Excursion to Forest Tree Breeding Center and front line of forest pest control in Tohoku District (June 14 - 16, 2012)

Japanese Oak Wilt and Its Control

1. Outline of Japanese oak wilt

Japanese oak wilt (JOW) is an epidemic in Fagaceae trees, especially *Quercus crispula* and *Q. serrata* (Fig. 1). JOW damage has been recorded sporadically since 1930s. After 1980s, the epidemic have intensified and spread mainly in the western coastal areas. By 2012, JOW has become nationwide, from northernmost Aomori Prefecture to the westernmost Yamaguchi prefecture in mainland Honshu Island (Fig. 2). Some factors such as over growth and/or senescence of Fagaceae trees and warming impact are considered to contribute the recent explosive expansion of JOW.

JOW is caused by *Raffaelea quercivora* (Fig. 3) which is the symbiotic ambrosia fungus of *Platypus quercivorus* (Coleoptera: Platypodidae) (Fig. 4). Thus, control of JOW will be accomplished by (1) eradication of *P. quercivorus* propagating in the damaged trees, (2) Mass trapping of newly emerged adult of *P. quercivorus,* (3) Prevention of the fungal growth in healthy trees with injecting antifungal agent, (4) local elimination of the host trees (next page).

In Tohoku District, the first examples of JOW damaged trees were found in Iwate and Aomori Prefectures in 2010, which means JOW-affected area covered whole Tohoku area (Fig. 2). As Tohoku have a rich standing stock of *Quercus crispula,* highly susceptible species to the disease, we are deeply concerned about further spread of JOW in the area.

Fig. 1 Damage by Japanese oak wilt
Left: Heavily damaged oak forest (Nagai, Yamagata Pref. 2010)
Center: Dieback of a 60-year-old tree of *Quercus crispula*
Right: Trunk attacked by *Platypus quercivorus*, Each hole was marked by putting a toothpick in.

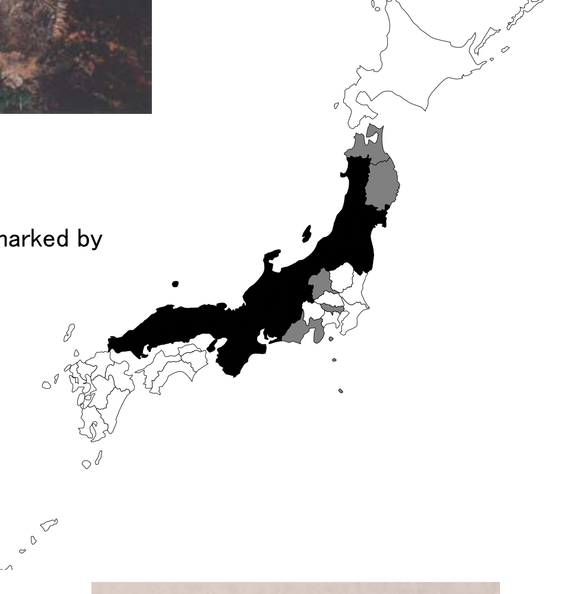


Fig. 2 Distribution of damage in *Quercus crispula* and *Q. serrata* trees on the prefectural basis.
Solid: confirmed before 2009, Gray: newly confirmed in 2010

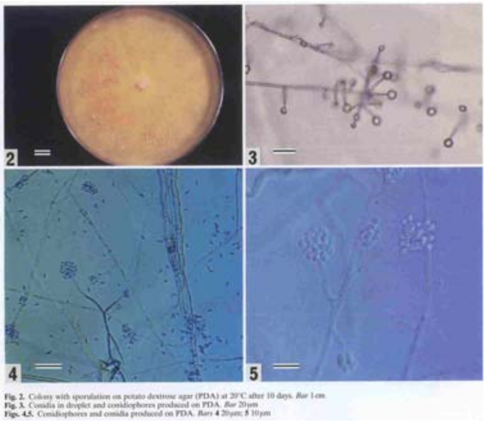


Fig. 3 *Raffaelea quercivora* as the causal agent of Japanese oak wilt (Kubono and Ito, 2002)

Fig. 4 The insect vector, *Platypus quercivorus*
Left: female, Right: male

2. Control methods against JOW in Yamagata Pref.

1) Eradication of *P. quercivorus* in damaged trees and deterrence of boring by the adults

