Toward the development of a commercial system to effectively harvest small-diameter woody biomass for energy production, habitat management and wildfire risk reduction

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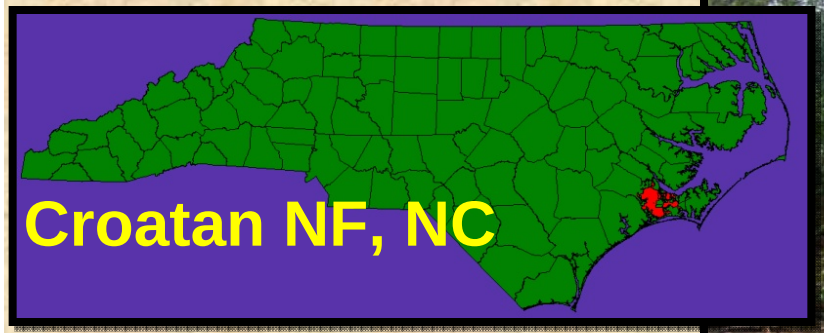
The AHWI H600 BioHarvester or FECON “Kraken”

Biomass Harvesting System Specifications

FECON 440 TRACTOR & AHWI H660 HEAD SPECIFICATIONS					
Track Pads	24" / 600 mm	36" / 900 mm	Ground Pressure ★	7.7 psi	5.5 psi
Weight Tractor Only	44,100 lbs.	47,500 lbs.	Ground Clearance	21"	21"
Weight with Head	54,100 lbs.	57,500 lbs.	Travel Speed (Lo/Hi)	2.6 / 3.8 mph	2.6 / 3.8 mph
Length Tractor Only	17' 1"	17' 1"	Travel Speed as Acres (Lo/Hi)	1.5 / 2.3 ac/hr	1.5 / 2.3 ac/hr
Length with Head	23' 2"	23' 2"	Track Gauge	78"	90"
Height	10' 9"	10' 9"	Power	440 hp @ 2100 rpm	440 hp @ 2100 rpm
Width Tractor	8' 6"	10' 5"	Cylinders	Inline 6	Inline 6
Width with Head	9'	9'	Fuel Tank	175 gal	175 gal
Rotor Cutting Width ★	5'	5'	Fuel Consumption	13.5 gph	?
Rotor Speed	1000 rpm	1000 rpm	PTO	2350 ft-lbs 1320 rpm max	2350 ft-lbs 1320 rpm max
Rotor Diameter	24"	24"			

Wetland Work Needs Low PSI

Pocosin Wildfire Risk Reduction in WUI



Flatwoods Wildfire Risk Reduction in WUI and Endangered Species Habitat; Croatan NF, NC

Kraken applications across the U.S. and globally

Biomass Market: Craven County Wood Energy, New Bern NC

- Craven County Wood Energy 45 mega watt plant (~ 30,000 homes) operating in New Bern, NC since 1991.
- Plant is ~ 10 miles from study sites
- Plant operations meet all Title V EPA Air Quality Permit and NPDES Water Pollution Permit requirements.

Use ~500,000 tons/yr

3 Main Factors Affecting Daily Net Operating Revenue

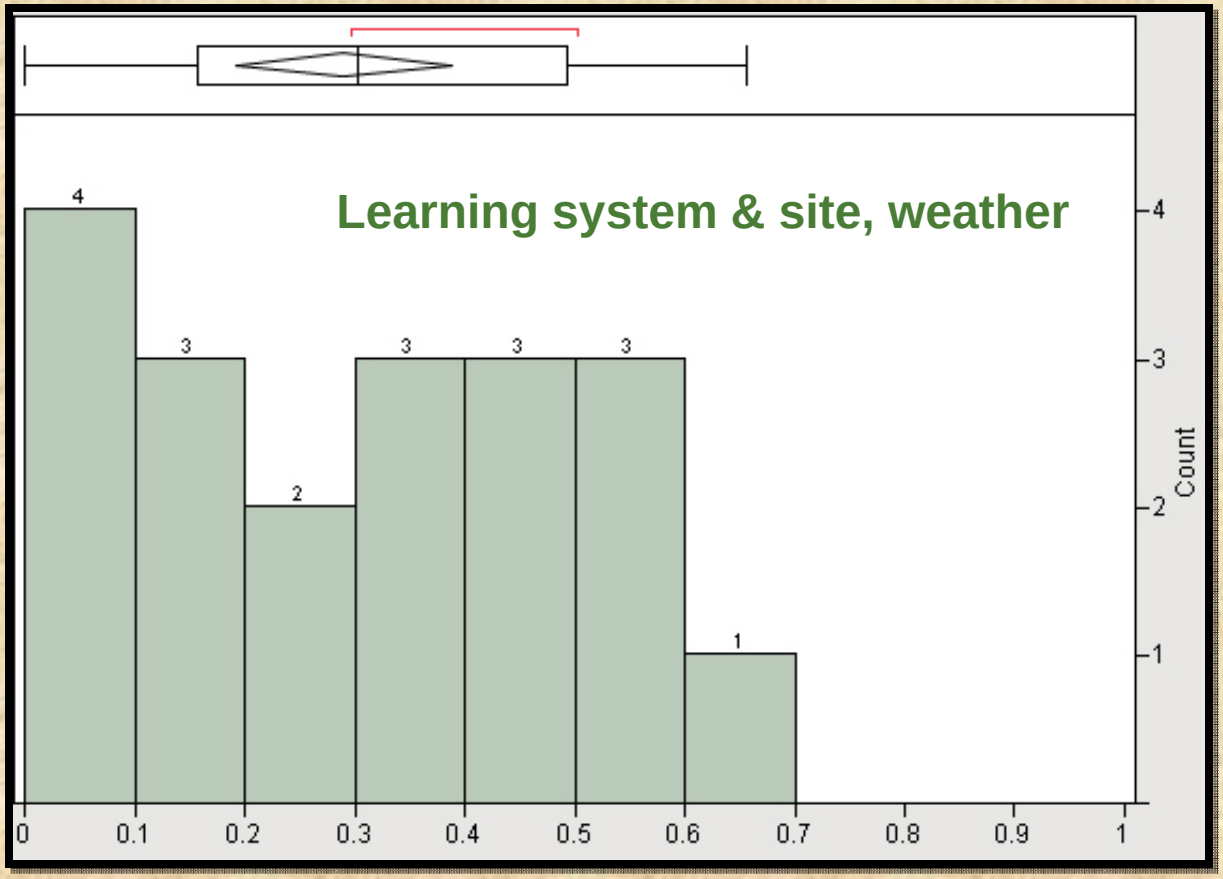
1) Utilization Rate – the amount of time the machine is actually bio-harvesting out of total scheduled work time as percentage

