Portrait of a Coral Reef

Visualizing Changes Over Time in a Coral Reef Ecosystem

Return to Bloody Bay Wall

This project explores and documents changes over time (eleven years) in a fragile Coral Reef ecosystem in one of the world's hotspots of marine biodiversity. Document a large area of an underwater coral reef in a seamless composite image with exceptional resolution and accurate full-spectrum color using a unique digital imaging process.

Create and exhibit via static displays (large scale side by side photos displaying changes over the last decade), electronic visualization, and web-based displays, the photographic results of this project to highlight the changes over time to the reef due to factors like climate change, pollution and invasive species.

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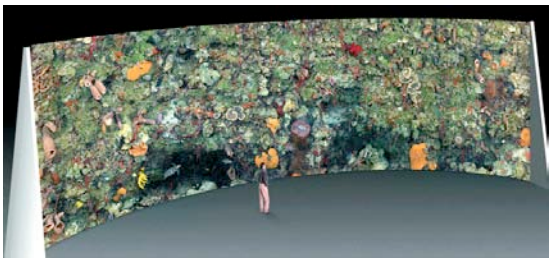
Intel
Little Cayman Beach Resort
Central Caribbean Marine Institute
UCSD Calit2
Jon Witman, Brown University
Ocean Technology Systems
Marine Camera
Seabotix
Underwater Kinetics
Ikelite

Background

"Portrait of a Coral Reef" Completed 1999 - 2000



The primary goal of the original "Portrait of a Coral Reef" project was to produce a life size wide-view image of a coral reef, preserving the full-spectrum color and details necessary to understand life on the reef. The concept was to photograph a large reef area in a sequence of close range images and use digital imaging techniques to assemble them into a seamless high resolution composite image that could be reproduced at actual size. The result was a high resolution image of Great Wall West, a site in an area called "Bloody Bay Wall" on Little Cayman Island in the British West Indies. The 1.77 Gigapixel, produced from over 300 individual images was among the highest resolution images ever produced, and has been displayed in different forms at multiple venues. It is currently on-line in a format that allows viewing the entire reef scene, or zooming and panning for an amazing macro scale detailed view.

http://www.portraitofacoralreef.com/bbw.shtml
http://www.portraitofacoralreef.com/hrgallerygww.shtml

The Great Wall West image was published in National Geographic (October 2001, "Portrait of a Coral Reef") and has received attention from many in the marine science community. The image is an accurate high resolution image of the reef wall and researchers have pointed out that the coverage and resolution of the image is a sufficient sample size to determine the biodiversity in an area, and that images like this can be important to marine science and that if photographed over time can be used to study reef sustainability.

The full resolution Great Wall West image is currently being used as a demonstration tool at UCSD's Calit2 Visualization Group using the HIPerSpace display system. The 286 MegaPixel tiled monitor display is driven by a cluster of Intel multi-core processors.

Project Description

Return to Bloody Bay Wall

This project proposal builds off the “Portrait of a Coral Reef” project, and involves returning to the site previously photographed in 1999, to obtain the images required to produce a new matching image eleven years later. The resulting image would be used to study changes in the reef over a decade time frame, and provides a unique and important baseline for future research.

Display comparison images on Calit2’s HIPerSpace system. The images remain for use in demonstrations and are made available to researchers via Calit2’s network and affiliates.

Public displays at aquariums will show large high resolution prints of the comparison images illustrating changes in the reef over time.

A web-based display of the images and results to promote environmental awareness, and Intel’s work and commitment towards environmental sustainability.

A documentary produced by the Intel team for internal education and promotion of this project will be part of the public display and used internally at Intel.

A short film produced by Compass Light Productions will be distributed to aquariums and museums.

