Log Level Chain of Custody Tag, Track and Trace Systems: From Harvester Head Through to Ship Loading

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Relevance of tag, track and trace systems to log export sector

In 2016 global industrial roundwood production amounted to 1874 million m$^3$. Approximately 7% of this production (132 million m$^3$) was exported in roundwood form globally. Australia was the sixth largest exporter of roundwood (3.9 million m$^3$).

In a global forest market, it is critical to maintain competitiveness by controlling costs and maximizing customer service wherever possible. Log tagging has enormous potential for improving production efficiencies in the log supply chain from stump to mill or port and ensuring that the right kind of timber is used for the end product that it is best suited for. It is also a necessity for some international log markets.

This FIRC Report summarises a technology review that examined the relevance of tagging, tracking and tracing systems to log export supply chains in Australia and identified the attributes of an ideal tagging technology (Murphy, 2018). It described a tag, track and trace system developed by a large log marshalling and stevedoring company operating in Australasia. It also described and compared current and potential log tagging technologies.

Benefits of tag, track and trace systems

Efficient log (and wood product) tracking and tracing is important to landowners, mill owners and wood product suppliers for several reasons, including the following:

- Curbing illegal logging and wood theft and loss of government taxes and revenues. Increased regulations to control illegal logging (such as the Lacey Act in the United States and the Illegal Logging Prohibition Act in Australia) have received international support.
- Environmental certification of forest products (such as with the Forest Stewardship Council - FSC) requires a system for tagging individual logs or batches of logs with certification status. Two surveys of value-added wood product manufacturers in 2002 and 2008 identified some of the primary reasons for stakeholders to get involved in certification.
- Improved logistics and stock control management, particularly where suppliers are preparing logs for niche markets. Knowing where logs have come from and how long they have taken to get to various intermediate points can help identify bottlenecks in the supply chain and potential sources of downgrade (eg loss of log freshness). Net revenue increases when logs are efficiently supplied to the most appropriate customers (mills or ports).
- Improved ability to identify, allocate, and track logs from stands or trees with particular wood properties (eg, logs with high stiffness or wood density characteristics. Technology currently exists to estimate wood properties in the field. However, if this information cannot be passed along the chain-of-custody, timber cannot be optimally allocated between different customers. This information is lost if a log is only visually sorted and tagged by grade.
- Facilitating comparisons between forecast and achieved grade and volume yields based on pre- and post-harvest forest assessments.

Brief case study of an Australasian tag, track and trace system

A recent review of traceability systems commented that a general lack of coordinated planning, control and benefits sharing by actors within the forestry supply chain “has created obstacles to recognition of the potential for performance gains and cost savings from many technological implementations including traceability” (Hunt et al. 2014). This comment cannot be said to be true of the tagging, tracking and tracing systems developed for log export supply chains in Australasia (pers. comm., J. Ellis, Scaling Technology and Research, 22 March 2018).

A brief description of a tag, track and trace system, developed by C3 Ltd. in New Zealand and used in Australia and New Zealand for more than 15 years, is provided to illustrate this point. C3 is New Zealand’s largest on-wharf logistics company.

Figure 1. Uni-directional barcodes, stapled to log ends, are commonly used in Australasia. In this photo logs are being digitally scaled on the back of a truck. A barcode reader is used to read both the log tag alphanumeric code and the log diameter (from mini-barcodes on the ruler).
On arrival to the port, every log is tagged with a unique paper-based barcode and measured by expert log scalers. The barcode and log measurements are captured using a handheld scanning device. Data relating to each log is stored in C3’s Data Warehouse via the C3 InView website. Through its unique ID and weblink to C3’s Data Warehouse, each log carries with it a full history of where it came from, who logged it, who carted it, its dimensions, grade and weight, when it was delivered to the port, whether the log came from a certified forest, how many other logs were on the truck or rail wagon, etc. Over the last 8 years C3 has tagged, measured and stored the data from over 260 million logs with a total weight exceeding 100 million tonnes.

### Tagging Technologies

Tags can be “passive” or “active” with respect to the information they carry. Passive tags carry only a unique code that is linked to a real-time database – information related to the tagged item is stored on the database. Active tags carry the information on the tag itself. Passive tags are more common and generally of lower cost than active tags. They have the disadvantage, however, that each participant in the supply chain requires some form access to the database to make use of the information.

Several different log tracking technologies have been developed and adapted for monitoring logs from stump to mill, including paint (conventional, microtaggant, and chemical tracer), hammer and punchmark branding, paper tags and barcoding, nail-based labels, radio frequency identification (RFID) tags, and biometric, genetic or chemical fingerprinting. Depending on the application, these technologies can track products at the truck level or stem (log) level. The advantages and disadvantages of different log tracking technologies are shown in some detail in Murphy (2018).

For the stakeholder, the optimal choice will depend on several factors, and it is quite possible that different stakeholders could arrive at a different choice. Tracking the movement of individual logs requires that they be cost effectively and uniquely tagged in a manner that can be easily and repeatedly read along the supply chain (from mechanized processing, to loading, to trucking, and delivery to the customer).

### Suitability for Application on Harvester Heads

As part of the Indisputable Key project the Royal Institute of Technology in Sweden used a multicriteria approach to rank thirteen potential tagging systems for their suitability for application in forestry supply chains.