2) Tons per Acre – the amount of tons of biomass collected per acre of ground covered/treated. This depends on the success of the collection system and habitat structure.

3) Acres per Hour – the number of acres treated per hour of harvesting. This is primarily dependent on site type and habitat structure.

Pocosin wildfire risk reduction…

1) Utilization Rate – the amount of time the machine is actually bio-harvesting out of total scheduled work time as %

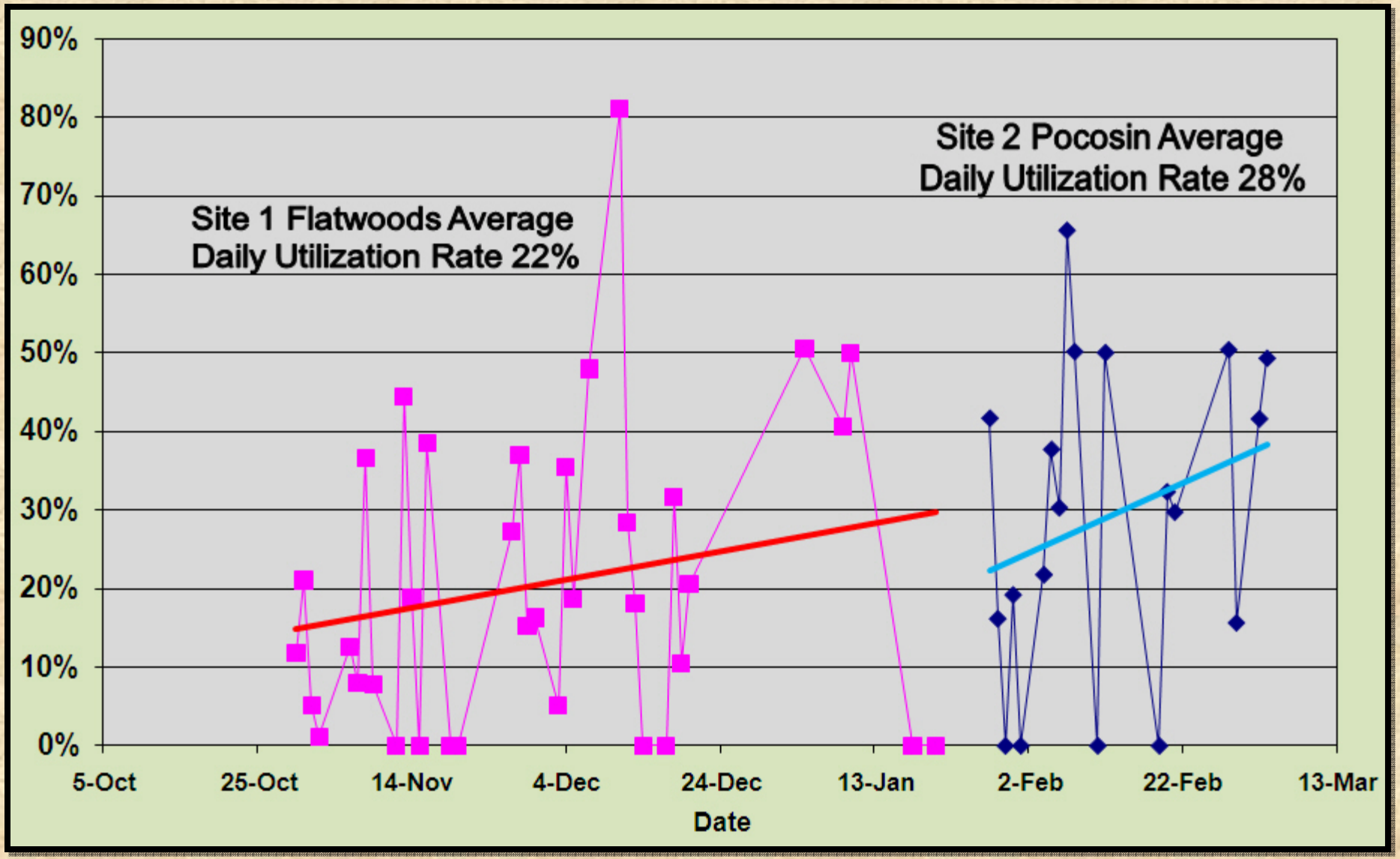


Pocosin Site:

Minimum = 0%
Mean = 29%
Median = 30%
Max = 66%

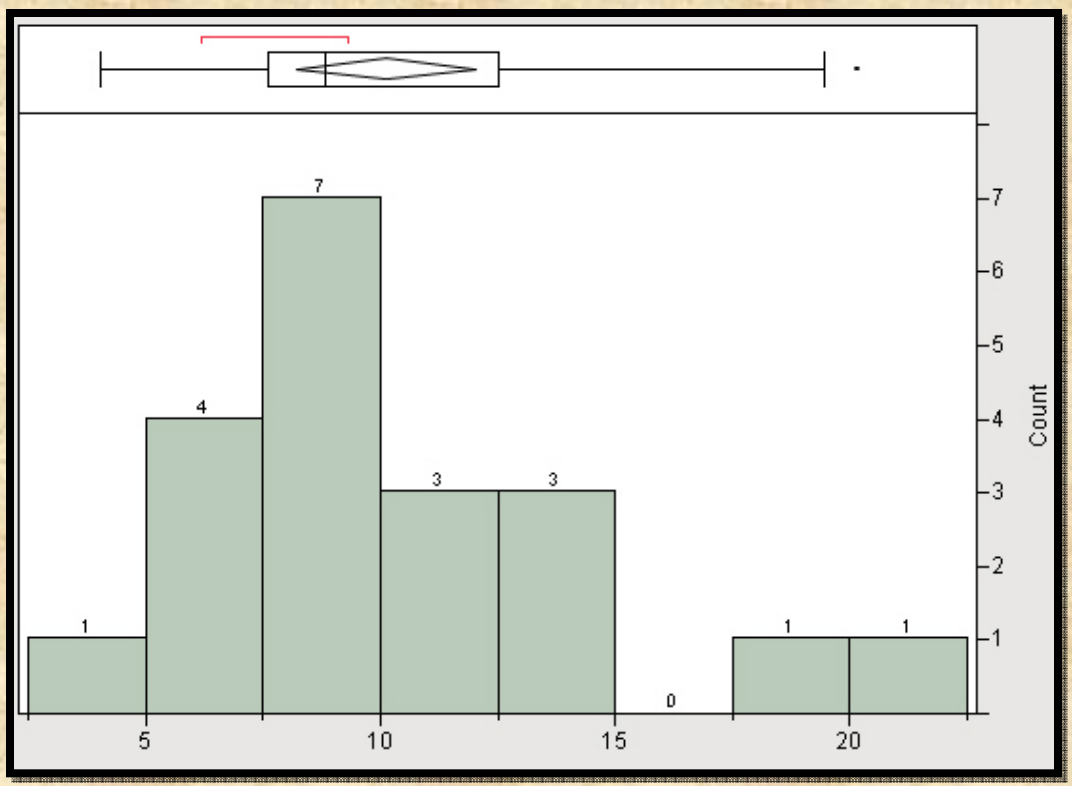
An hour spent actually harvesting biomass is a productive machine hour or "PMH"

Utilization Rates in North Carolina Study, Croatan NF



Time actually harvesting biomass as a % of scheduled time

2) Tons per Acre – the amount of tons of biomass collected per acre of ground covered/treated. This depends on the success of the collection system and habitat structure.