★Standing tree fumigation

Boring holes for injection

Injecting fumigant

★Fumigation of felled trees

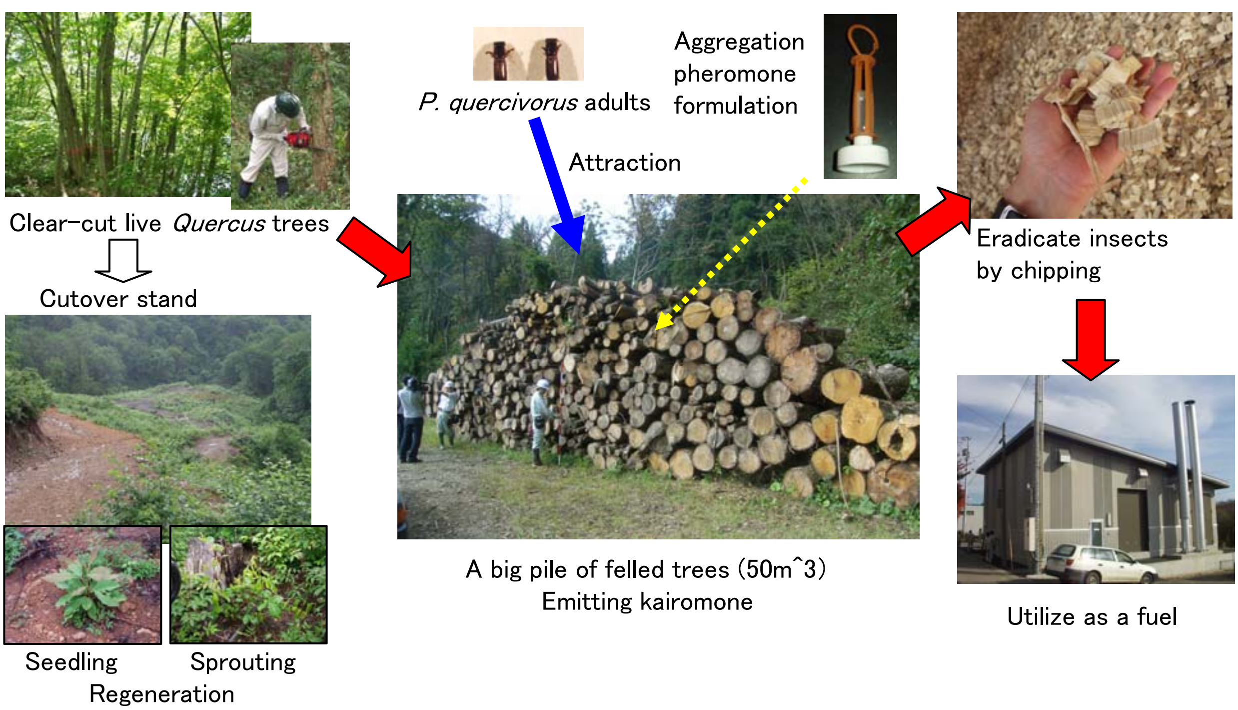
★Trunk treatment to deter boring by *P. quercivorus* adults

