimensions. In figure 1, the distance between sites (red and blue coloured points) reflect how closely related are the fish communities. In the figure, the red coloured dots are clustered and separated from the blue dots. This suggests that fish communities in Stage 1 and Stage 2-3 sites are distinct. The four character code denotes different fish species. From the figure, species represented by the codes RAKO, SYPE, and CHST are associated more strongly with Stage 2-3 sites while LUPU, HEKU, BEAK, CLNI, and OMJA are associated more strongly with Stage 1 sites.

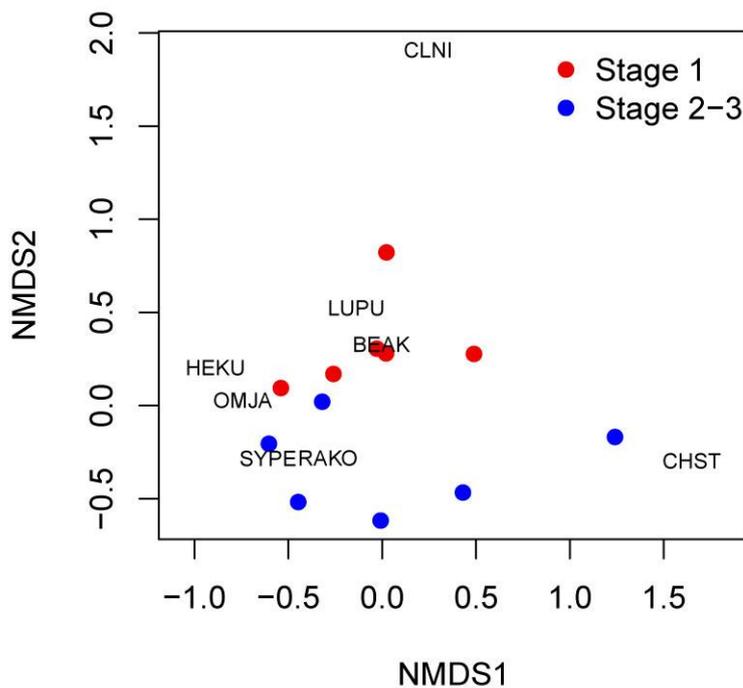


Figure 3. MNDS biplot of sites (points) and species (4 letter codes).

Continuing work and conclusion

I will be returning to Brunei Darussalam in April to August 2013 to complete sampling in the logged Stage 2-3 site as well as the logged/cleared Stage 1 site. When that is completed, we will have a better understanding of how logging and clearing PSFs affect fish communities. The preliminary results presented here shows that fish communities in Stage 1 and Stage 2-3 sites are quite different, therefore PSFs of different phasic communities or stages must be

conserved in tandem so as to preserve the full assemblage of species. Some of the fish and water samples have also been sent for stable isotope analyses and sampled fish are currently stored at the National University of Singapore. When the stable isotope analyses and gut analyses are completed, we will have a clearer idea of our the feeding ecology and trophic structure of fish communities differ in different PSF stages and whether they are impacted by logging or forest clearing. Various photos from our work in the field site are attached at the end of the report.

Note: I hope you can keep this report in confidence because it contains data and analyses that has not been published.

References

Anderson, J.A.R. 1961. The ecology and forest types of the peat swamp forests of Sarawak and Brunei in relation to their silviculture. Ph.D. Thesis, University of Edinburgh.

Yamada, I. 1997. Tropical Rain Forests of Southeast Asia. Monographs of the Center for Southeast Asian Studies, Kyoto University, English-Language Series, No. 20. University of Hawai'i Press, Honolulu.

Plate 1. Processing fish samples from a pool site in Stage 2-3 PSF.



Plate 2. Due to the waterlogged ground and huge buttresses, even a trek of a few hundred meters took about an hour.



Plate 3. Sampling fish from another pool site in Stage 2-3 peat swamp forest. This pool is formed when a large *Shorea albida* tree fell and produced a depression in the peat. Tree falls are common in PSFs owing to the soft and waterlogged peat substrate.



Plate 4. Processing fish samples in the field. Fish caught had to be euthanised using a chemical agent (MS222) approved by the university ethics board. We identified and took measurements of the fish. We also dissected a small piece of tissue and preserved it in table salt as there were no electricity to operate a dessicator at the site.



Plate 5. Night starts to fall over our campsite. As the Stage 2-3 site is on a remote peat dome that can only be reached by a small boat, we had to camp out for a week. However, the soft and waterlogged peat substrate meant that it was not possible to pitch a tent at ground level. Together with very skilled local forestry officials, we managed to build an elevated frame from which we could hang our “beds”.



Plate 6. A Stage 1 site (stream). Streams are only found at the periphery of a peat dome where mixed swamp forests are found. There were no streams in the Stage 2-3 peat swamp forest. Water in peat swamp forests are tea-coloured (and very acidic; pH: 3-4) due to the tannins and humic acids. This is also the reason why they are called blackwaters.