Sponsors

Intel
Project funding, documentary filming of project

Little Cayman Beach Resort / Reef Divers
Lodging, boat support, dive support

Central Caribbean Marine Institute
Research support, evaluation of results

UCSD Calit2
Visualization support, image processing

Jon Witman, Brown University
Research support, evaluation of results

Ocean Technology Systems
Underwater Communications

Marine Camera
Underwater Camera Housings

Seabotix
Thrusters and Motor Controllers

Underwater Kinetics
Undwater lighting and transport cases

Ikelite
Underwater Lighting Support

Project Team

Jim Hellemn, Project Lead
Project organization and planning
Equipment design, assembly and preparation
Photography operations, post production

Gregory Yent, Electrical Engineer and Software Designer
Electronics and software design for camera Platform

Courtney Platt, National Geographic Contract Photographer Photographic assistant / underwater camera operator

Jason Belport, Reef Divers
Onsite support, dive operations leader

Ken Brown, Intel Project Leader
Jeff Caroli, Intel Media Group, Videographer
Dan Sturm, Intel Media Group, Videographer/Editing
Documentary filming of project

Carrie Manfrino, Ph.D. Marine Researcher CCMI
Research support and evaluation of results

Jon Witman, Ph.D. Marine Researcher at Brown University
Research support and evaluation of results

Falko Keuster, Ph.D. Professor for Visualization and Virtual Reality, Calit2 / UCSD
Visualization support, image processing and evaluation of results

Little Cayman Beach Resort / Reef Divers
Lodging, Dive support, Boat Support

Ocean Technology Systems
Underwater communications equipment and support

Central Caribbean Marine Institute
Little Cayman Research Center
Project and research support

HIPerSpace Visualization System

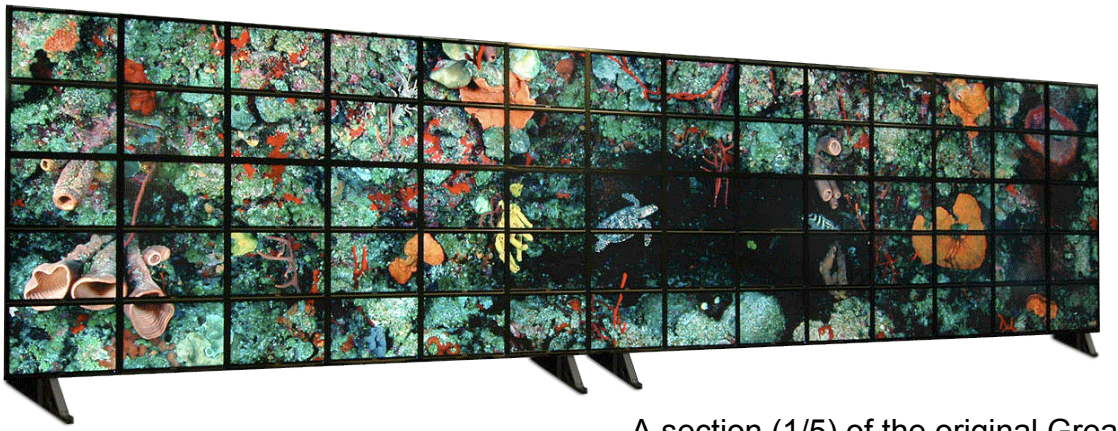
Visualization at Calit2, UCSD

Dr Kuester's team at Calit2 will process the data set and produce the pyramidal file structure required for visualization on the HIPerSpace tiled monitor wall and other systems at Calit2. A matching data set from the original Great Wall West image will be overlaid and compared with the new data using various techniques.

Evaluation of Data

High resolution images of the test data set and matching comparison data from the 1999 image will be posted on a web-site for analysis and evaluation by participating researchers. In addition, the high resolution data can be sent electronically to a number of visualization facilities around the world who run the CGLX software. Researchers will be invited to UCSD to review the data using the Calit2 HIPerSpace wall and other visualization equipment.

The 31.8 x 7.5 foot wall features 70 high-resolution Dell 30" displays, and is powered by 18 Dell XPS 710/720 computers with Intel quad-core CPU's.



A section (1/5) of the original Great Wall West reef image rendered at life size on the HIPerSpace System.

