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BIOMASS RECOVERY IN SECONDARY MIXED PEAT SWAMP FOREST, COASTAL RIAU, INDONESIA

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SUMMARY

APRIL group operates a half million ha of fiber plantation and restoration licenses on peatland in coastal Riau. Half of this area is mixed peat swamp forest (MPSF) that has permanently been set aside from development. Prior to becoming APRIL's, in an unregulated setting that then prevailed, the MPSF underwent uncontrolled local logging. Stands that have been monitored since 2004 indicate that secondary forest is now recovering structure and biomass. On heaviest disturbed sites *Meranti spp*. have become the commonest trees. Biodiversity is a future goal, for now secondary forest is showing resilience and protected area management is working to secure what remains. Production on 50% of the land, to finance and create a physical barrier around the set-aside 50%, is proving the way to maintain services of nature from a heavily modified landscape.

***Keywords**: secondary tropical peat swamp forest, basal area, biomass, biological recovery, Meranti trees, services of nature*

INTRODUCTION

The Kampar natural landscape consists of a central core of pole forest located on a raised plateau, surrounded at lower elevation by mixed peat swamp forest (MPSF). The two types of peat swamp forest occupy similar proportions of the Kampar. Most pole forest is pristine. All MPSF forest, however, experienced licensed selective logging from about 1980; a portion of the large merchantable trees were taken out by light rail. The impacts of this original logging are no longer obvious. From 2000 the MPSF was cut again, severely, by informal loggers. Logs were floated out to the nearest rivers along excavated ditches, of dimensions approximately 2 m deep by 2 m wide. Abandoned ditches continued to drain water from the area until APRIL took up ditch blocking in 2010 (Bathgate and Rachmady, 2012). While logging has greatly reduced structure and biomass of MPSF, vegetation re-growth has been luxuriant and forest fires very few under a rainfall that averages 200 mm per month and exceeds 100 mm for all except for 3 months in most years.

Today, within the Kampar landscape, APRIL manages more than 150,000 ha of lowland MPSF as well as 100,000 ha of the peat dome pole forests. Development has now ceased and nearly half of the Kampar landscape is formally protected, including large areas of heavily modified MPSF. The aim is to protect and restore the landscape to provide services of nature: catchment and riparian function, carbon storage, biodiversity and wildlife refuge. In this paper a small sample of logged MPSF that was originally measured in 2004 is examined with a view to whether the now protected MPSF is recovering biomass.

METHODS

An initial forest inventory took place in 2004 at a time when the informal logging in the study area had largely ceased. 30 bounded plots of 100 m x 20 m dimension were established within disturbed MPSF. Trees were tallied by species in diameter classes of 20-40-60- 20-40, 40-60, 60+ cm diameter at breast height (DBH). In 2016 the 15 plots that remained within forest that had been set aside from development were upgraded to Permanent Sample Plot (PSP). Stems >10 cm DBH were tagged, re-measured for DBH, and samples of tree heights taken. Six sites that received heavier logging than most are reported in this study. Due to limitations with botanic identification, local tree names are used here. One abandoned logging ditch was topographically leveled to indicate the amount of soil subsidence that has occurred. The location of the study area, including PSP and the leveling profile, are shown in Figure 1.

RESULTS

The MPSF plots all occur at about 6 m elevation (above mean sea level) and prior to being logged would likely have had similar biomass to one another. PSP have been allocated to two relative categories, ‗disturbed' and ‗intact' canopy. These types are compared for the change in density and basal area (BA) of stems >20 cm DBH; smaller stems were not recorded in 2004 (Figure 2). Detailed inventory of 2016 enables the current size structures between forest types to be compared (Figure 3).

Trees >20 cm in the intact type have increased over the observation period by 25% in number and 30% in BA. Most trees tallied in 2004 have survived, increased in girth and contributed to an unmistakable increase in basal area. Canopy gaps are relatively small and are closing over; biomass recovery is underway.

However in the disturbed type, 25% of 40-60 cm trees and all >60 cm trees of 2004 have since died (Figure 2), and many are now on the forest floor. This phase of high mortality, which may or may not have passed, is a lingering ‗edge effect' impact from canopy opening by logging. While stand basal area has not increased since 2004, 10-20 cm stems are numerous and contribute to BA (Figure 3). Now, over a decade after the logging, large numbers of small stems are replacing original canopy trees. It is unclear how long it will be before stand biomass accelerates/reaches the levels observed in the intact forest.

Forest composition, in terms of common trees per forest type, is summarized in Figure 5. Gaps in both forest types have developed into a dense secondary canopy of 10-20 m tall pandanus. Pandanus has a growth form that includes adventitious and prop roots, dense spreading canopy and heavy litter formation, and tolerance of flooding (Gunawan *et al.*, 2012). Pandanus can rapidly fill canopy gaps in heavily modified forest. Meranti and other species that would have been present pre-logging as suppressed small stems are now common as poles emerging through the pandanus. Meranti tree species are reported to have relatively fast DBH growth in lowland forest (Bin Kassim). Both Meranti and pandanus tree species are examples of dynamic pioneer populations. In the smaller gaps of the less disturbed forest the small trees are less numerous and of more varied composition than in the heavily disturbed type.

