



GreenSHIELD

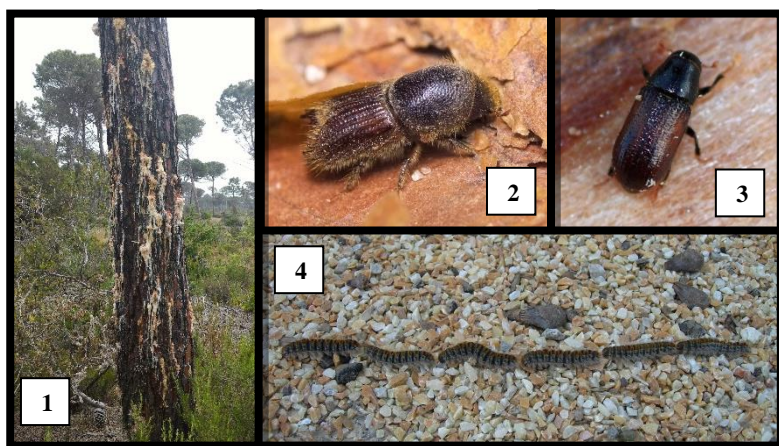
Integrated Pest Management

1. Introduction

Like other conifer forests in Europe, Mediterranean pine stands are an important habitat to several plant and animal species, also granting major economic resources such as timber, seeds, and recreational activities. Every year these environments are threatened by phytosanitary issues, which are often triggered by fires, climate change, and the introduction of alien pests. The problem is worsened by land fragmentation (parcellation of forest ownership among many public and private subjects) leading to a lack of integrated measures to mitigate insect infestations. Although IPM (Integrated Pest Management) is strongly advised by the EU, it is rarely carried out efficiently and most of the time it is restricted to single parcels, mirroring different management strategies from different owners, in different periods of time. Prevention, on the other hand, is underrated and almost non-existent.

Such an approach is **not** cost-effective, it is characterized by delayed actions, and leads to poor results. In fact, the identification of pests and plant diseases is rarely carried out by specialized entomologists and plant pathologists, thus causing misleading diagnoses. As a result, the wrong control strategy may be chosen causing more environmental issues (e.g. pollution by using ineffective chemicals as pesticides). Monitoring of the pest population is regularly neglected. Felling of infested trees is almost always delayed, vitiating the purpose of killing the insects about to emerge from it. Moreover, all these actions are usually carried out by different subjects, preventing an **ideal form of coordinated pest management**. Furthermore, some of the expenses are reproduced every time a different subject is employed, at least during the phase of diagnosis and planning which are contemplated in each action fee, but also when different strategies are chosen by different subjects.

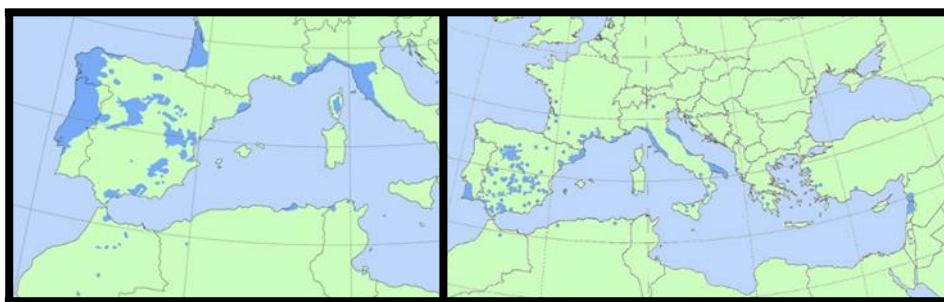
For these reasons, and since the market does not offer a comprehensive strategy to overcome them, a new approach is needed to better address pine pests in the Mediterranean area, focusing on the following major pests: Maritime Pine Scale (*Matsucoccus feytaudi*), Six-toothed Bark Beetle (*Ips sexdentatus*), Common Pine Shoot Beetle (*Tomicus destruens*), Western Conifer Seed Bug (*Leptoglossus occidentalis*) and Pine Processionary Moth (*Thaumetopea pityocampa*).



Major pests in Mediterranean area. (1) *D. sylvestrella* on maritime pine; (2) *I. sexdentatus* adult; (3) *T. destruens* adult; (4) *T. pityocampa* larvae.