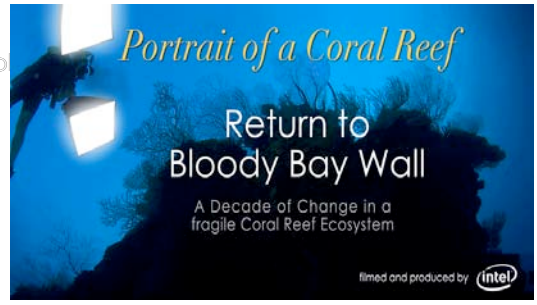
Displays

Public Displays at Aquariums

Ten foot wide high resolution glossy prints showing the original 1999 Great Wall West image displayed alongside the completed project image provides a comparison showing changes in the reef over a decade. An HD monitor displays the video documentary produced by the Intel team.

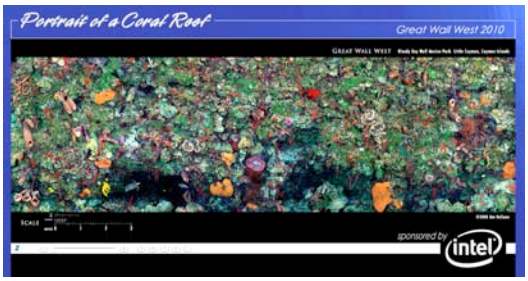
Public Displays at Intel

The exhibition prints will also be on display at various sites on the Intel campus. The documentary produced by the Intel team would be used online, and Intel campus.



Website Sharing Project Information and Images

Project information, results and comparison images will be shared on the web in a website dedicated to the project. The high resolution Great Wall West images will be displayed in a form that allows viewers to zoom and pan within the full resolution image, allowing researchers, students and the public to explore the images at actual size.



Documentary by David Conover

Theater Quality Documentary Film

- Document the project using state of the art RED cameras
- Film interviews with project personnel and researchers
- Document the process of creating the Great Wall West image from the on-site photography through the post-production, visualization and public display of the project results
- Produce a 12-15min film about the project for distribution to aquariums and museums
- Produce a 5 minute trailer to be used to pitch TV science networks for production funding of a full length documentary program

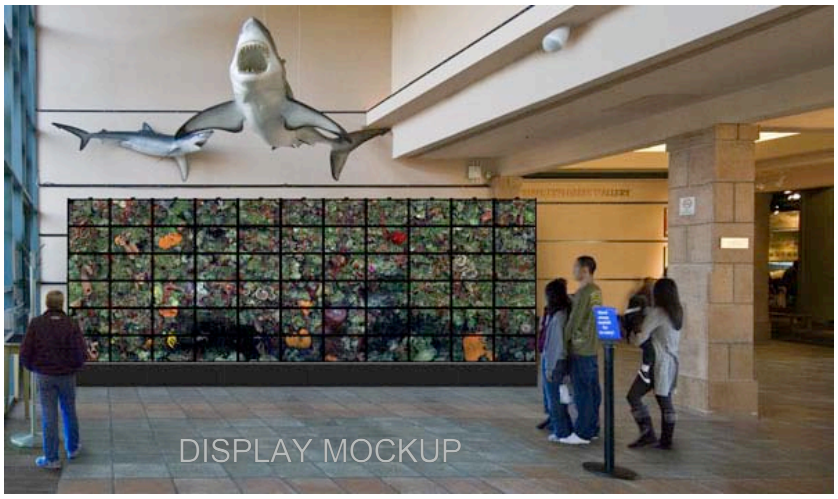
Producer: Compass LIGHT PRODUCTION

David Conover, Filmmaker
Compass Light Productions
Jordy Klein, Underwater Filmography

Follow-on Effort *(requiring additional funding)*

Tiled Monitor Display

Public Display using Calit2's HIPerSpace System



- Work with Calit2 to produce a dynamic presentation of the project imagery and comparison data using the HIPerSpace tiled wall display system and CGLX software.
- Present the exhibit to the public at aquariums using existing Calit2 display components.
- Explore the possibility of producing a traveling exhibit with sponsorship from a variety of sources.