The relationship between tree height and DBH for a sample of canopy and emergent trees from both forest types is shown in Figure 4. The intact forest includes both taller and larger diameter trees and several trees of approximately 35 m tall that are emergent over the canopy. Disturbed forest includes no large emergent trees: these have all been extracted by logging operations or subsequently died.

Figure 6 shows a leveled profile of ground elevation oriented across a log extraction ditch that was abandoned in 2004. Intensified drainage of ground water into the ditch appears to have formed a subsidence valley that is approximately 0.5 m deeper than the surrounding land surface, and extends to about 400 m in each direction from the ditch. During site visits, the soil water depth beside the ditch averaged -42 cm (Sep 2004), -98 cm (Oct 2011) and -70 cm (February 2016). At other plots distant from ditches, ground water depths from -40 cm to +10 cm (flooded) were noted. There are insufficient data to show the effect of ditch drainage on forest condition; however the disturbed type close to ditches does include several fastest growing PSP. Proposed blocking of ditches in all State conservation forest (Hendroyomo 2014 may have some benefit for soil moisture, but the deeper the subsidence valley the more limited the area of peat that is likely to be rewetted.

CONCLUDING REMARKS

Biomass recovery is an established trend in the semi-intact secondary MPSF. Where disturbance has been severe, numbers of small trees have increased and biomass recovery is now expected to follow. High turnover and fast growth of trees in disturbed gaps has been reported for tropical forest (Condit *et al* 1999). Disturbance and slight drainage apparently suit Meranti, which when mature tend to occupy well drained mounds in the undisturbed peat swamps (Shimamura *et al 2005*. It has become the commonest tree of secondary forest. Since monitoring started in 2004, APRIL and stakeholders have succeeded to halt the informal logging. Nearly half of the Kampar landscape is now formally protected and most is being effectively protected on the ground. The evidence from monitoring is that the secondary MPSF is now on the way to recovering structure and biomass. Potentially, APRIL's extensive holdings of secondary MPSF are set to capture considerable carbon through biomass growth in the decades to come.

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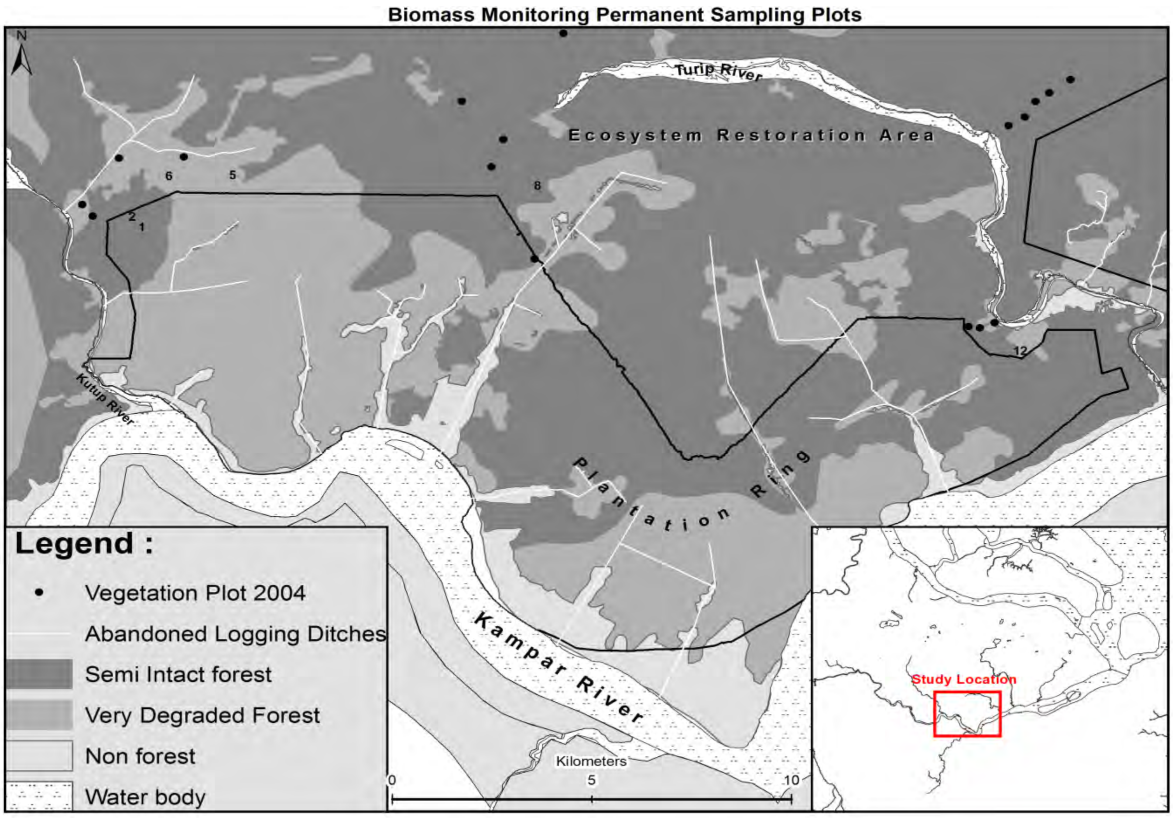