NEXT Genomics S.r.l. (NEXT) proposes a new package of services called **GreenShield (GS)** to overcome the above-mentioned problems. This package will include all the needed activities to manage pest infestations in Mediterranean pine forests: from diagnosis, to control planning, monitoring, and containment. **A single enterprise that surveys, plans and executes.** The package also includes network-building and informative events to promote GS-IPM, with the aim to progressively cover more territory over time. Such package is going to cover multiple scenarios (**both public and private**) so that scaling up in an over-fragmented land may be possible. The right integration of expert personnel and state-of-the-art services are going to be provided by a single enterprise, simplifying management and maximizing the benefit-cost ratio. More specifically, GreenShield endeavors to the following objectives:

- Precise and quick identification of pests
- Precise and quick infestation surveys (using drones and GIS)
- Prompt planning and execution of the best prevention/control practices
- Smartphone app to enhance infestation reporting, as well as planning and coordination of phytosanitary measures
- Supervision and counselling during phytosanitary felling
- Innovative testing and implementation of repellence techniques against bark beetles
- Monitoring of infestations to optimize planning and to verify control efficacy
- Protection of pests' natural enemies
- Networking with several forest owners to expand management over large continuous territories



Distribution range of maritime pine (on the left) and stone pine (on the right).

Source: Euforgen.

Overall, the GreenShield approach may grant benefits not only to forest owners but also to the community in general, since a conserved landscape is going to be appreciated from neighbor areas and the negative effects on the pest population reduce the risk of its spreading in new areas. Furthermore, this comprehensive management approach will prevent the abuse of chemicals, or felling thanks to a more precise and prompt line of work. As a result, the environment is going to be less polluted and trees are going to be felled only when it is strictly necessary. Consequently, positive outcomes will include also **production** (timber, seeds, etc.).

Instead of employing several subjects to address the phytosanitary problem, the owner will consult only NEXT, **saving time and money**.

NEXT points to become a leader in plant protection by offering the best integration of phytosanitary measures on a large scale. The market is unable to offer now all these services coordinated by a single enterprise. This is why NEXT has already developed a small-scale approach to integrated pest management in coastal pine forests of Italy: from counselling to direct control of pests, and coordinating every aspect of the work. With the present proposal, NEXT intends enhance its potential, researching and providing new phytosanitary tools as well as covering as much territory as possible.

In fact, NEXT wants to invest in the environmental sector, hiring expert personnel specialized in IPM, as well as developing **new instruments and strategies: custom control traps, new baits and repellents, new dispensers, new tree-injection compounds, drone-based strategies to monitor infestations, and dissemination networks to apprise the community**.

The GreenShield package **highly expresses the IPM concept complying to European regulations**. NEXT can prove with a market analysis that the activities described in the GS package are going to cost less when compared to the same activities if these are carried out by different competitors: e.g. the early stages (survey/diagnosis) would only be performed by NEXT (**just once!**), not by



several companies at different times (replication of costs). **So, the integrated package costs less than disjointed services!**

Now a business plan is needed to:

- identify and correct the weaknesses that could hinder the upscaling of the idea;
- Identify an adequate market strategy;
- Identify potential target markets for the first phase of expansion
- Identify strategic suppliers to ensure market relationships and prototype production

2. Concept and approach

GreenShield intends to integrate the most modern phytosanitary defense techniques to protect pine forests, making it more cost-effective and sustainable. Such an approach will be referred to as **GreenShield Integrated Pest Management (GS-IPM)**, which is founded on the following three concepts:

- **Streamlined coordination:** only one referent reviews, plans and directs all phytosanitary actions, ensuring a careful diagnosis of pests and their constant monitoring through the continued presence of staff in field and laboratory activities;
- **Continuous data processing:** this grants prompt planning and execution, avoiding logistical delays that often lead to aggravation of plant health, and allows NEXT to continuously interface with customers;
- **360° management:** a holistic approach offers an all-inclusive package of phytosanitary integrated services, which can be modulated according to each situation, in compliance with the IPM.

GS-IPM introduces the concept of *good practices* as "**novelty**", since they are always advised in this field, but today, mainly because of poor coordination between the parties, no one really does them. In addition to the significant reduction in customer costs, the implementation of GS-IPM in Mediterranean pine woods will reduce the environmental impact, with positive repercussions also on the community through the preservation of both landscape and timber. That is why NEXT calls this "**COMMON SENSE AS INNOVATION**".