Project Timetable

	Description	Start Date to Completion Date
Phase 1 *Preparation*	Prepare equipment Assemble and test camera platform Ocean test in Little Cayman	July 1 - August 10, 2010
Phase 2 *Photography*	On-site Photography at Reef 18 days,10 dive days	August 14 - September 1, 2010
Phase 3 *Processing*	1-2 Minute Video Project Brief Post-processing of composite image Review of results at Calit2 5 min - 30 min Video Documentary	September 1 - 30 September 7 - October 30, 2010 Q4 2010 Q4 2010
Phase 4 *Display*	Public Display Aquariums Image Display at UCSD Web Display Video Displayed onsite at Intel David Conover Film	Q4 2010 Q4 2010 Q4 2010 2011

Background - Getting the Big Picture

Helping Researchers Study Coral Reefs by Overcoming Limitations in Underwater Photography

Large area images with accurate high resolution data allow researchers to study an area as a whole. Sufficient resolution and a large coverage area enables researchers to determine biodiversity in an area from a single image. This becomes especially valuable when comparing images of the same area taken at intervals of several years.

- Conventional underwater photography is severely limited in camera to subject distance. Image quality and light transmission degrades rapidly at subject distances beyond 3.5 feet in typical mid-depth ocean conditions. At subject distances over 4-6 feet, images lose detail and most of the color spectrum.
- The necessity for close range imaging means that researchers must study hundreds of images, typically obtained using a quadrapod for detailed studies of coral reef environments.
- It's difficult to visualize and display what coral reefs really look like because of the limitations in underwater photography.
- Use of digital imaging techniques to create composites of close-up imagery overcomes limitations of conventional underwater photography and allows large areas to be photographed while preserving the true color and detail.
- Large area images with accurate high resolution data allow researchers to study an area as a whole. This becomes especially valuable when comparing images of the same area taken at intervals of several years.
- Use of emerging visualization technology allows large reef sections to be examined as a whole and easily compared to other data using the same baseline as well as other reef images and data sets.

Portrait of a Coral Reef video:

http://www.youtube.com/watch?v=cSuVen9_164

Jim Hellemn

San Diego based photographer Jim Hellemn has been involved in photography for over 25 years, ranging from commercial studio photography to scientific applications using high-speed cameras and laser imaging systems. An advanced diver with over 2000 dives, he discovered scuba diving and underwater photography in the mid 1980s and quickly became passionate about the ocean and environmental conservation.

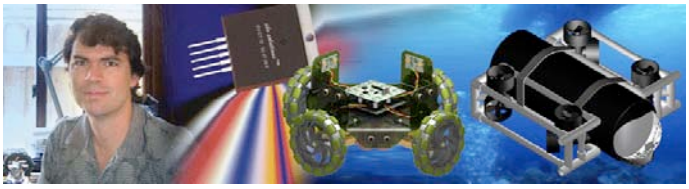
Hellemn founded Photographix in 1994 to explore digital photography and image processing, contracting work processing image data from laser and sonar systems and producing detailed mosaics. He began to experiment with underwater lighting and composite images, leading to his first “Portrait of a Coral Reef” project focused on creating a large mosaic image of Great Wall West, a vertical coral reef wall located at “Bloody Bay Wall” marine park in the Cayman Islands. At the time of it’s completion in December 1999, the Great Wall West image was perhaps the largest non-scientific image in existence at 1.77 Gigapixels. The image appeared in National Geographic (October 2001, “Portrait of a Coral Reef”). Hellemn returned to Bloody Bay Wall to make a new image at Great Wall East in 2003.

Hellemn has produced several more extreme resolution Coral Reef images in the Caribbean, Sulu Sea and Celebes Sea. His current work focuses on creating landscape images of coral reefs in the “hotspots of marine biodiversity” around the world, identified by researchers as the most important marine areas for biodiversity and endangerment.

He recently completed a commissioned mosaic image that covers a five story high wall of the Camana Bay Observation Tower in Grand Cayman.

www.portraitofacoralreef.com

Greg Yent



Greg Yent is an Electrical Engineer and Software Developer with a strong physics and mathematics background and over 20 years of experience in microcontroller design and robotics using state-of-art controller electronics and software.

In the early nineties, Greg was a crucial part of the Westinghouse Underwater Laser System development team, designing the scan motor and control electronics for advanced underwater laser imaging systems using fan scan and line scan technology. His company IDV Solutions developed intelligent NiMH battery charging systems for the OEM market using microcontroller technologies.