Figure 1: Location of study area

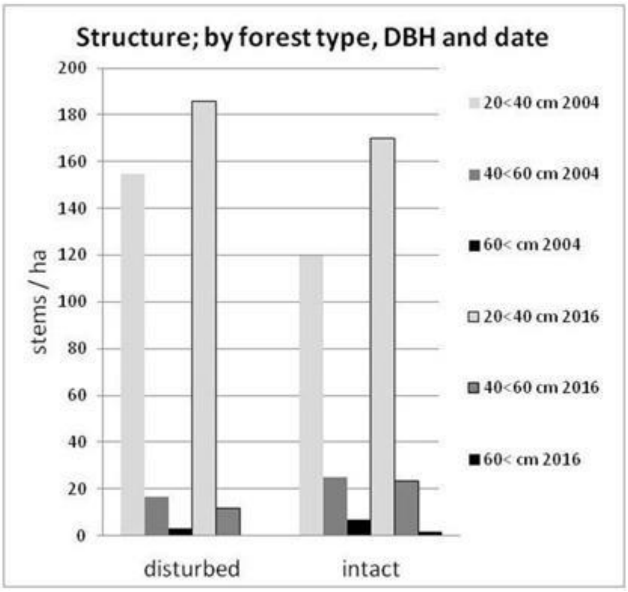

Figure 2: Change in forest structure 2004-2016

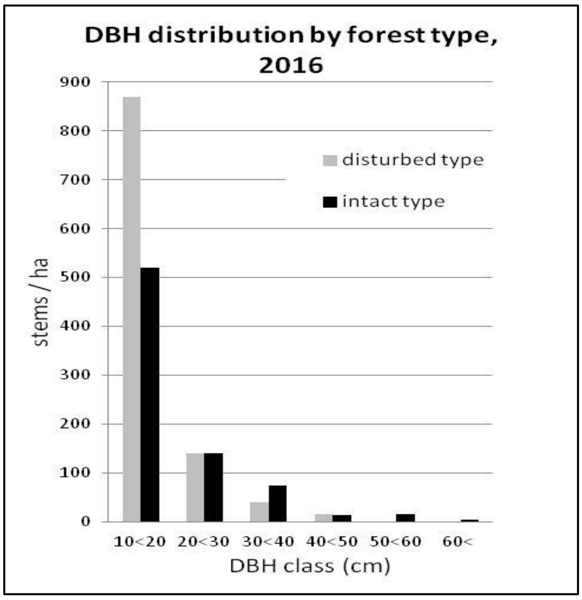

Figure 3: Stem size distribution in 20016

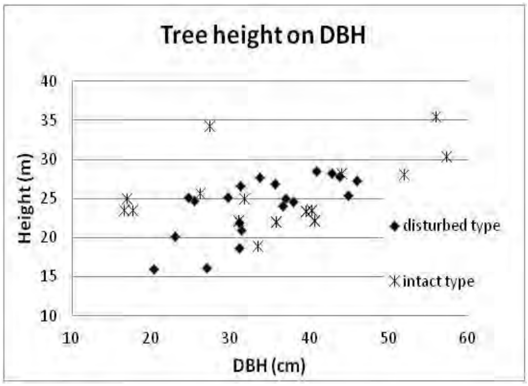

Figure 4: Tree height related to diameter breast height

Common trees in each type, by dbh class - 2016							distance
forest type	10<20	20<30	30<40	40<50	50<60	60< cm	to drain
disturbed	pandan meranti mixed	meranti kelat mixed	gerunggan mixed	mixed	-	-	<100 m
intact	pandan medang balam	medang balam pandan	medung balam kelat	kelat	kelat	mixed	> 1000 m

Figure 5: Table of common trees

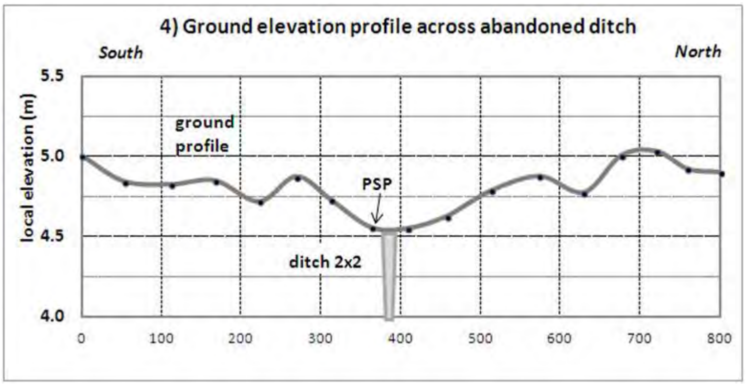

Figure 6: Ground elevation cross profile, Permanent Sample