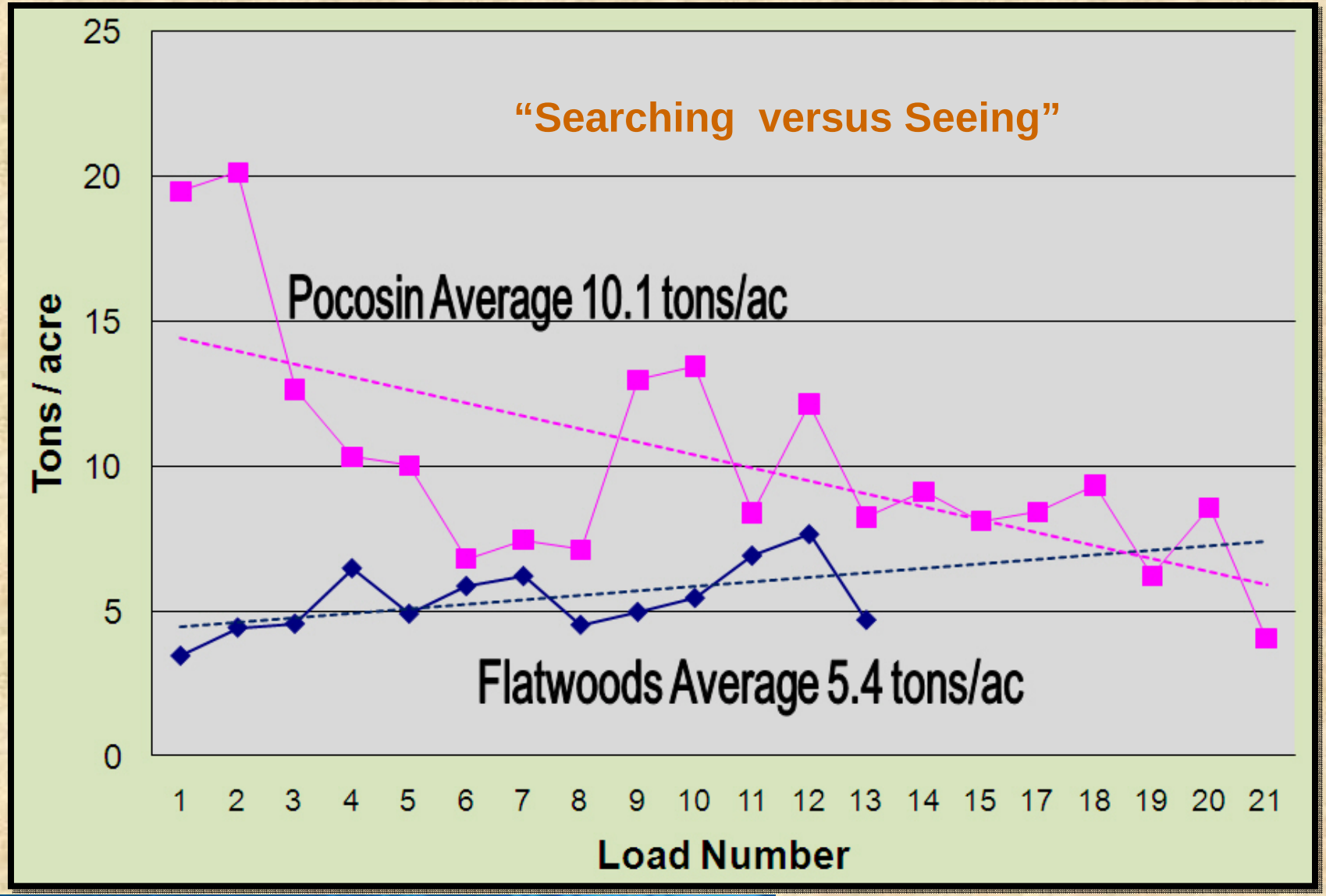


Pocosin Site:

