

Coastal pine forests damaged from the tsunami caused by the Great East Japan Earthquake

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Pine Species in Japan

- ◆ *P. luchuensis*
- ◆ *P. parviflora*
- ◆ *P. pentaphylla*
- ◆ *P. pumila*
- ◆ *P. koraiensis*
- ◆ *P. armandii* var. *amamiana*



P. densiflora
Japanese red pine



P. thunbergii
Japanese black pine



Takada-matsubara coastal pine forest blocked the drifting materials by an earthquake tsunami in 1960 (Photo by Agriculture, Forestry and Fisheries Department, Iwate Prefecture)



💧 **Is pine forest incompetent in coping with tsunami disaster?**



Pine forest was washed out and disappeared after the tsunami following the great east Japan earthquake

Objection against reforestation of coastal pine forest

- ✦ Pine tree is not a member of **potential natural vegetation**
- ✦ Spread of pine trees is just a **result of excessive human activities**
- ✦ **Monoculture** of coniferous forest are weak to climatic / biological damage
- ✦ Pine trees are selected only **for satisfying taste** in Japanese culture
- 💧 Pine trees are not resistant to tsunami because of their **shallow root system**
- 💧 Pine trees are **weak to seawater inundation**
- ➔ Ideal natural forest can not be established under barren seacoast conditions
- ➔ Pine forest is a form of correspondence of nature to the presence of human
- ➔ **Agree:** Diversity-oriented reforestation should be adopted
- ➔ Pine plantation in seacoast sand dune is an attainment of our forefathers' desperate efforts
- ⬅ Huge amount of pine trees was washed out from the root in various areas
- ⬅ Occurrence of foliage discoloration of the remaining pine trees in the tsunami affected area

A photograph of a dense pine forest. The trees are tall and thin, with sunlight filtering through the canopy, creating a dappled light effect. The ground is covered in dry leaves and pine needles. A semi-transparent grey box is overlaid on the center of the image, containing the text "Shallow root system in pine trees?".

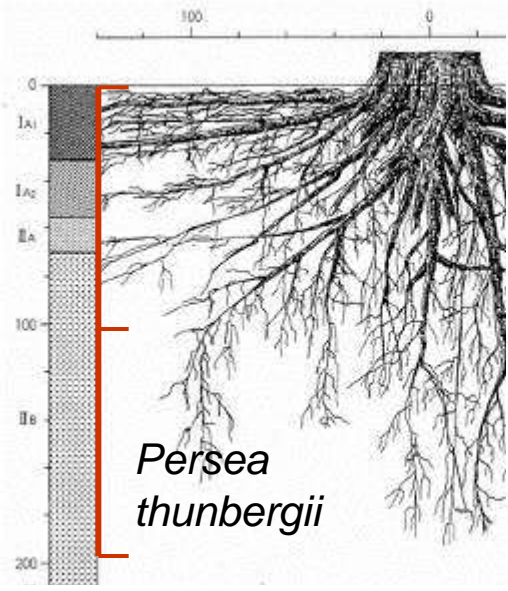
Shallow root system in pine trees?