Insecticide (MPP) application onto trunk surface

Application of adhesive compound

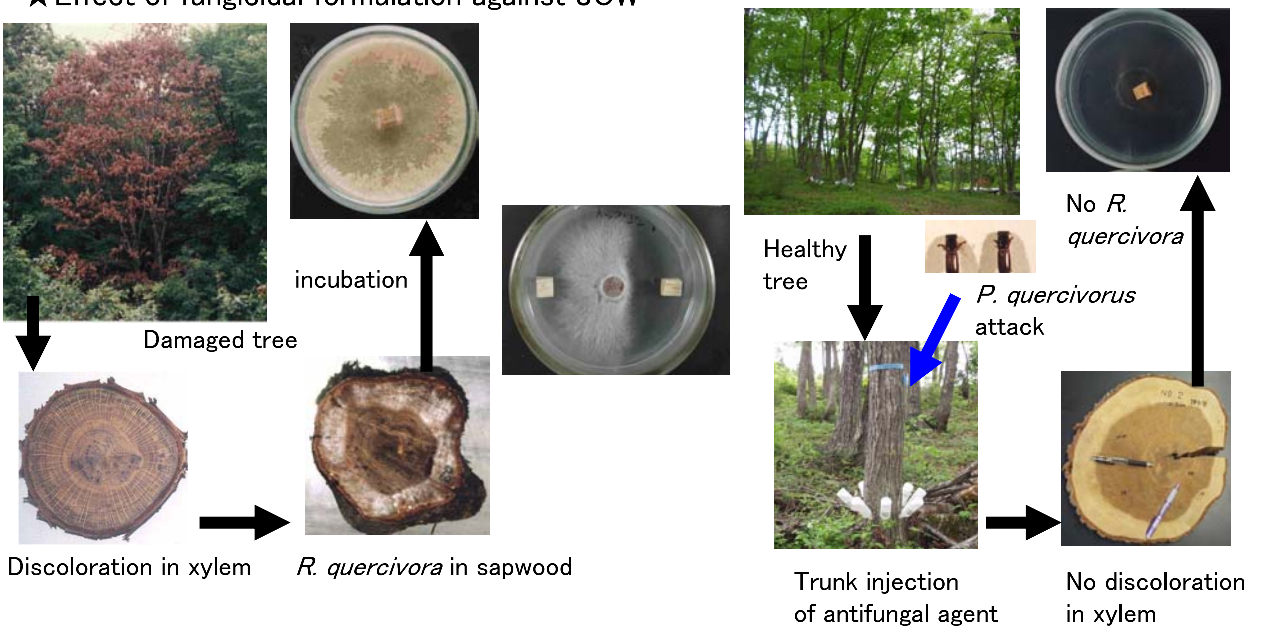
Covering trunk with plastic sheet

★Mass trapping of *P. quercivorus* by a big pile of felled trees with a pheromone formulation



2) Prevent disease development by antifungal agent

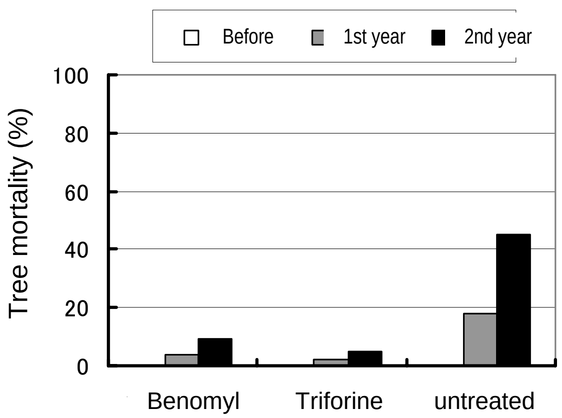
★Effect of fungicidal formulation against JOW



★Fungicidal formulation for JOW prevention (launched in 2009–2010)

Benomyl formulation (“Quer-suketto”, SumikaGreen Co. Ltd.)

Triforine emulsion formulation (“WoodKing SP”, Sankei Chemical Co. Ltd.)

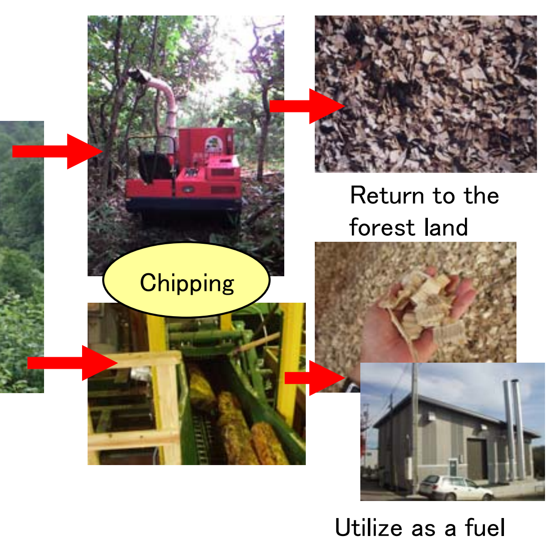


Effect of fungicide injection (Saito, 2009)

3) Preventive felling of *Quercus* trees

★Clear-cut followed by resource utilization and forest regeneration

Clear-cutting promotes regeneration



3. Observation site

1) Location

Onuma Camp Site
(Nishikawa Town, Yamagata Pref.)
N 38°25’ 14.6” E 140°06’ 23.2”
420 m a.s.l.