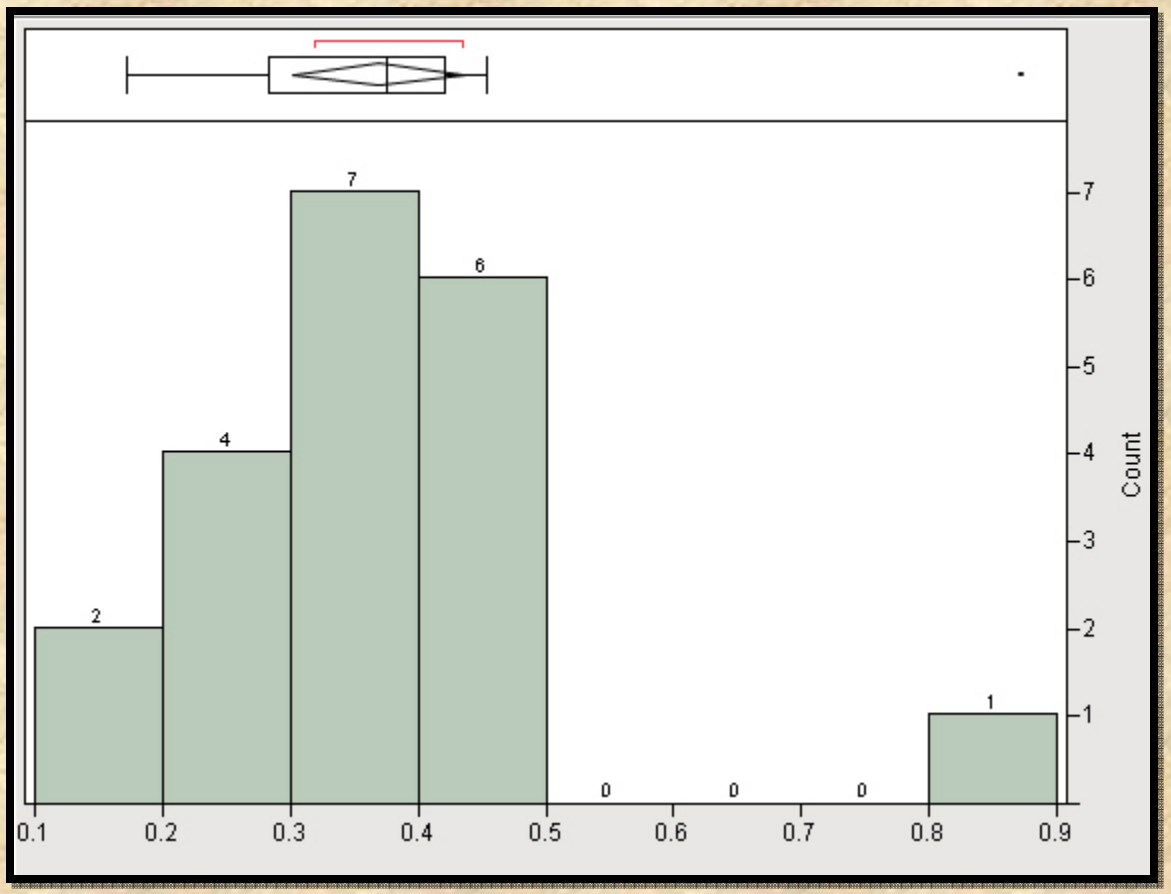
Miniumum = 4.0 TPA
Mean = 10.1 TPA
Median = 8.8 TPA
Max = 20.1 TPA

Missing the wagon was an issue

Tons Per Acre Collected by site type, Croatan NF, NC



3) Acres per Hour – the number of acres treated per hour of harvesting. This is primarily dependent on machine travel speed which is influenced by site type and habitat structure.