Uprooted pine trees showing shallow root system

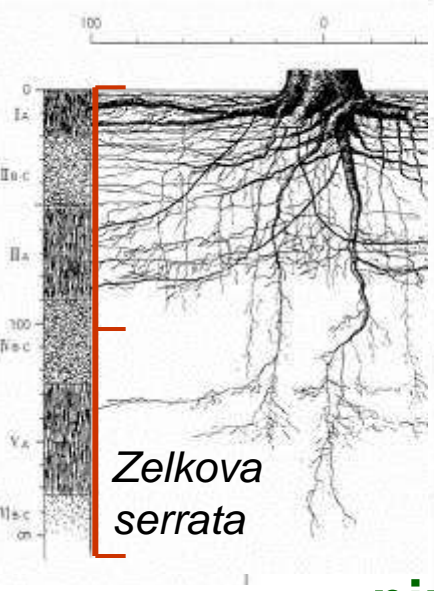


Prior knowledge: cedar trees have shallow root

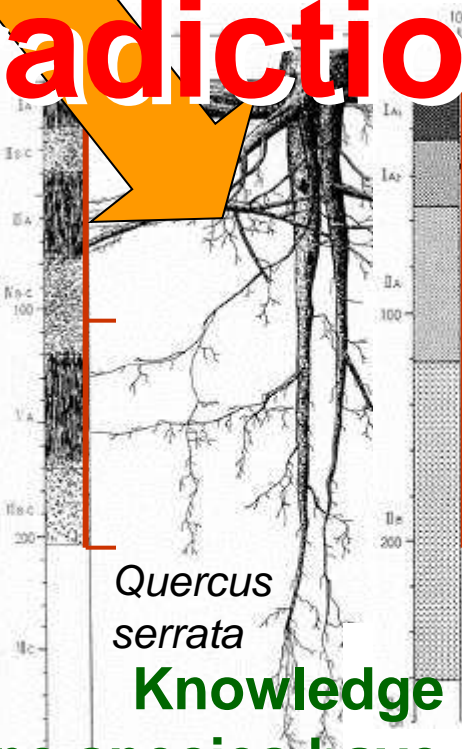
contradiction



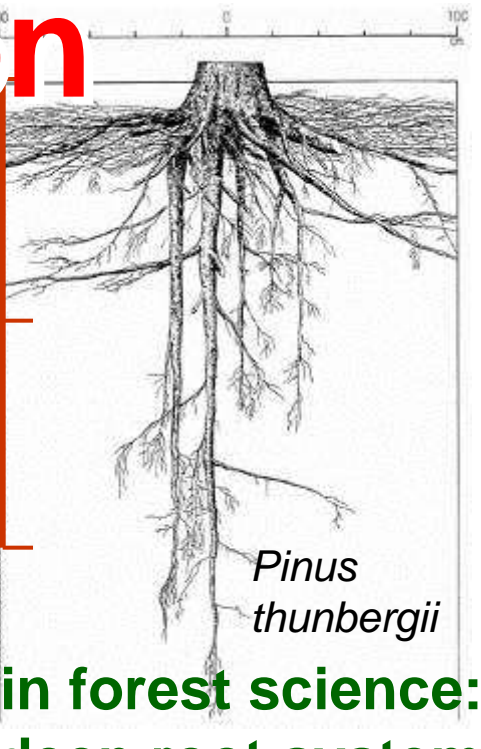
Persea thunbergii



Zelkova serrata



Quercus serrata



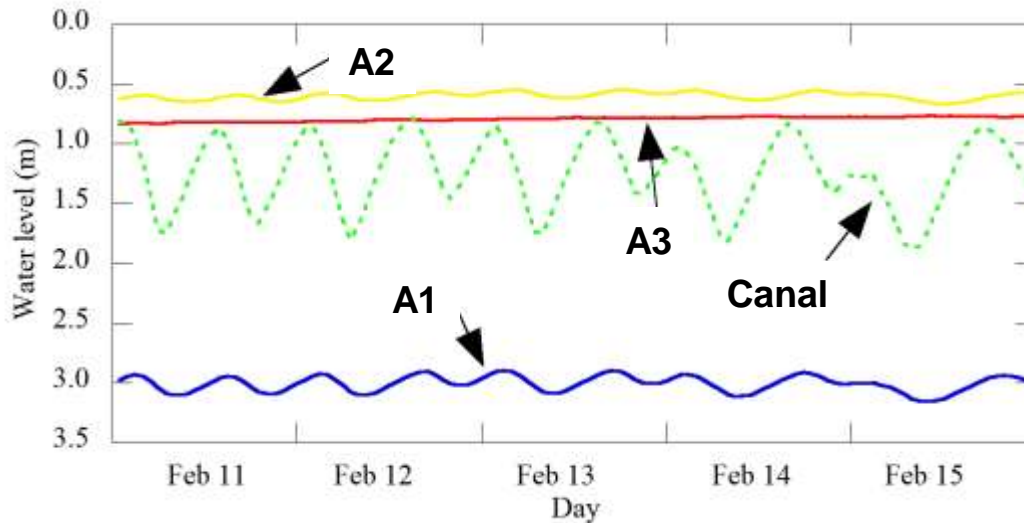
