Peak Carbon: Proprietary Approach to Origination of Transactions

Peak Carbon's ambition to deliver large scale positive environmental impact is built on a foundation of unmatched experience across North American carbon and biofuels markets in the context of operating across global energy commodity markets. At the time of publishing this paper, the Peak Carbon management team alone have identified, sourced, transacted and implemented approximately 55% of all US forest carbon transactions, built the US's largest of its kind biofuels to transport fuel value chain and developed several biomass pellet mills from forest floor to power station.

Built upon this experience and the associated accumulation of proprietary data, Peak Carbon has, through exclusive partnership with forest consultant specialist Finite Carbon, developed a proprietary tool that integrates, via machine learning, publicly available satellite and LIDAR data with a privately owned data set of plot samples – the largest in the US specifically suitable for both biomass and carbon inventory – that can identify optimal properties for the implementation of Peak Carbon's strategy across three criteria – carbon stock, available biomass and access to logistics.

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Glossary

CO_2 - the chemical formula for carbon dioxide, a greenhouse gas which can contribute towards global warming when released into the atmosphere.

ESA - the European Space Agency.

GIS - stands for Geographic Information System, and is a system designed to capture, store, manipulate, analyze, manage, and present all types of geographical/spatial data.

IFM - Improved Forest Management, a program supported by U.S. State and Canadian Provincial Governments to incentivize forest owners to increase the volume of CO_2 sequestered in their forest.

LIDAR - stands for Light Detection and Ranging, and is a remote sensing method that uses light in the form of a pulsed laser to examine the surface of the Earth.

USIEI - United States Interagency Elevation Inventory.

Contents

About the Author

Created in 2018 when top executives, independently benchmarked as the market leader in environmental commodities, left fossil fuel energy companies to set up their own firm in pursuit of their ambition to accelerate positive environmental impact in the low carbon and clean energy sector. Peak Carbon's goal is simple, to combine sector leading experience with proven analytical tools and techniques to deliver large scale investment opportunities with a positive environmental impact focus without sacrificing total return. Capitalizing on over a combined 50 years of proven investment success, building biofuel value chains and operating in global energy commodity markets, Peak Carbon has built a team of experts across the whole bioenergy value chain - from biomass growth and handling & logistics to bioenergy upgrading and engineering and finally distribution and utilization.

About this Paper

This paper sets out Peak Carbon's Proprietary Origination Approach - our methodology to identify and source the most impactful and valuable transactions for Peak Carbon. We combine unmatched sectoral experience with one of the largest privately owned carbon and biomass forest inventory data sources in the US, and through machine learning applications are able to derive the optimal forest properties to target when analyzing across carbon stock, available biomass and access to logistics. Through adopting this Proprietary Origination Approach, Peak Carbon believe we will deliver long term, lasting positive environmental impact where it economically makes most sense.

About Finite Carbon

Finite Carbon is North America's leading service provider for the development of forest carbon offsets. Finite Carbon provides clients with the expertise and resources for successful implementation of forest carbon inventories, carbon offset protocol selection, carbon project design, verification management, and issuance of carbon offsets. With offices in Pennsylvania, Florida, and Oregon, Finite Carbon's in-house team of professional foresters has been developer for North America's largest portfolio of compliance forest offset projects from Maine to Alaska.

Over the past six years, working with the Peak Carbon management team in their prior roles and with various other clients, Finite Carbon has privately developed the US's largest database of forest plot samples specifically carried out for both biomass and carbon inventories. Peak Carbon and Finite Carbon have in place an exclusive agreement for application of the data, through machine learning, into a carbon and biomass transaction identification tool, with Finite Carbon providing the carbon development services for any associated projects.

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1. Sources of Data

The overarching principle for Peak Carbon's data-driven approach is to overlay layers of data for increasing granularity of plot data and use machine-learning to pass correlations back up the data layers to be then be able to extrapolate these learnings across the data layer to plots where the lowest layer of granularity may not be available.