For the past year, Greg has been working with Jim Hellemn to develop a stabilized camera platform using emerging technology. The current system is comprised of of a motor control circuit for 4 independent dc motors running from a DSP chip. The circuitry has feedback from a 6DOF (degrees of freedom) IMU (inertia management unit) consisting of three axis accelerometer and 3 axis gyroscope. The z-axis also has feedback from a depth sensor. In addition to the IMU, a 3D camera based software routine visually calculates rotation and translation, the signal from these two systems are then sent to the DSP. The DSP software takes the input parameters and calculates a solution to stabilize the platform in x,y,z as well as pitch,roll,yaw. Further developments will enable the system to translate camera position frame to frame using visual information.

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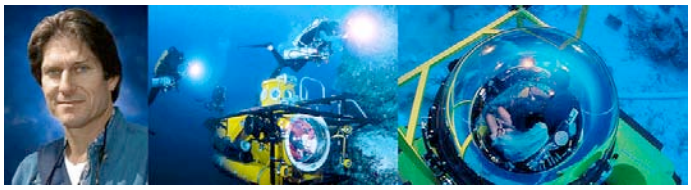
Courtney Platt



Courtney Platt is a professional photographer living in the Cayman Islands since 1983 and an extremely talented underwater photographer with 33 years of experience. Mr. Platt taught scuba in the 80's and has mixed gas, rebreather and deep diving experience. In addition to his experience as a diver and underwater photographer, Platt piloted over 2,500 dives in deep diving submersibles in Grand Cayman. He has photographed 8 assignments for National Geographic Magazine including "Down the Cayman Wall" which appeared in the Nov., 1988 issue. His academic background in marine biology coupled with thousands of scuba dives is yet another asset.

In 2003, Platt assisted in the Portrait of a Coral Reef project to photograph Great Wall East as well as other collaborations with Jim Hellemn.

Jason Belport

Jason Belport is a dive industry professional with over 20 years of experience in dive training, underwater photography and operations management. Jason's strong relationship with the ocean developed at an early age, receiving his scuba certification at the age of 12. His diving career and interest in underwater photography began in 1982 in the kelp forests of LaJolla and California's Channel Islands. While earning his degree at San Diego State University he worked for a local dive operation, earning his professional dive training credentials and gaining valuable experience in the dive industry. Intending to take "some time off" after college, Jason took a job as a Dive Instructor and Boat Captain at a small island resort in Cayman Brac. Over the years he built a following for his expertise and professionalism, becoming a sought-after dive guide for elite underwater photographers and recreational divers alike, and eventually managing the Reef Divers operation.

In 2007 Jason received the SSI Platinum Pro award for 5000 successful career dives. As an underwater photographer, Jason's photographs have been displayed throughout the islands and appeared in numerous publications and advertisements. One of Jason's most beautiful underwater scenes was used as the central element in Jim Hellemn's 72ft high coral reef mosaic at Camana Bay in Grand Cayman.

Currently Jason is the general manager of Little Cayman Beach Resort, with overall responsibility for day to day operations of the resort on Little Cayman and the Reef Divers operation on two islands with a fleet of nine state of the art dive vessels.

Carrie Manfrino, Ph.D.

Dr. Carrie Manfrino is a marine researcher at Kean University.

Oceanographer Carrie Manfrino is the President of the Central Caribbean Marine Institute and is an Associate Professor of Oceanography at Kean University and visiting Associate Professor at Rutgers University Institute of Marine and Coastal Sciences. Her Ph.D. was granted by the University of Miami's Rosenstiel School of Marine and Atmospheric Science in Marine Geology and Geophysics. Dr. Manfrino's research has focused on understanding what drives the development and evolution of the coral reef system and on understanding the dynamics responsible for maintaining resilience and natural variability in coral communities. Communicating research results through special publications and popular articles to create social change and increase conservation is a significant component of her work.

Dr. Manfrino's team of marine scientists completed the first and largest regional expedition to understand the distribution and structure of the reef communities around all three Cayman Islands as well as the Turks and Caicos Islands . This study continues to provide a reference for current and future research.