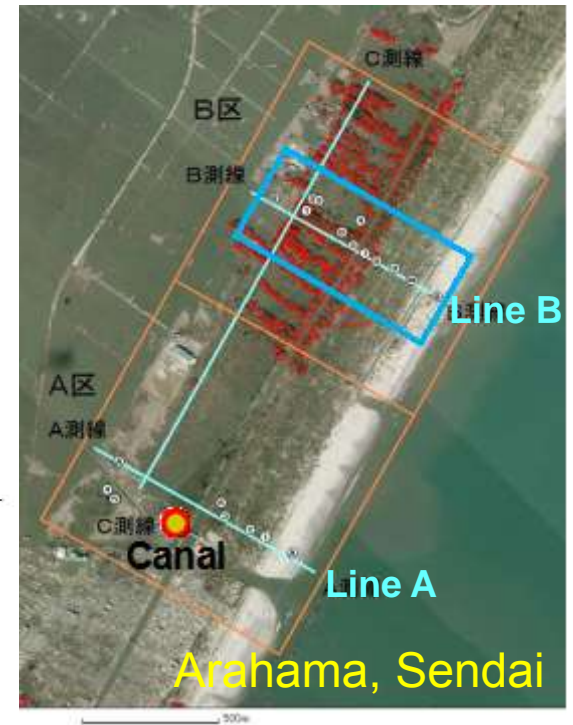
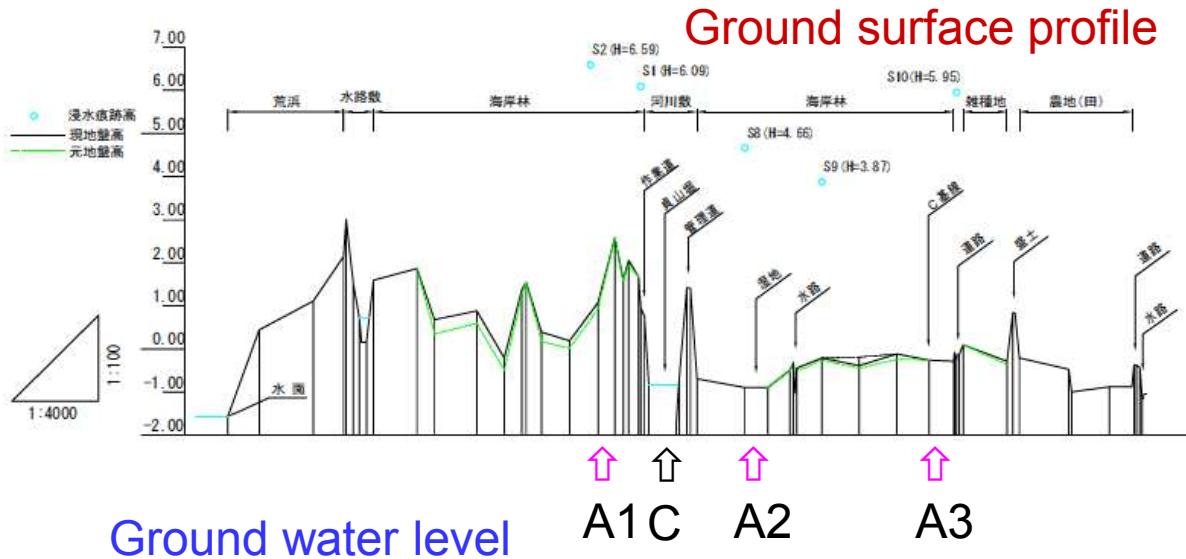
Pinus thunbergii

Knowledge in forest science: pine species have deep root system

“Illustrations of tree roots”(Karizumi, 1987)

Factor(s) for the shallow roots

- High ground water level



- Preparation of the planting seedling



Shallow root system in pine trees?