The three highest ranking tagging technologies in 2010 were ink-based printing of matrix codes on log ends, RFID tags, and punch codes. These three tagging technologies could also be considered to be most suitable for application on a harvester head in Australia.

![Figure 2. Three tagging technologies could be considered to be most suitable for application on a harvester head in Australia: ink-based printing of matrix codes (left), RFID tags (middle), and punch codes (right).](image)

As far as the author of this report is aware, none of these three tagging systems is fully operational on a harvester head. Ink-jet printing is perhaps the most advanced (e.g. Logcom’s Woodland Inkjet system) but it is unknown whether unique matrix codes can be printed on individual logs at this stage. Two Scandinavian machinery manufacturers, Ponsse and Rottne, developed prototype RFID tagging systems in the 2000’s. There is no indication on their websites that RFID tagging on a harvester head is offered as an “off-the-shelf” service.

Otmetka Log Marking’s patented Woodpecker punch code system has shown considerable promise in laboratory trials but, as yet, has not been trialled on a harvester head. Further development of all three tagging systems is warranted and required.

Once a log is tagged with a unique ID diameter and volume measured by the harvester could be linked to the tag ID. A challenge to overcome, however, with the tagging of logs on a harvester head, whether it be ink-jet printing, RFID or punch code tags, relates to the end of the log that is tagged. Harvesters process logs starting from the big end and working towards the small end. Unless the harvester was to put down the unprocessed stem section and pick up the last log processed, which would have a major impact on harvesting productivity, tagging of logs will occur on the big end. Australia’s largest log export market, China, uses the JAS m³ as the unit of measure for the export log trade. JAS m³ is based on the measurement of the small end diameter of the log. Verifying JAS diameter and volume for a given log will be difficult, particularly when the log is part of a stack of logs, when the tag is on the opposite end to the small end of the log. A check-scaling system, whereby a subset of logs is randomly selected, laid out, and remeasured, will help overcome this challenge and provide confidence in the measurements.

Tagging cost was one of the highest ranked criteria used by the Royal Institute of Technology in Sweden for comparing tagging technologies. Claimed tagging costs range from as low as US$0.003 per log (=A$0.004 per log) for punch code tagging to as high as €0.35 per log (=A$0.56 per log) for RFID tags. Tagging costs on a per m³ basis will depend on average log size. Small short logs will have higher tagging costs than large long logs.

![Figure 3. Shows the cost of tagging assuming a tagging cost of A$0.10 per log. Costs for different tagging technologies can be scaled accordingly, e.g. RFID tagging of 3.6 m logs with a 200 mm SED could cost A$4.20 per m³ (= A$0.75 per m³ * 0.66/0.10) and the same size log could cost A$0.03 per m³ (= A$0.75 per m³ * 0.004/0.10) if a punch code tagging system was used.](image)

Lastly, the StanForD protocol for data storage and reporting on harvesters is internationally accepted and used by many forest machinery manufacturers (Est 2001, Arlinger et al. 2012). Linking a unique code with the associated information about the log within the StanForD has been successfully trialled in the Indisputable Key project (Uusijarvi.2010). This data can then be transmitted to forest owners, sawmills and other actors in the wood supply chain as requested. It is expected that further work would be required to integrate StanForD data with log export databases similar to the one developed by C3 and described earlier in this report.

### Conclusions and Recommendations

- **Tagging Technologies**
  - Passive tags carry only a unique code linked to real-time database.
  - Active tags carry their own information.
  - Disadvantages include cost and access to database.

- **Suitability for Application on Harvester Heads**
  - ink-based printing, RFID tags, punch codes.
  - Challenges include tagging at the small end.
  - Verification of JAS diameter for stacked logs.

- **Tagging Cost**
  - Costs vary widely, from US$0.003 to €0.35 per log.
  - Per m³ costs depend on log size.

- **StanForD**
  - Data storage and reporting protocol.
  - internationally accepted.

Further work is suggested to integrate these systems effectively.
• Tag, track and trace systems are considered to be an essential part of the business in many industries.

• Tag, track and trace systems at the individual log level are well established from the port gate in Australasia to international customers.

• Although the benefits for the forestry sector are many, little use of these systems currently occurs between the forest and the port gate.

• Three tagging technologies would appear to be most suitable for application on a harvester head in the near future. These are ink-jet printing of matrix codes, RFID tags, and punch code tags.

• Further development of these technologies on a harvester head is required, however. Forest owners, harvesters and log exporters should communicate their need for the development of at least one of these technologies to machinery suppliers and manufacturers.

• The tag is only one part of a tag, track and trace system. The full benefits of tag, track and trace systems will undoubtedly require merging of forest to port gate (or mill) track and trace systems with the established systems from the port gate to the international customer. Improved communication between on-forest harvesting operations and on-warehouse operations will be essential if this is to happen.

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We also acknowledge the assistance given by C3 Ltd by providing information on their current operational tag, track and trace system which is applied to more than 40 million logs annually from Australasian suppliers. C3 staff also willingly discussed their views on future developments of tag, track and trace systems.

References

Murphy G. (2018) Technical review of log level chain of custody tag, track and trace systems: from harvester head through to ship loading. Project Report 1, Forest and Wood Products Association, 30 pages

Full citations for other references cited in this Bulletin can be found in the FWPA Project Report cited above.