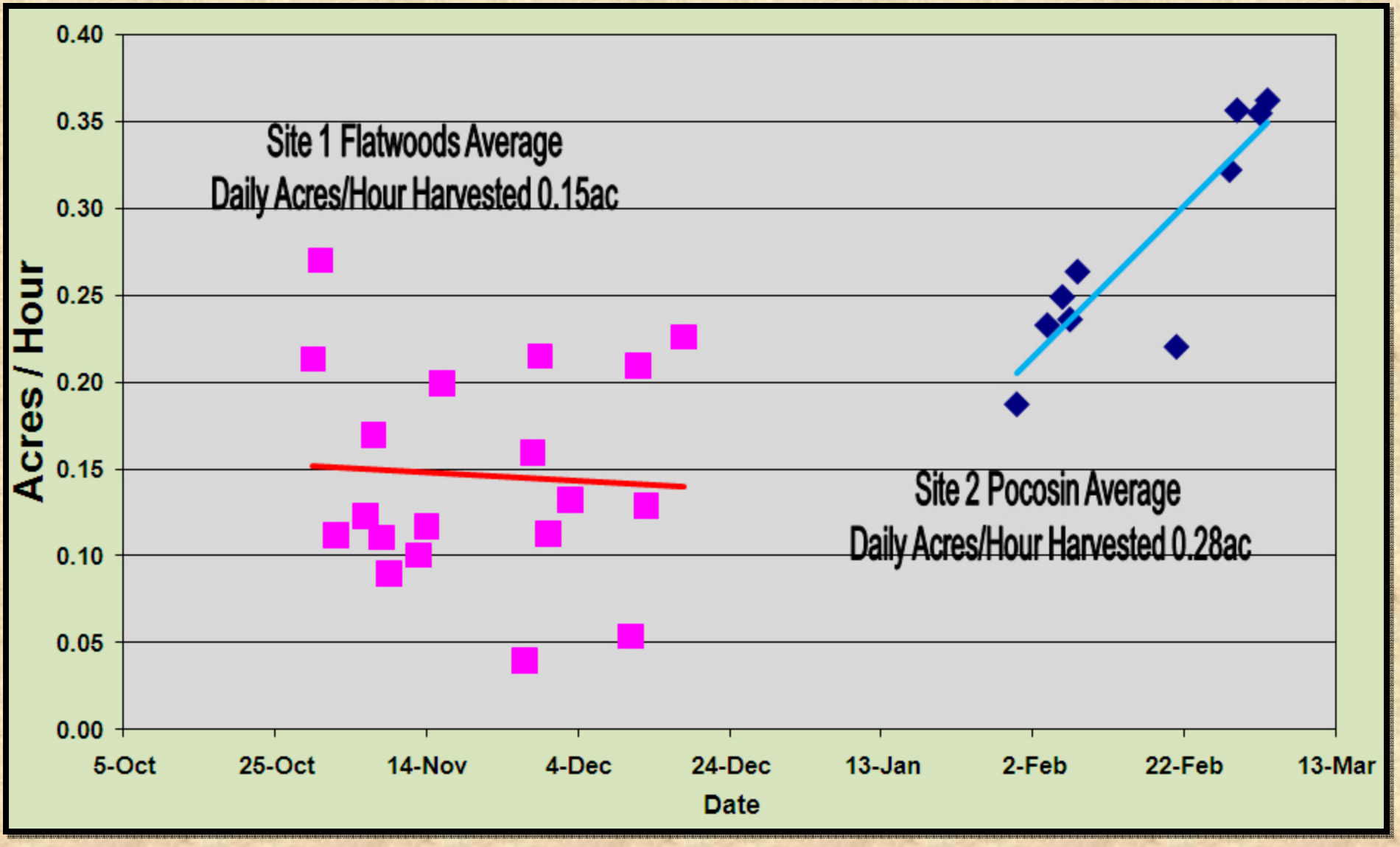


Pocosin Site:

Miniumum = 0.17 ac.hr
Mean = 0.37 ac/hr
Median = 0.37 ac/hr
Max = 0.87 ac/hr

Machine top speed of 3.8 MPH translates to top collection area of 2.3 acres/hour, but collection may decrease as vegetation pushed over and not collected.