NEXT has already embarked on implementing some phytosanitary measures following the GreenShield concepts in some forest areas of the Italian coast. In this respect, encouraging results have been reported regarding the integration of the following activities:

- **Survey and diagnosis:** Identifying the infestation outbreaks or any hot spot for plant health risk allows data-gathering which results essential for mapping and planning. Recognition of symptoms and accurate systematic identification of pests, thanks to laboratory analysis (morphological,



anatomical and molecular), are essential for a proper assessment of phytosanitary issues and for calling the right actions;

- **Management consultancy and supervision:** the most appropriate and environmentally friendly measures are offered to the customer, so that they are appropriately integrated with each other, while also ensuring constant situation reports. Supervision of phytosanitary felling and bait plants selection will be carried out in order to maximize pest containment as well as to synchronize the operations to the life cycle of each target pests. The GreenShield package aims to achieve swift and steadfast IPM, simplifying the relationship with the clients, thus saving clients' money;

- **Monitoring and Mass Trapping:** The installation of insect-specific traps, baited with attractive volatiles (sex or aggregation pheromones, as well as generic attraction), can allow the capture of adult pest specimens: this will permit to identify population dynamics so as to schedule control actions at the right time. In addition, for some pests, it is possible to capture a very large number of adults, so as to dramatically limit the population growth;

- **Repellence:** this is a novelty for Europe. The technique consists in using specific dispensers of a naturally occurring substance which imitates the mechanism that some bark beetles use to discourage the competition among themselves on the infested plants: i.e. the odor of this substance reduces the chance of attack because pests experience a kind of "overcrowding smell" that drives them to go elsewhere. These dispensers are to be placed on tree trunks in areas at risk. Trials conducted so far in coastal pines have given encouraging results;

- **Tree injection (Endotherapy):** It is a curative technique (also effective in prevention) based on the injection of active compounds in the plant's vascular system, which translocates and distributes them into the wood and canopy. Their pesticide/fungicidal/nutritional action is granted without polluting the environment as it usually happens with aerial treatments. It is apparent from the literature that at present only a few molecules are available that can be used against pine pests, but with uncertain results.

NEXT proposes some **enhancements and additional activities for GS-IPM** making the service even more advanced and competitive on the market:

- **Drone:** The quality of the surveys could be further improved by using a drone equipped with GPS and enhanced optical sensors (e.g. with near infrared sensor, thermal infrared sensor, etc.). This device will implement the quality of the data captured in the field. Owing to advances in sensor technology, increasingly smaller, lighter, and cheaper sensors have become available for drone remote sensing applications;

- **Smartphone Application (APPlant):** In order to make it even easier to interface with NEXT, an application will be created to report symptomatic plants, send photos, advise treatments, etc.;

- **Customs traps:** NEXT points at developing trap modifications to reduce impact on non-target species by effectively reducing catches of pests' natural enemies and other useful arthropods by up



to 50%, without reducing catches of target species, thus safeguarding the natural biological control carried out by predators;



Implemented phytosanitary measures (GS-IPM). (1) Insect-specific trap and (2) drone.

- **Repellent Dispensers:** Dispensers will be further enhanced by NEXT, relying on the gathered experience in Italian coastal pinewoods, to maximize dispersal efficiency. Industrial scale production will be possible by partnering with local manufacturers;
- **Novel Tree Injection Compounds:** Following interesting findings by various suppliers, NEXT intends to undertake laboratory and field tests to identify the most effective molecules to control pests by tree injection, favoring those which are allowed in organic agroforestry. In addition, it proposes the development of new plastic injectors, which allow the translocation of the active compound in a simple and speedy manner.

ACTIVITIES	PROPOSED INNOVATIONS
Survey and Diagnosis	Remote sensing Drone
Management consultancy and supervision	Smartphone App
Monitoring and Mass Trapping	Ecofriendly Custom traps
Repellence	New protocols and enhanced dispensers
Tree Injection	Novel active compounds

Preliminary economic analysis and the curiosity shown by several potential customers based on the interesting results already attained, show that GreenShield could be a management and economic success. In fact, such a complete and integrated approach to plant health does not exist at this time and it could mark a breakthrough in IPM of large territories with similar phytosanitary issues. Through the collaboration with recognized specialists, NEXT will develop a professional Business Plan according to international specifications to ensure the correct document setup. The document will identify the business strategies, economic and financial development, and the internationalization process for NEXT, with particular reference to the choice of component suppliers and the correct positioning on the market. So, the GreenShield package represents an



ideal approach, always recommended but never fully realized, revolutionizing the current modus operandi of the plant defense industry, especially in the Mediterranean environments. This phytosanitary service package, based on the implementation of GS-IPM, will result in a much **faster coordination**, leading to a **cost reduction** of each activity, **prompt action** provided by constant monitoring, and a **reduced environmental impact** by optimizing phytosanitary tree felling as well as favoring ecofriendly treatments.