✳ Pine trees (conifers) are shallow
⇔ Broad-leaved trees are deep

✳ Root of pine trees can't penetrate deep in the ground when ground water level is high

✳ Pine trees are not resistant to tsunami and shall be replaced by broad-leaved trees



→ False

→ True

No difference between pine and broad-leaved trees

→ Incorrect

➤ Pine roots were **strong enough** to resist the tsunami and broken at the stem

➤ No trees can be resistant to the extremely powerful tsunami: **irrespective of species**

A sepia-toned photograph of a pine forest. The trees are dense, with many branches visible in the foreground and middle ground. The lighting is soft, creating a hazy atmosphere. A semi-transparent rectangular box is overlaid in the center of the image, containing the text "Weak to seawater inundation?".

Weak to seawater inundation?

Foliage discoloration in the tsunami-damaged pine trees



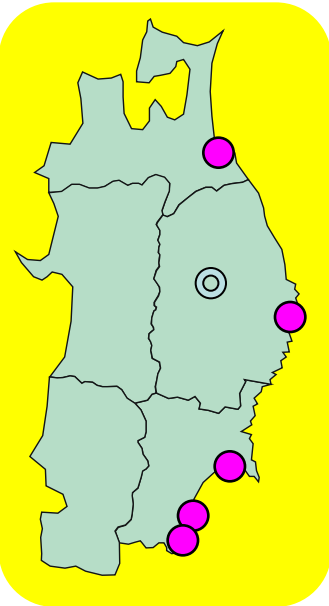
Species of pine tree

P. thunbergii
P. densiflora

Difference in places

Temporal change
(Development/recovery)