Acres Traversed per PMH by site type, Croatan NF, NC



Pocosin site more travel for fewer tons through time

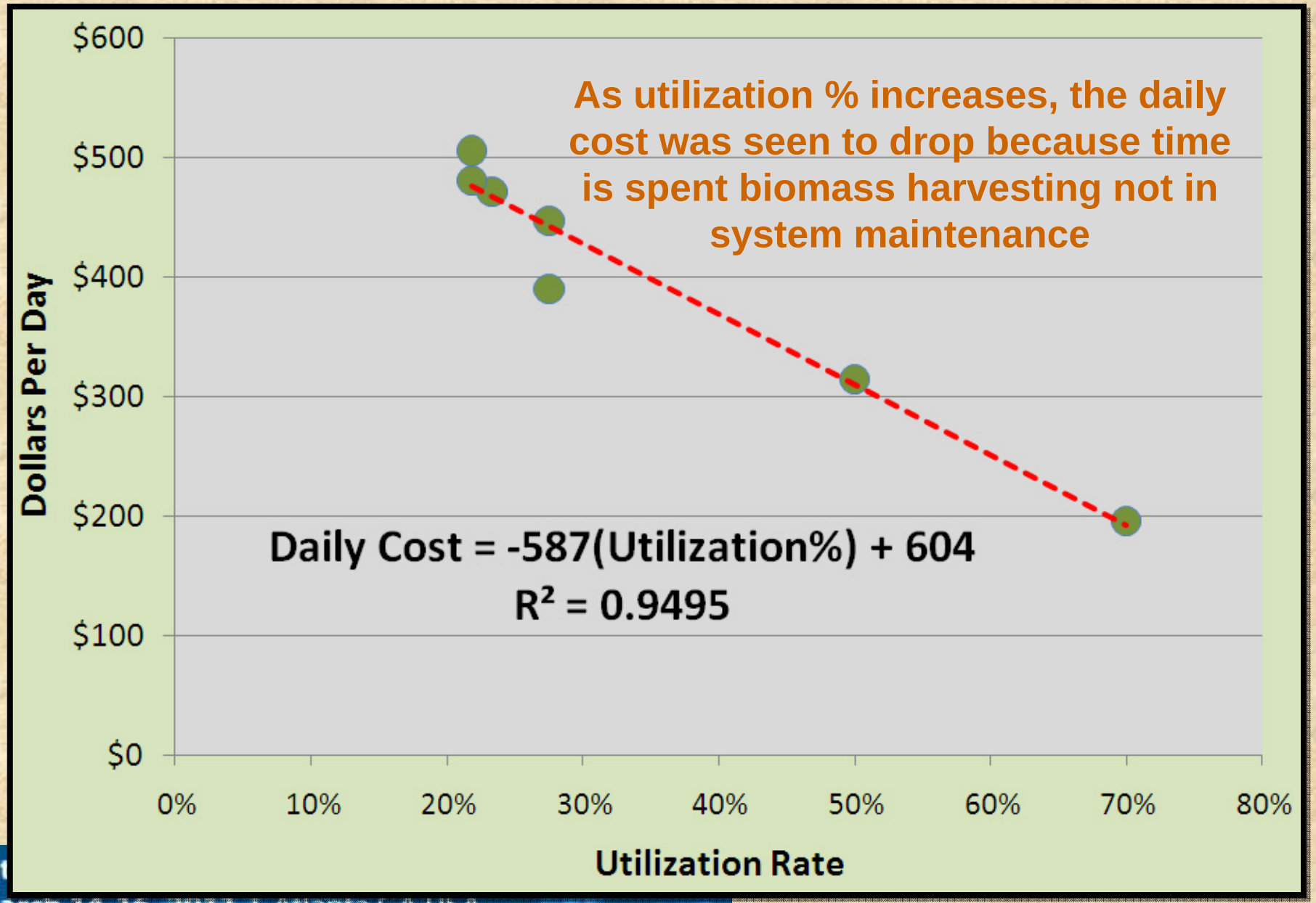
Machine & Labor Costs as a function of Productive Machine Hours