Dr. Manfrino founded the Central Caribbean Marine Institute (CCMI in 1998, which is guided guided by its mission to conduct and facilitate research, education, conservation and outreach that will sustain marine diversity for future generations. The organization is incorporated as a US 501(c)3 non-profit organization (ID# 22-3609293), a UK charity (# 1104009) and a Cayman Islands charity. From its inception, CCMI has proven a valuable asset in the effort to understand changing coral reef and tropical marine environments. CCMI programs provide a solid foundation for education and awareness for students and researchers both in the Caribbean and around the world.

In 2006, CCMI opened the Little Cayman Research Center (LCRC) on Little Cayman Island near Bloody Bay Wall to serve as a field education and research station, with labs, a classroom, and dormitory-style or private-room living accommodations to support researchers and students.

Jon Witman, Ph.D.

Dr. John Witman is a marine researcher at Brown University.

Growing up near the broad horizon of the ocean undoubtedly influenced my interest in large-scale marine ecology. I was trained in marine benthic ecology as a high school student at Sandy Hook Marine Lab, NJ. Studying the impacts of sewage and dredge spoil dumping on offshore marine life impressed upon me the need to mitigate anthropogenic impacts on the ocean. As an undergraduate, I was fortunate to conduct a year long independent study of animal-sediment relations in a New Zealand estuary. This experience taught me how to do science and it helped develop my world view of ecology and sense of belonging to a global human community. I spent another year and a half in the South Pacific, working my way through the Fiji and New Hebrides Islands to see pristine coral reefs before they were altered by human disturbance. I began to learn the spectacularly diverse marine invertebrate fauna of the western Pacific during this time, which helped enormously when I began a global biodiversity study nearly two decades later.

I re-entered the academic community at the University of New Hampshire. Excited about the opportunities in marine community ecology, I went straight through for a PhD with Larry Harris. A post-doc at Northeastern University's Marine Science Center with Ken Sebens led to my first faculty position. I helped develop the East West Marine Biology Program there and enjoyed teaching marine benthic ecology in Nahant and coral reef ecology in Jamaica. I am deeply committed to training the next generation of ecologists and to developing the best marine conservation science. I moved to Brown University in 1994. I have been fortunate to conduct research in six out of seven oceans of the world.

Falko Kuester, Ph.D.

Dr. Falko Kuester specializes in scientific visualization and virtual reality, with emphasis on collaborative workspaces, multi-modal interfaces, and distributed and remote visualization of large data sets.

Dr. Kuester obtained an M.S.E. degree in mechanical engineering in 1994 from the University of Michigan, and a year later received another M.S.E. degree from Michigan in computer science and engineering. From 1996 to 1999 he was a senior software engineer at Integrated Systems in Sunnyvale, CA. He received a Ph.D. from UC Davis in 2001 and joined the faculty at UC Irvine as an assistant professor in 2001, where he was thrust leader for Computer Graphics and Visualization at the Irvine division of the California Institute for Telecommunications and Information Technology (Calit2). He is the director of the Calit2 Center of GRAVITY (Graphics, Visualization and Imaging Technology) and a founding member of the Transdisciplinary Imaging Genetics Center (TIGC). He joined the faculty of UCSD in 2006.

Dr. Kuester's research interests include tera-scale scientific visualization and virtual reality, image-based modeling and rendering, as well as distributed and remote visualization. His research efforts are aimed at creating intuitive, high-resolution virtual environments, providing engineers and scientists with a means to intuitively explore and analyze massive and complex, higher-dimensional datasets. In this context, his focus is on developing new methods for the acquisition, compression, streaming, synchronization and visualization of data. He applies these techniques to research challenges posed by distributed virtual environments and their application to earth system science, earthquake engineering, biomedical engineering and medicine. Dr. Kuester has been active in virtual reality research for over a decade and the stringent VR requirements have served as important performance criteria for his large-scale distributed data analysis and visualization projects. He is also active in research and development of digitally enabled workspaces that support distributed, collaborative and pervasive office of the future and classroom of the future environments. Other application areas of his research include simulation-based design, rapid prototyping, computational fluid dynamics, command and control and forensic analysis.

