

ISSN 1644-0722

# **ACTA SCIENTIARUM POLONORUM**

---

Scientific journal (quarterly), issued since 2002,  
whose founder and advocate is the Conference of the Rectors of Universities  
of Life Sciences

## **Silvarum Colendarum Ratio et Industria Lignaria**

Forestry and Wood Technology

18(2) 2019

April – June



Bydgoszcz Kraków Lublin Olsztyn  
Poznań Siedlce Szczecin Warszawa Wrocław

ACTA Scientiarum Polonorum Silvarum Colendarum Ratio et Industria Lignaria was founded by all Polish Agricultural Universities in 2001 and it is published by Poznań University of Life Sciences Press.

## Honorary Advisory Board of Acta Scientiarum Polonorum

Józef Bieniek (University of Agriculture in Krakow), Barbara Gąsiorowska (Siedlce University of Natural Sciences and Humanities), Wojciech Gilewski (Warsaw University of Life Sciences – SGGW), Janusz Prusiński (UTP University of Science and Technology in Bydgoszcz), Julita Reguła (Poznań University of Life Sciences), Wiesław Skrzypczak (West Pomeranian University of Technology, Szczecin), Krzysztof Szkucik (University of Life Sciences in Lublin), Jerzy Sobota (Wrocław University of Environmental and Life Sciences), Ryszard Żróbek (University of Warmia and Mazury in Olsztyn)

Affiliation

Faculty of Forestry

Poznań University of Life Sciences, Poland



This journal is the open access and non-profit enterprise. The published papers may be collected, read and downloaded free of charge – with Author's rights reserved. We have adopted a Creative Commons licence CC BY-NC (Attribution-NonCommercial).

The papers are published in four issues yearly.

**Covered by: AGRO, Arianta, CABI, EBSCO, Index Copernicus, Google Scholar, PBN Polska Bibliografia Naukowa**

ISSN 1644-0722 (print) ISSN 2450-7997 (online)

Cover design	Daniel Morzyński
Text editor	Lucyna Borowczyk, phone: +48 61 848 7807
Computer typesetting	Stanisław Tuchołka • panbook.pl

© Copyright by Wydawnictwo Uniwersytetu Przyrodniczego w Poznaniu  
Witosa 45, 61-693 Poznań, Poland  
e-mail: [wydawnictwo@up.poznan.pl](mailto:wydawnictwo@up.poznan.pl) <http://www.wydawnictwo.up-poznan.net>

Edition 60 copies. 7.7 publisher's sheets.

Print: Zakład Graficzny Uniwersytetu Przyrodniczego w Poznaniu  
Wojska Polskiego 67, 60-625 Poznań, Poland

# Scientific Board of Acta Scientiarum Polonorum Silvarum Colendarum Ratio et Industria Lignaria

## Editorial Chief

### Andrzej Mazur

*Biodiversity, Ecosystems Valorization*  
Faculty of Forestry  
Poznań University of Life Sciences  
forestry.acta@gmail.com  
andrzejm@up.poznan.pl  
phone: +48 61 848 7676

## Associate Editors

### Marek Wieruszewski

*Wood Sciences, Wood Technology*  
Faculty of Wood Technology  
Poznań University of Life Sciences  
**Poland**  
forestry.acta@gmail.com  
marek.wieruszewski@up.poznan.pl  
phone: +48 61 848 7438

### Robert Kuźmiński

*Plant and Forest Protection,  
Forest Entomology*  
Faculty of Forestry  
Poznań University of Life Sciences  
**Poland**  
forestry.acta@gmail.com  
phone: +48 61 848 7885

### Krzysztof Adamowicz

*Economics, History of Forestry,  
Zoology, Hunting*  
Faculty of Forestry  
Poznań University of Life Sciences  
**Poland**  
e-mail: forestry.acta@gmail.com  
phone: +48 61 848 7688

### Janusz Szmyt

*Silviculture, Forest Botany,  
Forest Management*  
Faculty of Forestry  
Poznań University of Life Sciences  
**Poland**  
forestry.acta@gmail.com  
jszmyt@up.poznan.pl  
phone: +48 61 848 7735