COSTS PER PMH	Flatwoods	Pocosin
Lubricant Factor	$2.42	$6.49
Fuel	$45.29	$39.86
Parts/Belts/Filters	$10.78	$14.92
Maintenance Labor	$129.87	$55.39
Operator Labor	$30.00	$30.00
Total Cost	$218.36	$146.66

Transportation	$8.18 Per Ton
PMH = Productive Machine Hour	

Transport Costs Per Ton

Daily Cost as a function of Utilization Rate



Model of Net Daily Revenues on Pocosin Site based on Means

Pocosin bio-harvesting at the mean performance levels observed in the study DOES NOT BREAK EVEN
…but energy gain is positive

Energy Accounting
79,733,703 BTUs produced/day
7,067,203 BTUs used/day
72,666,500 Net BTUs/day

Would need to be paid $50/ton for delivered biomass to break even (no machine system purchase costs are considered)

	LOGISTICS
8	Scheduled Daily Harvest Hours
29%	Utilization %
2.32	Productive Machine Hours (PMH)
10.1	Tons/acre Harvested
0.37	Acres/Hour Traveled
3.5	Tons/Hour Collected
8.2	Tons/Day Collected
	PAYMENTS & REVENUES
$18	Payment for Delivered Biomass $/ton
$0	Eco-service payment $/acre
$148	Gross Biomass Only Revenue $/day
$148	Gross Biomass & EcoService Revenue $/day
	COSTS & EXPENSES
$147	Biomass Harvesting Costs $/PMH
$8	Transport Costs $/ton
$237	Biomass Harvesting & Transport Cost $/day
	DAILY BOTTOM LINE
-$89	Net Biomass Only Revenue $ /day
-$89	Net EcoService & Biomass Revenue $ /day

Model of Net Daily Revenues on Pocosin Site based on Maximums

TAPPI people resources solutions

Net daily revenue NOW positive BUT system purchase cost is NOT included…

Calculated on a daily basis owner cost is: $303 / day

Energy Accounting
505,604,486 BTUs produced/day
28,266,205 BTUs used/day
477,338,281 Net BTUs/day

At these maximums, would need to be paid $21/ton for delivered biomass to break even AND purchase the biomass harvesting system

	LOGISTICS
8	Scheduled Daily Harvest Hours
66%	Utilization %
5.28	Productive Machine Hours (PMH)
20.1	Tons/acre Harvested
0.87	Acres/Hour Traveled
9.9	Tons/Hour Collected
52.1	Tons/Day Collected
	PAYMENTS & REVENUES
$18	Payment for Delivered Biomass $/ton
$0	Eco-service payment $/acre
$938	Gross Biomass Only Revenue $/day
$938	Gross Biomass & EcoService Revenue $/day
	COSTS & EXPENSES
$147	Biomass Harvesting Costs $/PMH
$8	Transport Costs $/ton
$813	Biomass Harvesting & Transport Cost $/day
	DAILY BOTTOM LINE
$125	Net Biomass Only Revenue $ /day
$125	Net EcoService & Biomass Revenue $ /day

Model of Net Daily Revenues on Pocosin Site based on EcoService

TAPPI people resources solutions

WHAT IF – Utilization can be increased to 70% and ½ acre per hour can be harvested.

MOST IMPORTANTLY – A PAYMENT FOR ECO-SERVICE (rather than low value biomass) CAN BECOME THE BASIS OF THE REVENUE STREAM.

Energy Accounting
244,862,968 BTUs produced/day
19,028,203 BTUs used/day
225,834,765 Net BTUs/day