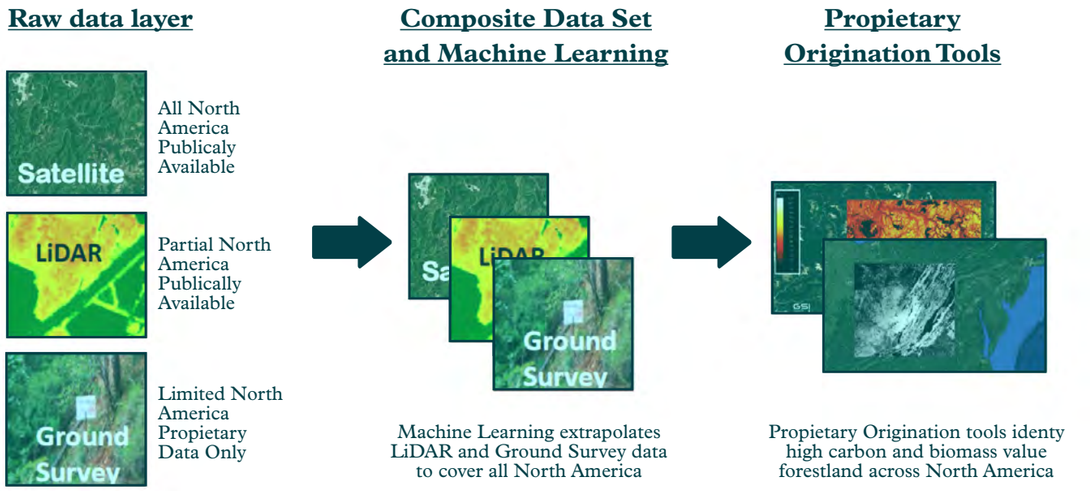

Fig.1: Change in atmospheric CO2 concentration resulting from displacement of coal by wood.
Diagram to illustrate integration of data layers and application of machine learning to create proprietary tools that identify high value carbon and biomass forestland across North America

At the highest level raw data is collected from the European Space Agency (ESA)'s Sentinel-2 programme. Under this programme ESA make publically available the imagery from two Earth observing satellites built to support services such as forest monitoring, land cover changes detection, and natural disaster management. This raw data can be used to create single, data-rich images that cover the entire US and Canada. The raw data however translates to pixel granularity equivalent to an area of land 10m by 10m. Without further processing there is little advantaged understanding that can be obtained at this level of granularity.

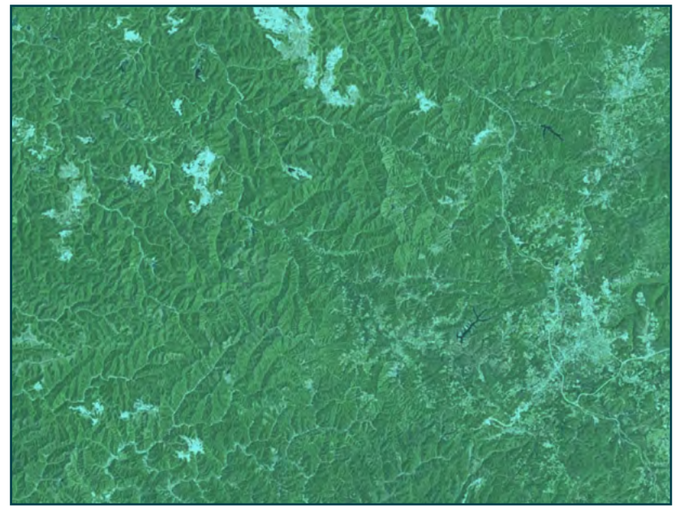

Fig.2: Sample of ESA data showing 10m by 10m granularity map of West Virginia forestland

The next data layer is provided through Light Detection and Ranging (LIDAR), a remote sensing method that uses light in the form of a pulsed laser to examine the surface of the Earth. The United States Interagency Elevation Inventory (USIEI) currently provides the most comprehensive public resource for LIDAR across the United States. This high-accuracy topographic data provides granularity down to 0.5m by 0.5m, and can provide accurate measurement of certain forest characteristics, such as forest canopy height, tree crown diameter and hardwood vs. softwood, but lacks the granularity to determine specific species type, carbon stock and cycle maturity.

The 0.5mx0.5m pixel LIDAR data is merged into packets of 10mx10m pixels for a given area of land. This is to match the 10mx10m resolution of the ESA Sentinel-2

data. Machine learning is then employed to match the LIDAR pixels to the Sentinel-2 pixels for the same given area of land. The machine learning tools are therefore used to interpret connectivity and correlations between the LIDAR and Sentienl-2 data layers. While the LIDAR data is limited to partial coverage of the US, these connections and correlations can be extrapolated to provide an understanding of the forest characteristics, such as forest canopy height, tree crown diameter and hardwood vs. softwood, to areas with Sentinel-2 imagery but not yet covered by LIDAR.