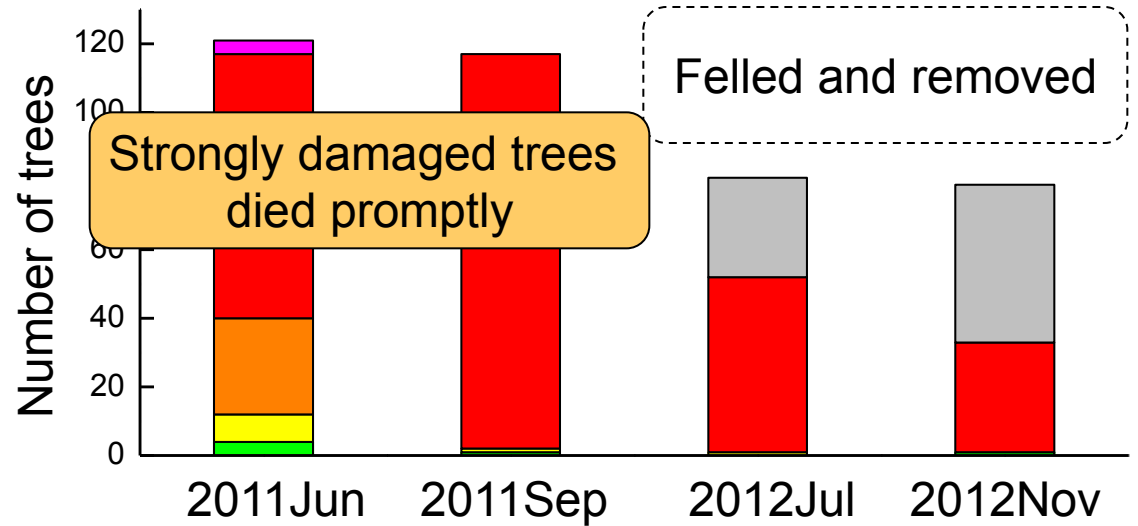
Factors other than tsunami-damage



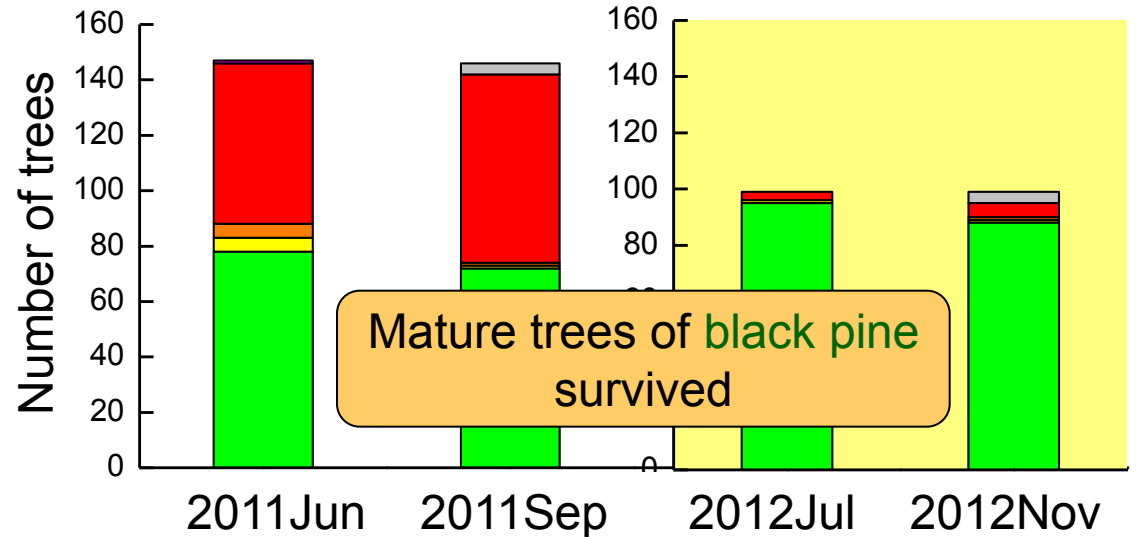
Conclusion

Weak to seawater inundation!

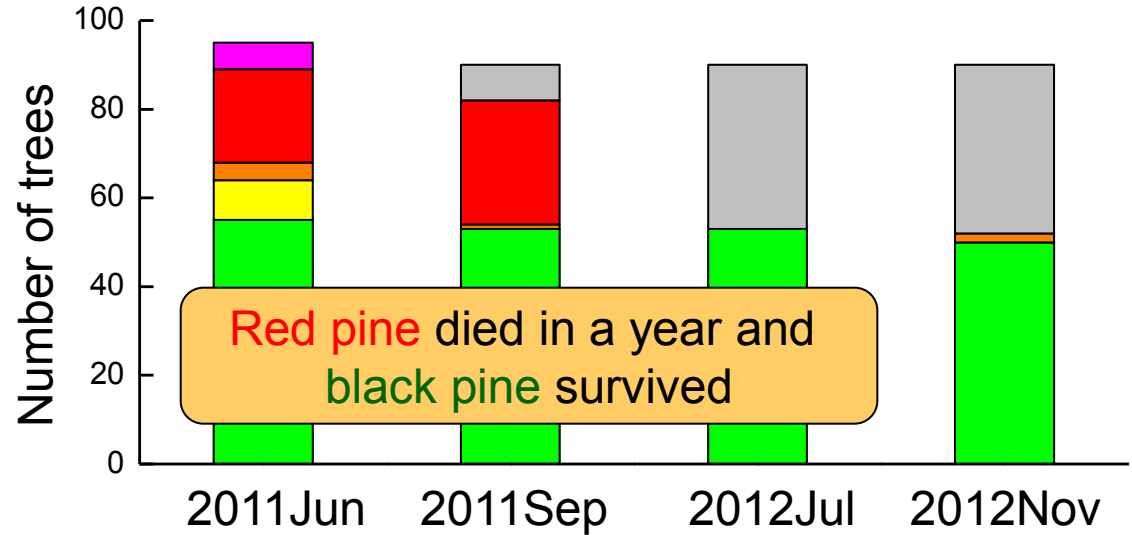
Front-line stand of *black pine* (Watari, Miyagi Pref.)