Now profit is slim ($81/day) but system purchase is possible…

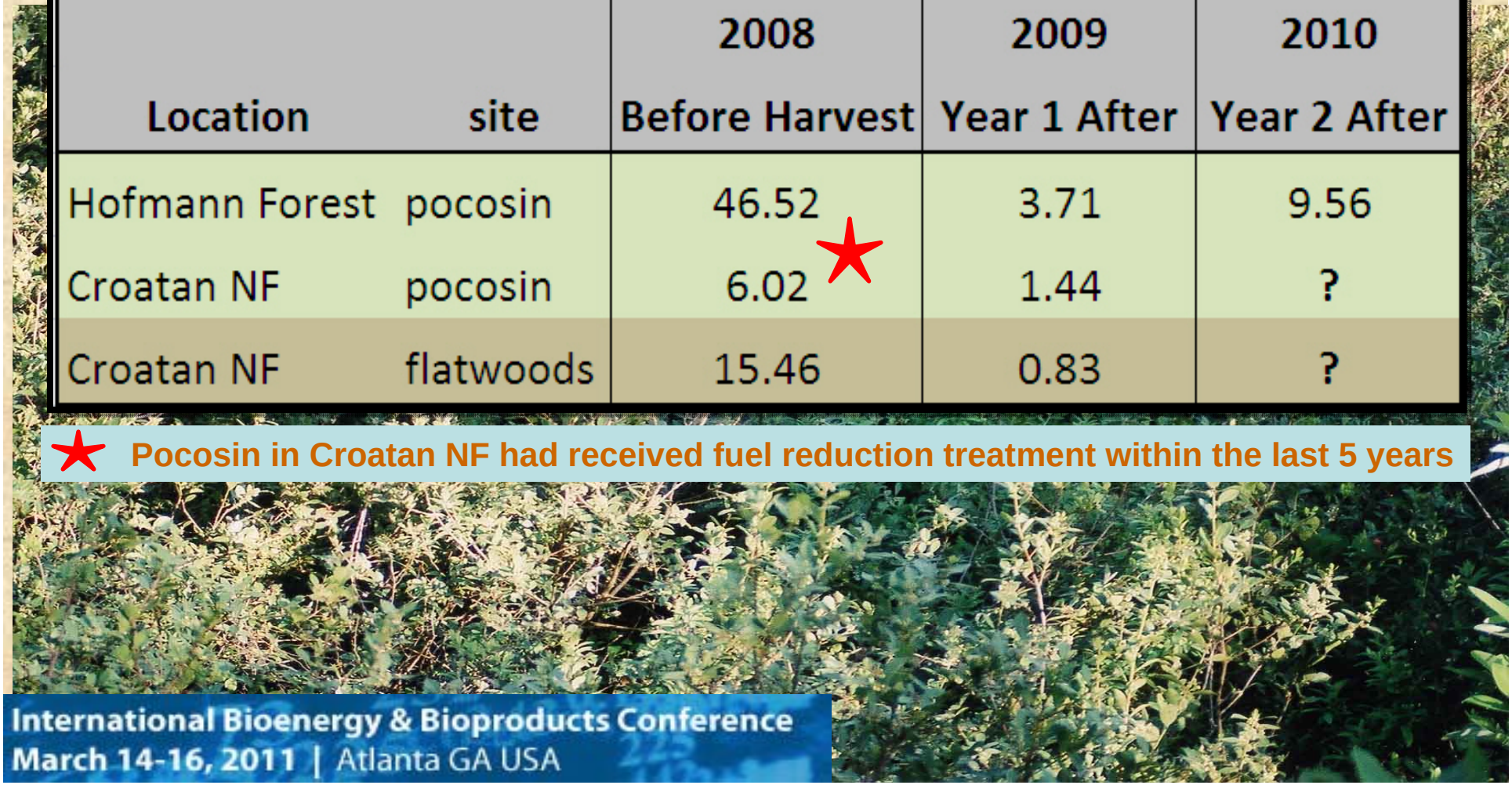
	LOGISTICS
8	Scheduled Daily Harvest Hours
70%	Utilization %
5.6	Productive Machine Hours (PMH)
10	Tons/acre Harvested
0.5	Acres/Hour Traveled
4.5	Tons/Hour Collected
25.2	Tons/Day Collected
	PAYMENTS & REVENUES
$18	Payment for Delivered Biomass $/ton
$195	Eco-service payment $/acre
$454	Gross Biomass Only Revenue $/day
$1,000	Gross Biomass & EcoService Revenue $/day
	COSTS & EXPENSES
$147	Biomass Harvesting Costs $/PMH
$8	Transport Costs $/ton
$617	Biomass Harvesting & Transport Cost $/day
$303	FECON machine purchase cost $/day
	DAILY BOTTOM LINE
-$465	Net Biomass Only Revenue $ /day
$81	Net EcoService & Biomass Revenue $ /day

Measured re-growth on Biomass Harvested Sites (60 plots at each site)

SPEED OF REGROWTH: Tons per acre of small diameter woody vegetation measured onsite before biomass harvesting and each year thereafter.

Location	site	2008 Before Harvest	2009 Year 1 After	2010 Year 2 After
Hofmann Forest	pocosin	46.52	3.71	9.56
Croatan NF	pocosin	6.02 ★	1.44	?
Croatan NF	flatwoods	15.46	0.83	?

★ Pocosin in Croatan NF had received fuel reduction treatment within the last 5 years



The AHWI H600 BioHarvester or FECON "Kraken"

- Biomass Harvesting should been seen as a ecosystem service first and paid for accordingly.
- Energy production is a byproduct of the eco-service and biomass harvesting collects far more BTUs than it expends.
- Second generation harvesting head is in use and higher utilization rates appear attainable (jamming reduced).
- Besides wildfire risk reduction and habitat creation for RCWs, the Kraken could be used for pre-commercial release in pine plantation silviculture (~$40/acre)
- Although serviceable, the collection system needs improvement.

2nd Generation Kraken 2011

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Any Questions ?

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