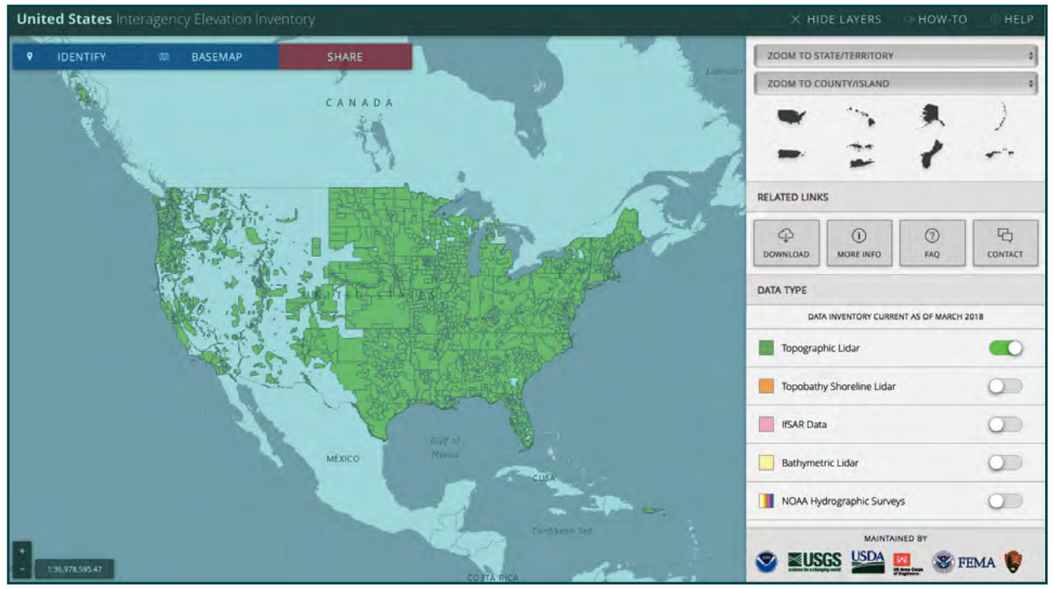

Fig.3: Map showing (in green) US LIDAR coverage provided by the United States Interagency Elevation

The most granular layer of data is provided through Finite Carbon's private database of forest plot samples. Over the past six years, working with the Peak Carbon management team (in their prior roles) and with various other clients, Finite Carbon has been involved in the development of more than half of all North America forest carbon projects eligible in US state or Canadian province regulated carbon markets. Through this work Finite Carbon has created a privately held database of more that 33,000 acres of plot samples, the largest in the US specifically carried out for both biomass and carbon inventories.

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Peak Carbon: Proprietary Approach to Origination of Transactions

Each plot sample covers a radius of 50ft, and has precise information on species type, carbon stock and stage of development in the forest lifecycle. While the plot sample data is limited to partial coverage of the US, the same machine learning tools can interpret connectivity between the plot sample data and satellite imagery/LIDAR that cover the same forest plots. This analysis helps to ground truth the extrapolated data and assigns a species composition and carbon stock probability per pixel. The resulting output allows a user to estimate the species, trees per acre, timber and carbon volume for each pixel.