3. Ambition

The proposal by NEXT is based on the implementation of the "good practices" for plant protection, but with new strength and resolution, thanks to innovation and new technologies. That is what others consider only as common-sense concepts but that are almost never put into practice. This is mainly due to lack of coordination and expertise. The holistic approach, and its rational simplification, defines a new way of understanding IPM in Mediterranean forests, **with the prospect to export the methodology to all other forest systems**, aiming to extend the range of action from a local scale to larger areas, facilitating plant health control in the fragmentation of the territory between public and private.

NEXT can tell you about its service package:

"FROM COMMON SENSE TO REAL IPM!"

Currently there is nothing in the European landscape that is promoted, planned and realized entirely by a single subject, able to supervise all phytosanitary activities. In fact, NEXT aims to become a reference point in the Mediterranean market for the preservation of pine forests, especially those for productive and tourism purposes, with the aim of becoming a partner of campsites, residences, municipalities, parks, pine wood & seed producers, private citizens, etc.

GS-IPM has the following major benefits for potential customers, which are **currently unavailable as a single package offer** (the comparison is always performed between NEXT services and those provided by competitors):

- **Coordination:** All plant protection services are planned and supervised by a single referent, eliminating delays, overlaps and skill-related controversies;
- **Modularity of the package:** the customer can select the activities to be performed, depending on their budget, under the supervision of NEXT experts and in agreement with IPM guidelines;
- **Increase in readiness:** constant monitoring will grant faster execution of the proposed activities, avoiding delays that currently undermine the success of phytosanitary measures;
- **Cost Reduction:** by having only one referent will allow the customer to save a lot on the costs of individual activities, without having to be charged each time for call costs, diagnosis costs, planning costs, etc.;



- **Environmental Impact Reduction:** Pesticide control activities will be carried out by always choosing the most environmentally friendly solutions and limiting the environmental impact by using biological compounds, respecting non-target insects, planning tree felling only when strictly necessary, etc.

Such an approach is going to preserve landscape, indirectly favoring both community and economy, by positively affecting tourism as well as timber/nut production.

Unfortunately, in the plant-defense market, companies tend to offer the services in which they are specialized and not those that really would best control the pest. This is the common practice, so that they can give something to the customer. Just looking at what's on the market one can say that **GreenShield is a simple yet innovative idea.**

We can stress these assessments based on preliminary market studies and statements received from early customers with phytosanitary problems who had given up doing something about it due to the difficulties in finding someone capable of providing a modular and complete service.

Thus, NEXT has found a solution where scientific and technical knowledge are integrated in a plant defense project that has already been tested with interesting results only at a small-scale level. NEXT will be able to devise a package of services yet more advanced in the future. A decisive improvement will be possible, thanks to GS-IPM, the company will be able to coordinate and supervise activities in larger areas, thus creating "**pest free**" territories with benefit also for the health of neighboring forests. Research on this field will have to consider the commitment of specialized personnel, with an overall increase in professional and technological standards in the phytosanitary sector.

Impact

a) Users / Market

The NEXT approach can produce benefits by simplifying coordination of plant- defense activities, trying to reduce environmental impact in landscape protection and promoting new market solutions (eg. repellence). So, it can provide benefits to all stakeholders:

PUBLIC ADMINISTRATIONS: GreenShield allows administrations to optimize coordination in their territories and facilitate their exchange of information with private owners, also speeding up the implementation of many activities.

PRIVATE OWNERS: GreenShield guarantees modularity in package planning, but above all a reduction in costs, which is imperative in small private properties.

TOURISM OPERATORS: GreenShield would be of assistance to camping villages, residences, hotels, caravan park areas, etc., as it allows constant monitoring, counseling, and planning of any plant-health issues that may arise as a threat to tourism seasons.

COMMUNITY: GreenShield deals with a new way of integrating phytosanitary measures that require high standards of applied entomology and plant pathology, and therefore a higher level of professionals.



Streamlining of coordination and modularity of the package are the new features proposed by NEXT for the Plant Protection sector. To date, no operator in this field is now able to actually offer this system. Modularity is the most important technical aspect that influences the potential customer because it corresponds to flexibility, conforming to any specific situation, thus leading to **fewer expenses**. Coordination and modularity are certainly the main aspects NEXT will concentrate on its advertising campaigns.

In addition, the concept of **constant monitoring is not secondary for the customer**, both in small and larger environments, since it ensures a concrete **increase in intervention readiness** affecting positively the efficacy of control measures as well as costs.