2) Stand Condition

Dominant tree species:
Quercus serrata, Q. crispula,
Castanea crenata, Fagus crenata
Tree age: 65–150 yrs.
Strand density: ca. 500 /2ha of the area

3) Management

Nishikawa Town owns the land and delegate management to the local community
Outline of the management practice:

- ➢Bush cutting (2–3 times/yr) as maintenance of the camp site
- ➢Disposal of the Oak wilt damaged–trees: standing tree fumigation, felling, chipping
- ➢Trunk injection of antifungal agent to the healthy trees

4) Yearly change of the JOW damage level and control operation employed

Year	2009	2010	2011	2012
Trees killed (%)	2 *Q. serrata* trees (0.4%)	6 *Q. serrata* trees (0.4%)	12 *Q. serrata* trees (0.4%)	
Eradication	All damaged trees are treated by standing tree fumigation method and then felled and crashed into chips.			
Prevention (pilot trial)	None	Trunk injection with fungicide* (189 trees) > 6 killed by 2011 >7 killed by 2012	Trunk injection with fungicide* at high density and low doses (71 trees in spring / 45trees in autumn) > 5 killed by 2012	Trunk injection with fungicide* at high density and low doses (scheduled)
Damage level in neighboring untreated stand	18%	22%	25%	

*WoodKing PS® (Triforine formulation)

➔JOW damage is minimized by the implementation of proper control methods.

Decline of Deciduous Broadleaved Forests by a Scale Insect *Comstockaspis macroporana* (Hemiptera: Diaspididae)

1. Forest damage by *Comstockaspis macroporana*

Recently, outbreak of a scale insect *Comstockaspis macroporana*, (Fig. 1), resulting in an extensive damage by blight in broadleaved trees (Fig. 2) has occurred in various regions in Japan; it has been reported in Yamagata, Fukushima, Nagano, Yamanashi, Niigata, Miyagi and Iwate Prefectures by 2010, and introduced into Akita Prefecture in 2011 (Fig. 3).

This insect had been well known as a pest in orchard, especially chestnut trees. Spread of the insect from abandoned orchard into nearby forests and accidental introduction of contaminated nursery trees by humans are the plausible factors of recent expansion of *C. macroporana* outbreak.

C. macroporana attacks most of deciduous broadleaved trees, and in case of *Castanea crenata* and *Quercus serrata*, heavily damaged trees are often killed. They do not attack some deciduous broadleaved trees such as *Rhus trichocarpa* and *Robinia pseudo acacia*, as well as evergreen broadleaved trees and conifers.

Once the damage occurred, 30% of the standing trees of susceptible species are killed within 3 years. Then, in most cases, the survived trees start to regrowth although the forest crown remains open. Insect itself disappears 3 years after the onset of the damage in the stand, with spreading their distribution to the neighboring stands. The spread speed is usually at a pace of 300–400 m per year, while a new outbreak can occur abruptly within 5–10 km radius form the original damaged area.

A parasitoid wasp Pteroptrix sp. (Aphelinidae) are known as an natural enemy of *C. macroporana*. In Yamanashi Prefecture, *C. macroporana* damage ceased in 2008 following the occurrence of the parasitoid wasp.

Fig. 1 *Comstockaspis macroporana*
Left: Heavily colonized branch of *Quercus Serrata*
Upper: Scale and newly emerged larvae
Lower: Crawlers (1st instar larvae)

Fig. 2 Forest decline caused by *C. macroporana*
Left: Heavily damaged deciduous forest in Yamagata Pref.
Right: Top-dieback after the sucking of the scale insects.
Center: Recovery of survived trees depending on the epicormic shoots.

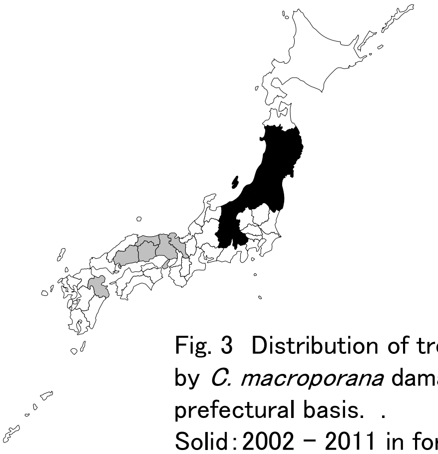


Fig. 3 Distribution of tree damage by *C. macroporana* damage on prefectural basis. .
Solid : 2002 – 2011 in forest trees
Gray: before 2001 in orchard