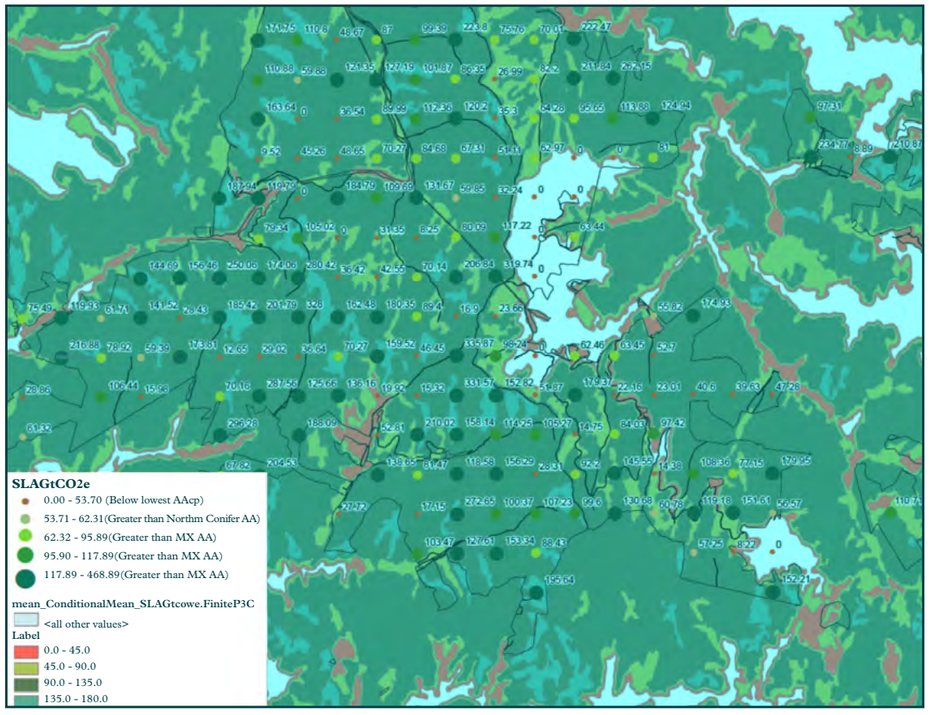

Fig.4: Example plot sample from West Virginia showing plot specific species and carbon stock data.

The final data layer is the overlay of physical data, in the from of a shapefile, from a database or service provider which can provide additional information about a specific group of pixels that represent a given area of forestland. Examples of shapefiles include a parcel data set from CoreLogic which will provide ownership information for all land parcels in the U.S., or a rail and road data set from arcGIS which will overlay the North American railway or road network.

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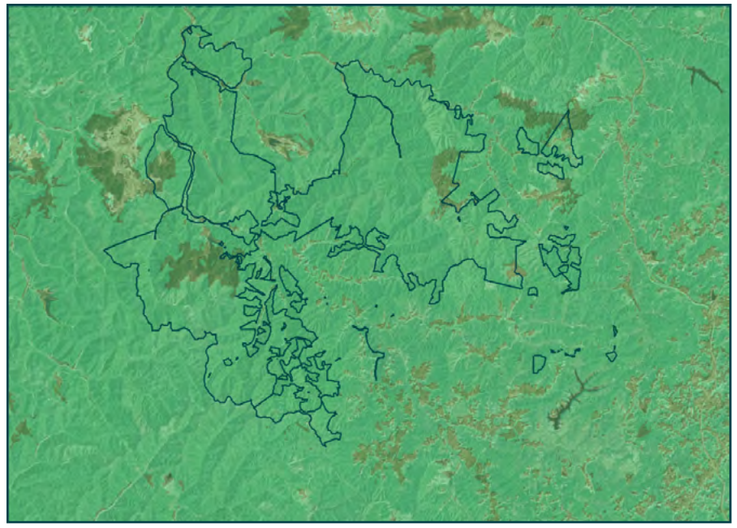

Fig.5: Example of data on ownership of parcels of land being layered over pixels derived from learning between Sentinel-2, LIDAR and plot sample data layers.

Peak Carbon and Finite Carbon have in place an exclusive agreement for application of the data, through machine learning, into a transaction identification tool specifically for both carbon and biomass, with Finite Carbon providing the carbon development services for any associated projects.

80-90% accuracy in estimating available carbon and biomass on any given forest parcel