The initial goal is to enter the market for the plant protection sector, starting from Mediterranean pine woods, which is certainly lacking in terms of technical innovation, with the aim of managing forest environments in a way that is **both effective and environmentally friendly**. The development of a **streamlined system** together with **specialized personnel** as well as **new phytosanitary measures** (drone, custom traps, smartphone app, new molecules, etc.) represent a **new way of doing IPM**.

The European Community has about 161 million hectares of forests (of which 60% private and 40% public), which in many cases are threatened by abiotic and biotic factors. Today this is more than ever aggravated by ongoing climate change. Among the abiotic factors (i.e. physical or chemical) that threaten forests are included fires (especially in the Mediterranean region), droughts, storms (on average, during the last sixty years, each year at least two storms have significantly damaged European forests) and atmospheric pollution. In addition, the fragmentation of forests caused by transport infrastructures poses a risk to biodiversity. As for biotic factors, harmful insects and diseases can take advantage of such weaknesses and can cause damage to the forests. Overall, around 6% of forest areas are damaged by at least one of these factors (European Parliament data). Climate change is already posing a big challenge for European forests and for those working in the field of plant protection. It affects pest growth rates, their area of distribution or the frequency and intensity of extreme weather phenomena. The management of forests according to these environmental changes and the control of harmful parasites represent the real challenge for those who invest in safeguarding these ecosystems.

GreenShield aims to limit the management problems that currently concern plant protection, which are mainly due to poor coordination among the various actors involved. In fact, streamlined and adjusted management according to specific situations will allow IPM to be carried out smoothly and effectively in designated Mediterranean pinewoods. In fact, GreenShield makes available what other competitors do not even propose in plant protection, or that they could do only to some extent (see table). For example, Regional Phytosanitary Services respond only to the emergencies reported by governmental decrees, carrying out only those diagnostic and control activities



contemplated by the current legislation. Forestry studies (freelance professionals in general) can sometimes deal with phytosanitary diagnosis, although they often lack a suitable level of expertise in this area, while generally dealing with the part of supervising forestry operations. Pest control companies, on the other hand, are specialized in control (e.g. tree injection) and may also identify phytosanitary problems, although diagnoses are often biased by necessity to promote only the services they can offer. Thus, nobody supervises the phytosanitary measures from the start to finish, having customers to interface with several parties (sometimes very discordant with each other).

In addition, these subjects do not propose important phytosanitary measures such as traps for monitoring and mass capture, nor do they apply the repellence technique, which NEXT not only implements, but is also willing to invest in developing and further improving it.

Forest pest management	NEXT Genomics	Phytosanitary Services	Freelance professionals	Pest control companies
Diagnosis	✓	✓	✓	✓
Lab analysis	✓	✓		
Forestry operations supervision	✓		✓	
Monitoring	✓	✓		
Mass trapping	✓	✓		
Repellence	✓			
Tree injection	✓			✓

A careful analysis of the costs and amortization for the service package is necessary and a good market strategy is today the biggest requirement to enter the market.

The GreenShield package by NEXT will be initially introduced in Mediterranean Europe where there is more interest in the environmental protection of **pine forests** and where this type of forests has a strong impact on the tourism sector, which in many areas is the **driving economy**.

NEXT intends to strengthen partnerships with local authorities, including the organization of conferences, meetings with the population, and entrepreneurial initiatives promoted by regional and national policies.

To succeed, NEXT will need trusted suppliers to guarantee the company's role in this business, which are supposed to be well-versed in the market and can best deliver **high-quality products**. From this kind of partnerships, and the quality of the resulting services, more **trust from potential customers** is also gained.

b) Company

The plant protection market, especially in forestry, is dominated by small and medium-sized enterprises. Thanks to management streamlining, improvements to existing technologies, and the



proposed innovations, GreenShield can be the foundation for a real change in plant protection, leading to an overall improvement in available technologies for small and medium-sized businesses. The proposed idea is the culmination of a long process of theoretical and experimental research that has been conducted on the potential of this work. Now an **in-depth analysis of the economic features** is needed to identify the position of GreenShield on the market. The **scaling process** of this kind of services is certainly complex and makes it difficult to quantify the actual volume of trade agreements that will take place in the first period.

NEXT develops avantgarde IPM techniques (GS-IPM). This kind of activities require improvements to new technologies or new pesticide molecules that are not available on the market today. That is why NEXT is also studying and developing custom traps and molecules to achieve better and better results in both large and small areas.