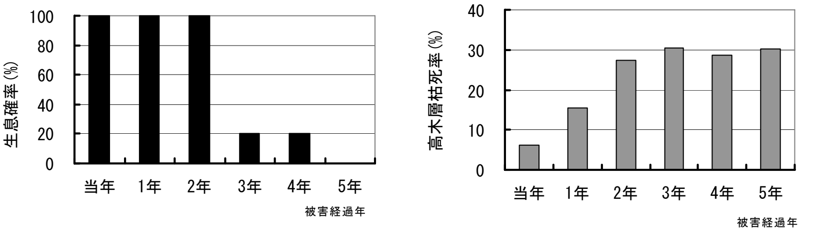


Fig. 4 Characteristics of *C. macroporana* outbreak in forest settings
Left: Proportion of the trees attacked by the insects
Right: Cumulated number of killed trees.

2. Trunk injection of pesticide to prevent dieback caused by *C. macroporana*

<<<Developed by Yamagata Prefectural Forest Research and Instruction Center>>>

1) Why trunk injection works?

Most scale insects like young branches with thinner bark. In host trees of *C. macroporana*, however, young branches are on the top of the tree, thus hard to access for us. In addition, resist rated pesticide for *C. macroporana* in chestnut orchard are supposed to be applied to crawler larvae, which occurs only 2–3 days in their life cycle. Consequently, eradication of *C. macroporana* by spraying pesticide is not realistic in forest settings.

Alternatively, by injecting aqueous solution of a pesticide from the lower trunk, we can expect that the pesticidal agent would delivered up to the top branches along the movement of water in the tree and kill the sucking insects like *C. macroporana*.

2) Procedure

(1) Pesticide used: "MatsuGreen liquid formulation 2" (NissoGreen Co. Ltd.)

- ➢active ingredient: acetamiprid 2%
- ➢Originally developed to apply to the pine sawyer beetle (*Monochamus alternatus*) adults

(2) Preparation of the formulation

- ・Dilute the formulation by 50-fold with water, then put into a 200ml plastic bottle with injection nozzle.

(3) Boring injection holes

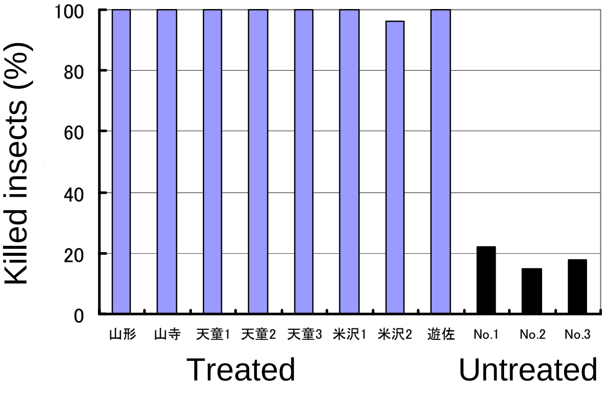
- ・Measure the diameter of the target tree to decide the required number of the bottle.
  - ☞ 4 bottles for trees less than 20 cm dia. 6 bottles for20–30 cm, 8 bottles for 30–40 cm
- ・Make required number of holes (30 mm in depth at an 45° angle) using 8 mm diameter drill.

(4) Injecting pesticide

- ・Put the nozzle of the bottle into the injection hole.
- ・Leave 24hours, then remove the nozzle.

(5) Effect

- ・100% successful injection in 24 hours.
- ・The insect colonized on the treated trees were killed at as high as 96–100%.



3) Collective application to prevent the spared of the damaged area

If we can set a proper blocking area, in which all host trees of *C. macroporana* are injected with pesticide, along the boundary between damaged and healthy stands, we can deter the expansion of the damaged area. The blocking area requires 20–30 m width, that is 3–5 trees orthogonal to the boundary. (See Yamadera's case in the next page)

3. Observation site

1) Location

Sagae Park
(Nagaokayama, Sagae City, Yamagata Pref.)
N 38°23' 5.3" E 140°16' 12.5" / 145 m a.s.l

2) Stand Condition

Dominant tree species
Quercus serrata, *Castanea crenata*, *Prunus grayana*, *Magnolia obovata*
Tree age 45–60 yrs.
Stand density ca. 6,000 /4ha of the area