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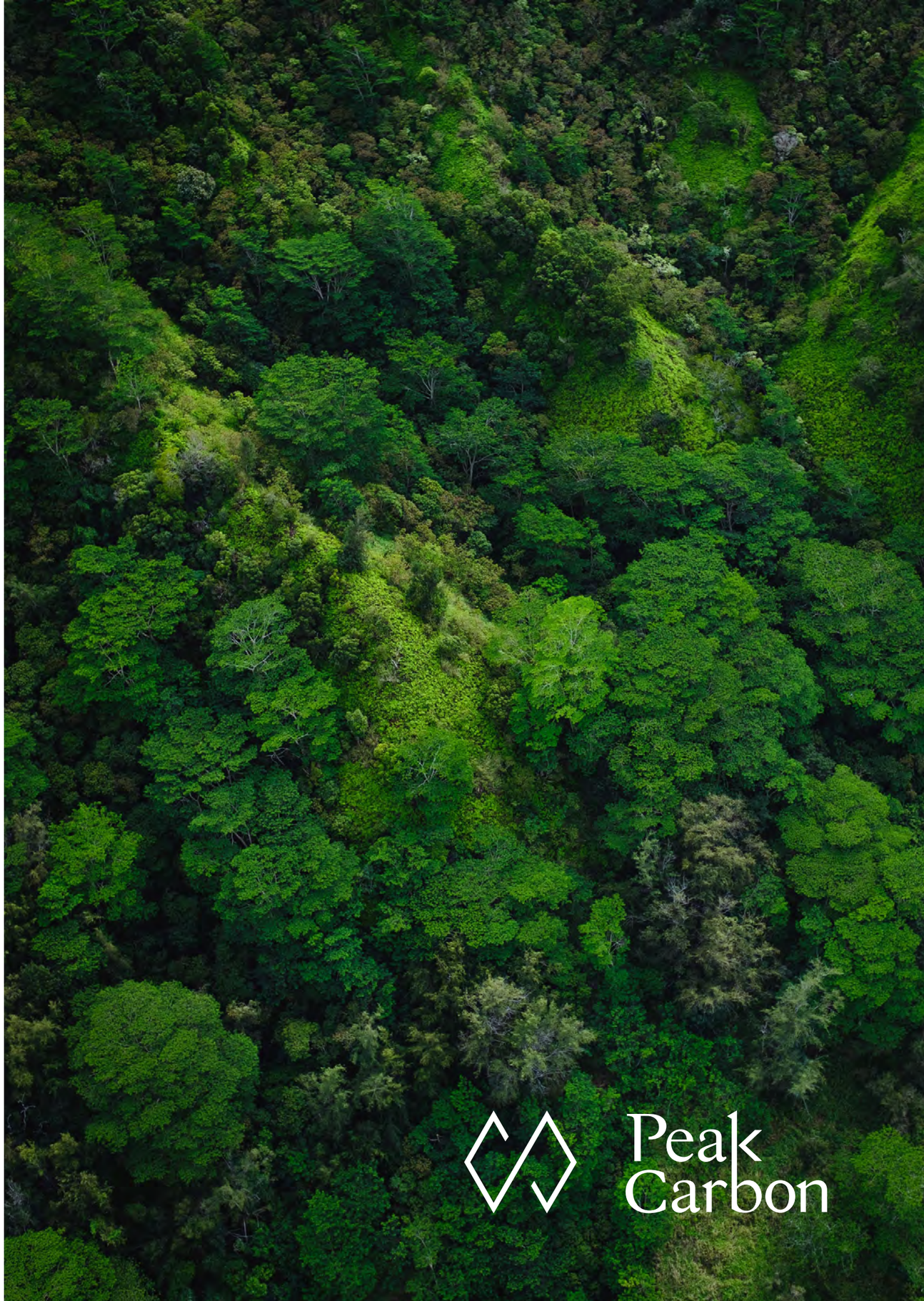