Dr. Kuesters's HIPerSpace tiled display wall is the next generation concept for ultra-high resolution distributed display systems that can scale into the billions of pixels, providing unprecedented high-capacity visualization capabilities to experimental and theoretical researchers. HIPerSpace has held the distinction of the "World's Highest Resolution Display" since it was first introduced in 2006, taking the top spot previously held by his previous project HiPerWall , which held it since 2005. HIPerSpace is powered by CGLX our cluster graphics library, enabling the development of massively scalable visualizations. Other members of Kuester's team include Kevin Ponto, So Yamaoka, Kai-Uwe Doerr and Joseph Keefe from Calit2's visualization group.

David Conover

David Conover is an American documentary film and television director. His production company, Compass Light, based in Camden, Maine, produces Sunrise Earth for Discovery HD Theater.

David Conover was born and raised in a New England family with strong ties to the sea and a tradition of active storytelling. Both grandfathers were amateur filmmakers in the 1920's and 30's. Upon graduating with a degree in comparative religious studies from Bowdoin College in Maine, David worked as a professional seaman – he has extensive experience in the Atlantic and Pacific, which includes two transatlantic crossings in small boats. He spent five years designing and teaching sea courses for kids age 14-18 at the Hurricane Island Outward Bound School in Maine and in Florida. This was followed by a Master's Degree in Education at Harvard, where David studied moral development and then a second year as a Kennedy School teaching fellow in leadership studies. In 1987, he directed and produced his first documentary, OUTWARD BOUND, which aired on National Geographic Explorer.

David's subsequent early film experiences took him to a river in Kamchatka on a project for Channel 4/PBS, and he also worked on a film about measuring Mt. Everest for PBS NOVA. An additional early project for PBS NOVA introduced him to the changing commercial fisheries, an interest he maintains to this day. His relationship with PBS programming continued with a six-show stint as a producer on the outdoor how-to series TRAILSIDE.

COMPASS LIGHT grew out of David's early work mentioned above, and the studios were moved to the seaport of Camden, Maine in 1994 in order to be closer to the ocean and the stories being produced. The company has now produced over 80 films for broadcast and educational clients. Awards include the National Outdoor Production Award, a Blue Ribbon by the National Educational Media Competition, and a nomination for a National Emmy as Outstanding Director. For several years David also taught documentary film courses at the International Film and Television Workshops in Rockport, Maine. In 2007, David co-founded BlueMarvel in Rockland, Maine, an aggregator and distributor of the EXPERIENTIAL TV format.

Endorsements

"In the big scheme of things, we humans are still relative newcomers to the wonders of what is happening under the surface of our planet's seas. Mostly ALL the spectacular imagery of that part of the world has been captured within the lifetime of today's middle-aged adult. Not too long ago, observers of the sea as varied as Joseph Conrad and Rachel Carson described the sea as 'eternal and unchanging.' This understanding has only recently been seen as naïve and first-generation. In fact, the sea changes enormously. Why has it been so difficult to understand this? The challenge of seeing the wide picture of sea change over time. Alongside the gorgeous beauty of Jim Hellemn team's past high-resolution work, we now add this benchmark opportunity for second-generation understanding. He pulled it off once. The work will only get richer, better, more compelling here on out."

"I heartily endorse Jim's 'Portrait of a Coral Reef' project and look forward to helping him carry it's significance to a broad international television viewership. Through our morning series SUNRISE EARTH, we've been fortunate enough to give a little extra meaning to dawn, for over 40 million viewers around the world each morning. Our narrative programming about the world's oceans for PBS NOVA, DISCOVERY, and NATIONAL GEOGRAPHIC has helped do a little of the same for the seas. I think that programmers in the global broadcast community are now hungry for the second generation view of underwater life, a wide AND long-term story of life underwater. Beyond that forum, I believe the sensibility demonstrated in Jim's work has intrinsic value for solving many of humanity's other challenges today. So go for it!" *David Conover*

Jon Witman, Ph.D.
marine researcher at Brown University

Falko Kuester, Ph.D.
professor for Visualization and Virtual Reality, Calit2 / UCSD

David Conover
Filmmaker, Compass Light Productions

Emory Kristof
National Geographic Photographer, Ocean Explorer