3) Management

Sagae City owns the land and manage as a city park.
Outline of the management practice
- Bush cutting (once /yr) along the trail
- Felling and fumigation for pine wilt-damaged trees
- Felling and staking of the scale insect-infested trees

4) Yearly change of damage level by *C. macroporana*

Year	2006	2007	2008	2009	2010	2011
Trees killed (%)	0 (0%)	0 (0%)	6 (0.10%)	29 (0.48%)	66 (1.1%)	3 (0.01%)
Tree health index *	5	4.9	4.7	4.1	3.9	4.3

*Tree health index: 5: good condition ⇔ 1: bad condition

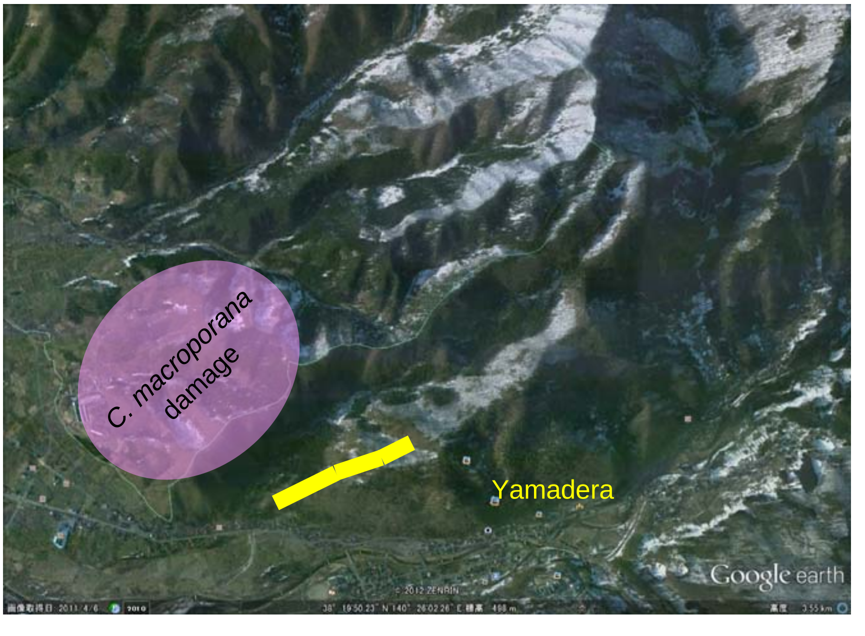
Killed trees occurred from 2008, peaked in 2010, then abruptly decreased. Overall mortality was as low as 1.1% even in the peak year, but survived trees also showed dieback which is reflected in the decline in tree health index. The outbreak seemed to finish in 2011.

4. A test case of collective application of trunk injection against *C. macroporana* in Yamadera scenic area

1) Location: Yamadera, Yamagata City, Yamagata Pref. / N 38°18' 44", E140°26' 11", 260 m a.s.l
North: deciduous broadleaved forest / East: Pine forest ～ high elevation area
West: deciduous broadleaved forest ～ farming area / South: Valley