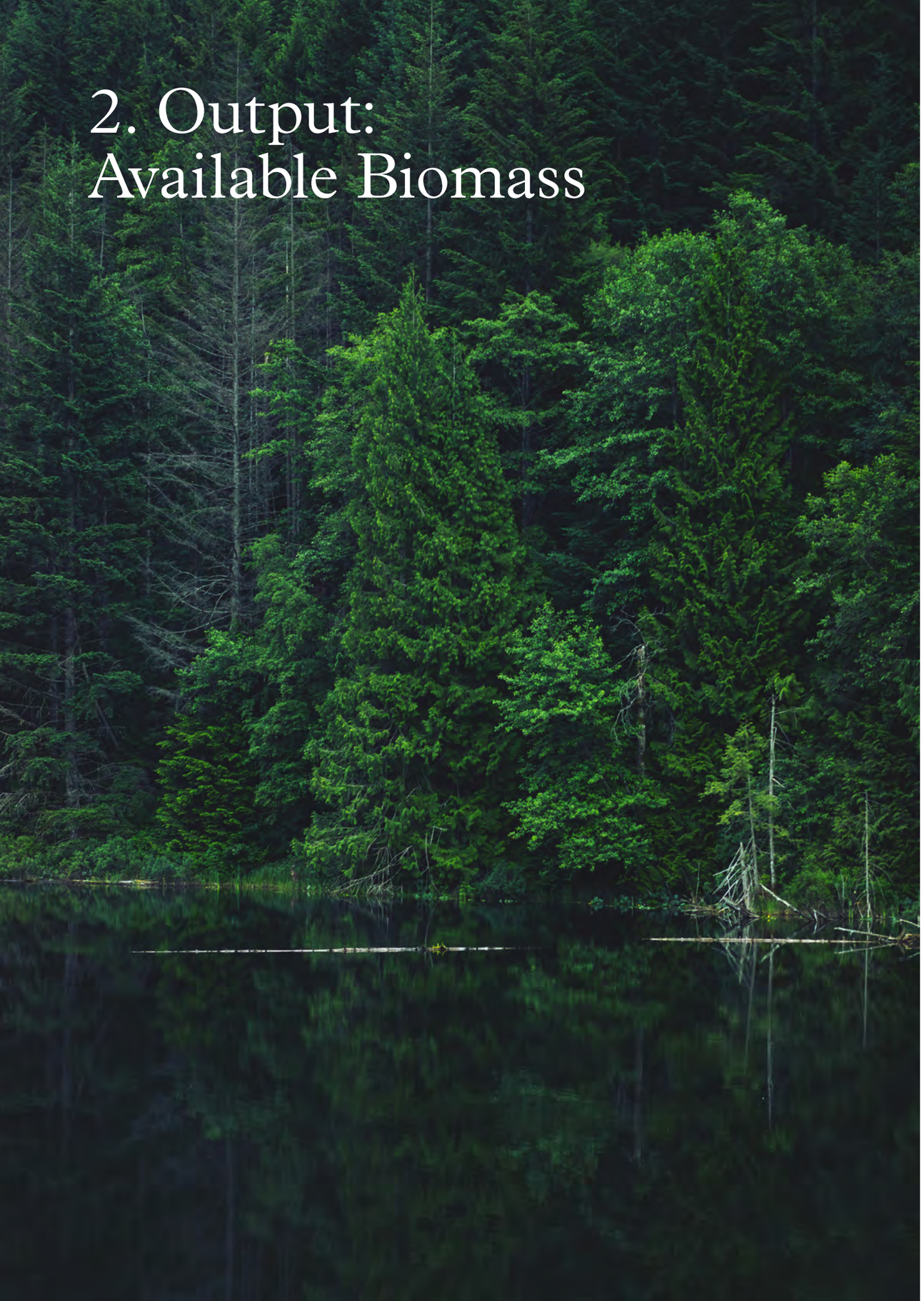

2. Output: Available Biomass

The output of the application of machine learning across the various data layers is that it is possible to, on a per pixel or granularity of 10m by 10m, estimate the species, trees per acre, and timber volume (diameter and height) for a given area of land. While not all of this biomass is waste wood suitable for biofuels, information can be derived to forecast available waste wood supply depending on the region and characteristic forest management practices. For example in the forests of the North-West the availability of invasive species, such as tan oak, within a commercially viable radius can be assessed, or in more homogenous plantations of the South-East the trees per acre could determine if an area had been thinned or not thinned, with the number of unthinned acres creating and approximation of future thinning operations and the build up of a 20-year supply analysis of thinning waste for any given radius around a potential biofuel plant.

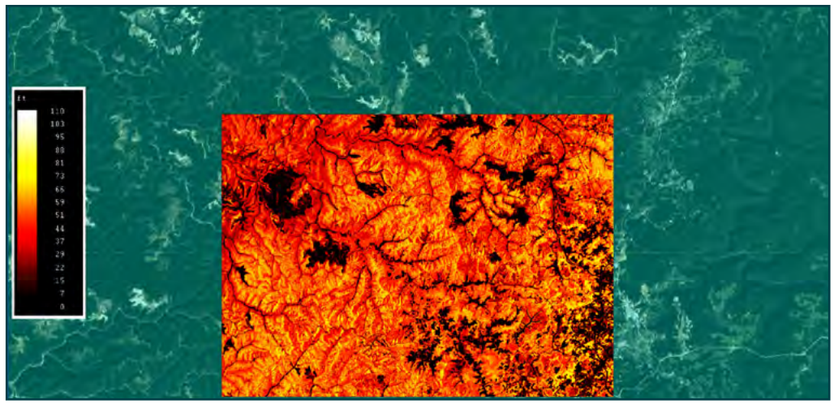

Fig.6: Output from analysis across data layers showing volume of available timber by specific species per 20 acres, in this instance the density of tanoak - highest density in yellow.