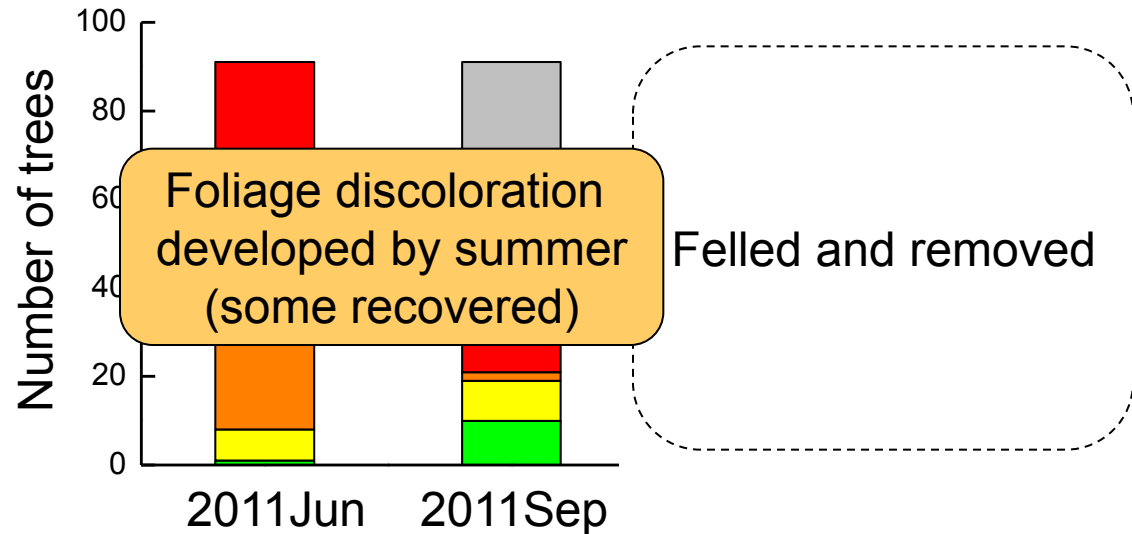
Backward stand of *black* and *red pine* (Watari, Miyagi Pref.)



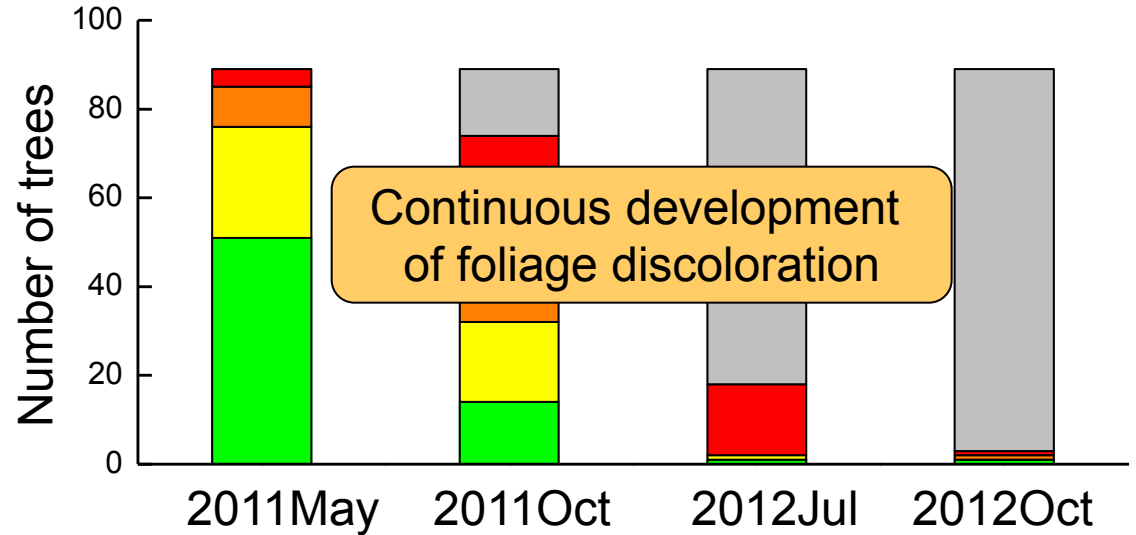
*Backward stand of **black** and **red pine** (Yamamoto, Miyagi Pref.)*