### Jakub Glura

*Coordinator of website, Statistical  
Analysis, Forest Management*  
Faculty of Forestry  
Poznań University of Life Sciences  
**Poland**  
forestry.acta@gmail.com  
jglura@tlen.pl  
phone: +48 61 848 7687

### Catherine Burbridge-Labędzka

*Language Editor*

## Members

### Rudolf Alexandru Derczeni

Transilvania University of Brasov  
**Romania**

### Tatiana Flisikowska

Technische Universität München, Munich  
**Germany**

### Jerzy M. Gutowski

Forest Research Institute, Białowieża  
**Poland**

### Dariusz J. Gwiazdowicz

Poznań University of Life Sciences  
**Poland**

### Jaroslav Holuša

Czech University of Life Sciences, Prague  
**Czech Republic**

### Roman Jaszczak

Poznań University of Life Sciences  
**Poland**

### Nenad Djuro Keca

University of Belgrade  
**Serbia**

### Nikolas G. Kerallieratos

Agricultural University of Athens  
**Greece**

### Jan Klimaszewski

Natural Resources Canada, Canadian  
Forest Service, Laurentian Forestry Centre  
Quebec, **Canada**

### Piotr Łakomy

Poznań University of Life Sciences  
**Poland**

### Piotr Robakowski

Poznań University of Life Sciences  
**Poland**

### Emilia-Adela Salca

Transilvania University of Brasov  
**Romania**

### Kerrie Sendall

Georgia Southern University  
**USA**

### Jerzy R. Starzyk

University of Agriculture  
Kraków, **Poland**

### Koike Takayoshi

Tokyo University of Agriculture  
and Technology  
**Japan**

*Dear Readers,*

*We are very glad to be able to let you have the consecutive issue of ACTA SCIENTIARUM POLONORUM Silvarum Colendarum Ratio et Industria Lignaria, a scientific journal published by all the agricultural universities in Poland. Our journal publishes original scientific papers reviewed by the best specialists in a given field of science. Its high scientific ranking is confirmed by the fact that its name can be found in databases of prestigious indexing institutions. Initially, in years 2002–2006, the journal was published twice a year and since 2007, it has been published as a quarterly. Since 2006 the journal has been published in the English language with summaries and table and figure headings in Polish (for details, please, check Internet web site: [www.acta.media.pl](http://www.acta.media.pl)). Abstracts, key words and summaries of papers can be found on our internet site: [www.forestry.actapol.net](http://www.forestry.actapol.net). We would like to encourage all our Readers to cooperate with our journal and to disseminate it in your professional environment.*

*With our best regards  
The Editorial Staff*

*Szanowni Państwo*

*Przekazujemy Państwu kolejny zeszyt ACTA SCIENTIARUM POLONORUM Silvarum Colendarum Ratio et Industria Lignaria, czasopisma naukowego wydawanego przez wszystkie uczelnie rolnicze. Czasopismo nasze zamieszcza oryginalne prace naukowe, recenzowane przez najlepszych specjalistów w danej dziedzinie. O jego randze naukowej może świadczyć umieszczenie w bazie danych prestiżowych instytucji indeksujących. Początkowo, w latach 2002–2006 czasopismo ukazywało się dwa razy do roku, a od 2007 roku jest publikowane jako kwartalnik. Od 2006 roku jest wydawane w języku angielskim, ze streszczeniami oraz opisami tabel i rycin w języku polskim (szczegóły podano na stronie internetowej [www.acta.media.pl](http://www.acta.media.pl)). Abstrakty, słowa kluczowe i streszczenia prac są umieszczone na stronie internetowej [www.forestry.actapol.net](http://www.forestry.actapol.net). Zachęcamy Państwa do współpracy z naszym czasopismem oraz do jego upowszechniania w swoim środowisku zawodowym.*

*Z poważaniem  
Zespół Redakcyjny*