Estimates of species, trees per acre, timber and waste wood volume and characteristic forest management practices

3. Output: Carbon Stock

North American state and provincial regulators, such as the California Air Resources Board, provide incentives, in the form of carbon credits, to forest owners to increase the amount of CO_2 stored within their forest through Improved Forest Management (IFM). Under IFM carbon credits can be awarded for either maintaining within the forest greater carbon stocks per acre than the regional average, or allowing a net annual growth of the forest having deducted the volume harvested. One of the key drivers to determine existing forest carbon stock and CO_2 sequestered from growth is to have a detailed understanding of the associated species, trees per acre, and timber volume (diameter and height) for a given area of land. This data can be combined with carbon accounting modeling to derive a carbon volume per acre.

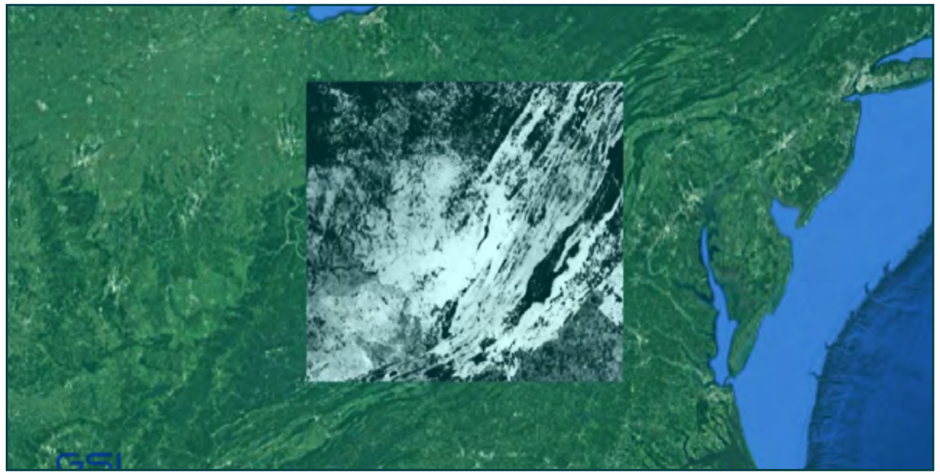

Fig.7: Output from analysis across data layers showing volume of carbon stored in tonnes of CO_2 per 20 acres relative to regional baseline. Highest density in white.

Carbon accounting modelling combined with biomass estimates derive CO2 stored per acre

4. Output: Access to Logistics

Transportation can account for as much as 25-50% of delivered costs for woody biomass feedstocks into a bio-refinery. Whilst long-term contracts may be available on rights to the standing biomass, managing feedstock costs requires minimizing transportation distance between the wood basket and conversion asset.

Peak Carbon will utilize GIS spatial optimization algorithms to assess the optimal location for a conversion asset and provide a high degree of certainty over transportation costs over the life a project. Overlaying data on available biomass and output of future thinning operations with transport infrastructure including within forest road networks, Peak Carbon can compute the haul costs for each ton of sustainable wood fiber expected to leave the forest.

As the bio-economy grows and demand for low-carbon fuels grows, the ability to optimise product flows via transportation, be it pipeline, ship or train will be key to growing revenue associated with a bio-refinery. Peak Carbon's GIS analysis will ensure assets are optimally located to leverage the required infrastructure to make this possible.

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5. Summary of Transaction Identification

Peak Carbon's Proprietary Origination Approach - combining public and privately owned carbon and biomass forest inventory data sources through machine learning – creates a tool that can accurately assess carbon stock and biomass on any property in North America, and therefore facilitates the identification and sourcing of transactions for Peak Carbon. Where sufficient proximate fixed-radius plot data is available accuracy level is at a 90%+, or 80%+ accuracy for areas with minimal plot data in the region.

It is important though to emphasize that the tool developed and described above is initially used as a transactional screening tool, and does not substitute the need for in depth sectoral expertise, as well as further due diligence and ground truthing. This screening can be for identifying properties within a forestland portfolio where Peak Carbon believe they can unlock additional revenue streams for the land owner, or can be used to support acquisition of new properties where the buyer would be seeking additional revenues from Peak Carbon to support their investment decision.

Once forest stands with attractive biomass and/or carbon stocks have been identified, the tool can be used to run more detailed simulations of the evolution of logistics costs and availability (and associated cost) of the waste wood basket to optimize the location and financial planning of a biomass facility over its operating life.

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