2) Proceedings

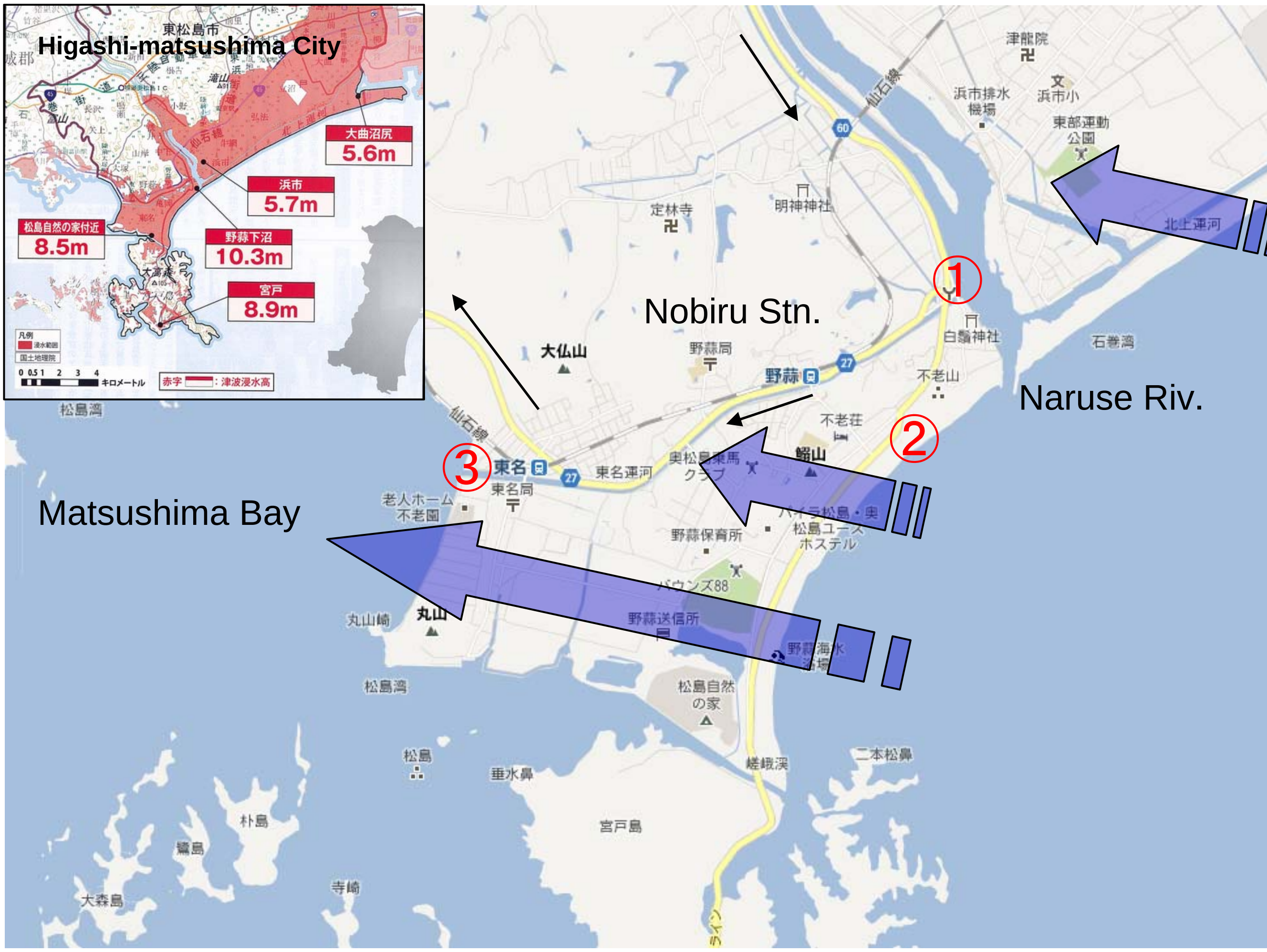
- *C. macroporana* outbreak had raged northern adjacent area by 2007.
- Blocking area of 20 m wide and 200 m long was set in the premise of Risshakuji temple. Trunk injection of the pesticide was applied to 220 trees in the blocking area in June, 2008. This project was performed by Yamagata City and Yamadera Tourist Association.
- Colonized insects on the treated trees ware all died. Treated trees had almost no sign of damage.
- No *C. macroporana* damage has been found since 2008.



Tsunami-damaged Seacoast Pine Forest, a Potential Source of Infection of Pine Wilt Disease

A huge tsunami (tidal wave) following the Great East Japan Earthquake on March 11, 2011, struck the Pacific coastline of Tohoku District. In the southern part of Miyagi Prefecture, the tsunami easily overflow the bank and flooded vast area of coastal plain behind.

Higashi-matsushima is one of the most severely damaged areas. The 8–10 m-height tsunami reached 4 km inland along Naruse River or flew away through the southern part of the area into Matsushima Bay. The land subsided and in some area went submerged. The number of missing and dead was over 1,000 and some 7,500 houses were destroyed in Higashi-matsushima City alone.



There was a wind break forest of *Pinus thunbergii* along the coast line. Houses, resort facilities and other public buildings surrounded by *P. densifrora* forest were behind.

Some of the seacoast *P. thunbergii* trees were felled or bent by tsunami and died promptly. The background *P. densifrora* trees, which seemed no or small damage, became to show needle chlorosis in summer. Unlike other areas (shown in the poster by Nakamura et al.), those dead trees were oviposited by *M. alternatus*, while *B. xylophilus* infection was not so common. The beetle adults flown to the dead trees would be originated form pine wilt-damaged trees remained on the hills nearby.