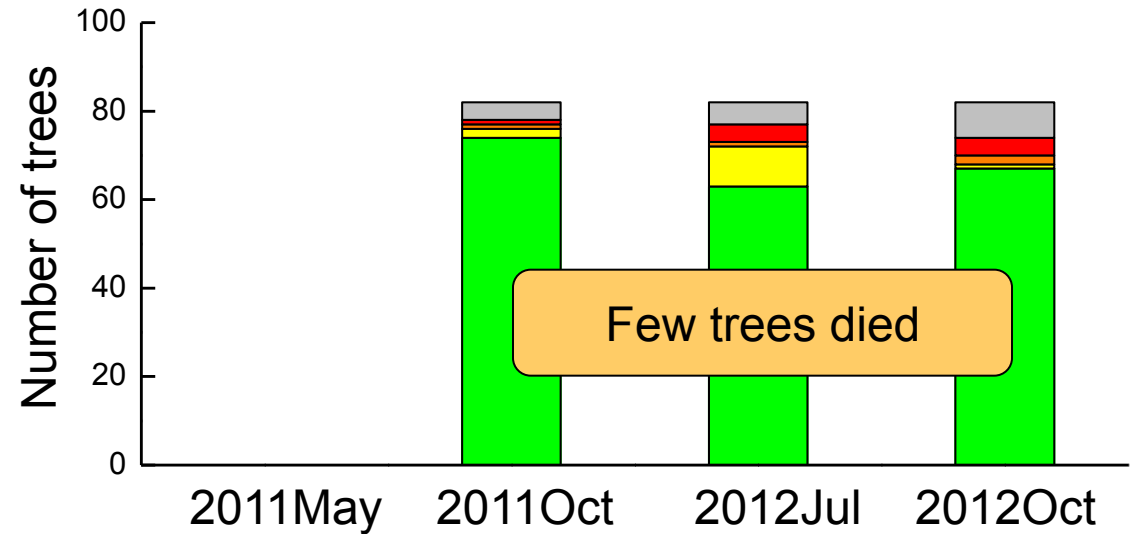
*Backward stand of mature **red pine** (Higashi-matsushima, Miyagi Pref.)*



Backward stand of *black pine* #1 (Hachinohe, Aomori Pref.)



Backward stand of *black pine* #2 (Hachinohe, Aomori Pref.)



Weak to seawater inundation?

- ◆ Pine trees accounted for most of the dead trees in tsunami damaged area, BECAUSE most of seacoast forest had been consisted of pine trees exclusively.
- ◆ In many cases, mature *P. thunbergii* trees survived after tsunami disaster.
- ◆ Strongly damaged trees and small shaded trees were prone to die shortly after the tsunami. Ill-drained condition of the soil may have caused death in mature *P. thunbergii* trees.
- ◆ Many of *P. densiflora* trees died in the tsunami flooded area, but the declining process looked slow-advancing.



❖ Skepticism about the competence of pine trees in seacoast forest is based on misunderstanding

✓ root system ✓ vulnerability to seawater inundation

➔ Need to avoid hasty conclusions

❖ Seacoast pine forest had some critical deficits in coping with tsunami disaster

✓ High ground water ✓ drainage ✓ vulnerable red pines

➔ Need to be improved

❖ Optimized use of pine and other tree species should be pursued to provide the seacoast forests with enhanced functionality and robustness

- ❖ Scenic natural landscape usually locates on somewhere with disaster vulnerability
 - ✓ seaside ✓ riverside ✓ cliffs and waterfalls ✓ mountains

➔ Need to consider disaster-preventing function of the landscape

- **Evaluate** functionality in scientific manner
- NOT place **excessive expectation**
- Think about a **multi-layered** disaster-preventing system

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